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**POTENTIAL FOR E-REPORTING AND E-MONITORING IN THE WESTERN AND
CENTRAL PACIFIC TUNA FISHERIES**

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1. There are 4 Objectives specified in the report.
 - 1 Develop a common understanding and language of what e-reporting and e-monitoring will mean in the WCPFC
 - 2 Document and evaluate current and future e-reporting technologies that are potentially suitable for collecting information in the WCPFC tuna fisheries, and recommend the best potential options for WCPFC tuna fisheries.
 - 3 Document and evaluate current and future e-monitoring technologies that are potentially suitable for WCPFC tuna fisheries; and
 - 4 Propose recommendations for practical and efficient framework of e-reporting and e-monitoring in the WCPFC fisheries to guide discussions of a dedicated small working group.

Note that globally through the GEF process that additional trials of this technology will take place in Fiji and Ghana;

2. There are 32 Recommendations and 5 Strategic recommendations in this report. The WCPFC 10 should focus initially in the 5 Strategic recommendations.

The 5 Strategic recommendations are :

1. Implement both E-Reporting and E-Monitoring programs without delay.
2. Adopt an approach of developing standards, specifications, and certification procedures for both E-Reporting and E-Monitoring, against which any provider can seek to be certified, in preference to seeking a single provider.
3. The implementation of E-Reporting should be undertaken in a phased approach determined by technical feasibility, and practical considerations and constraints..
4. E-Monitoring be formally recognized and adopted as a legitimate, appropriate and acceptable monitoring tool as both an alternate to human observer programs and a supplement to observer programs, for certain WCPO tuna fisheries.
5. Implement separate but parallel processes to move E-Reporting and E-Monitoring technologies forward towards implementation.

It is recommended that WCPFC10:

- 1 Discuss and agree as appropriate the 5 Strategic recommendations in the Consultant's report.

2 If these strategic recommendations are agreed, determine a process to move these issues forward within the Commission and this may include the establishment of a small working group that includes both members and Secretariat staff to progress this issue, with the small working group to be responsible to the WCPFC but that it also report its develops and findings to SC and TCC so that holistic and well-reasoned approaches come to WCPFC for approval or discussion;

3 If Strategic recommendation 3 is agreed then determine a timeframe for progressing this priority in the Commission; and

4 Identifies a suitable budget to continue and implement these initiatives within the WCPFC.

Potential for E-Reporting and E-Monitoring in the Western and Central Pacific Tuna Fisheries



Steve Dunn and Ian Knuckey

2013



SPC
Secretariat
of the Pacific
Community



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Steve Dunn and Ian Knuckey

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Title: Potential for E-Reporting and E-Monitoring in the Western and Central Pacific Tuna Fisheries

Authors: Steve Dunn¹ and Ian Knuckey²

¹ IC Independent Consulting
82 Hilder St Weston ACT 2611
steve.dunn@icic.net.au
www.icic.net.au

² Fishwell Consulting Pty Ltd
27 Hesse St Queenscliff VIC 3225
ian@fishwell.com.au
www.fishwell.com.au

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Executive Summary

This report defines E-Reporting and E-Monitoring, and documents products and programs involving both. It makes recommendations about what the Commission, regional organisations, and Commission members should be doing next. The project has involved discussions and consultations with a wide range of stakeholders including flag States, coastal States, fishing companies, and technology and solution providers (Appendix 8).

Those responsible for fisheries management are becoming increasingly dependent upon electronic solutions for information management. These solutions have continued to evolve to the point where computers and tablets can be used to capture fishery data through electronic logsheets, observer reports, and offload records; cameras can record fishing activity and catch, and sensors can report on winch, drum, hydraulic system pressure, and engine activity. Geo-fences can be readily set up to report EEZ transits, and protected area incursions. Data can be transmitted in near real time, or stored for retrieval at a later date.

E-Reporting and E-Monitoring both involve electronic technology; they are interwoven through logistics, communication demands, and the need for effective information management, but distinguished by their specific purpose and goals. For the purpose of this report the following definitions have been developed:

E-Reporting is generally considered to be “*open system*” because manual inputs are required and accepted, for example from skippers and observers. Examples of E-Reporting include electronic entry and transmission of catch logsheets, observer reports, transshipment reports, and offload records. E-Reporting provides the opportunity for real time reporting of critical information through satellite transmission or mobile networks, as well as to store data for download at the end of a trip.

E-Monitoring is generally considered to be “*closed system*” because it does not accept external or manual input that impacts on its core functionality. It relies on automated operations, and sealed and tamper-evident equipment. The most common example of E-Monitoring is a Vessel Monitoring System (VMS), where GPS position and time data are collected automatically, and securely transmitted at prescribed intervals to relevant agencies.

This project reviewed E-Reporting technology revealing an abundance of products and worldwide adoption of this technology in both large and small fisheries. The ability to record catch and effort logbook data and observer information with simple-to-use software loaded on computers or other purpose-built hardware is well established. E-Reporting brings improved data quality through ease-of-use tools such as drop-down boxes, data input checking, and the automatic capture of GPS data. E-Reporting is revolutionizing fisheries information in terms of timeliness, convenience, efficiency, and quality, as well as driving down total cost. There are now no barriers to implementation of electronic logsheets in developed countries, and no insurmountable barriers in developing countries. The capacity

to transmit data in near real time provides a range of further opportunities for research, compliance and management.

The review of E-Monitoring products and programs shows a worldwide adoption of VMS technology, but only very limited adoption of video, sensor, and other systems. There is a steady adoption of enhanced mobile transmission units (E-MTU) on VMS which enables the use of VMS communication channels for other purposes. Whilst the definitions for E-Monitoring are broad, and other technologies are mentioned, this project has ultimately confined itself to consideration of E-Monitoring using video and sensors, and E-Monitoring using just sensors. The use of the terms E-Monitoring or E-M in this report should therefore be read narrowly, with that in mind. Technologies such as VMS are already well established, and other technologies were not sufficiently advanced or significant enough to distract us from the principle E-Monitoring technologies under scrutiny.

There is significant potential for video and sensor systems to improve the quality of fisheries information, and to support science and compliance in the Western and Central Pacific Ocean (WCPO). This technology can go where observers cannot, can supplement human observer programs, can underpin management objectives, provide a wealth of data in support of stock assessment and other scientific programs, and can support regulatory and enforcement programs.

There are barriers to implementation of this technology including politics, bureaucratic change, cost, human capacity, logistics, and geographical remoteness. But none of these are insurmountable.

Video and sensor technology are in common use in other environments. We see it every day in the street, in workplaces, and on public transport. But it has not developed in the fisheries sector to the point it can be considered mainstream. There are only a handful of hardware and software providers focussed on the fisheries sector and just four we have identified who have implemented E-Monitoring with video and E-Monitoring with sensor programs to meet regulatory requirements in a fishery.

The progress the Commission makes in implementing E-Reporting and E-Monitoring solutions will depend on undertaking a comprehensive preparatory and planning process, and consideration of a number of key factors. These include the regulatory framework, an effective approach to the development of standards, specifications and type approvals, the benefits to stakeholders in terms of cost and efficiency, the preparedness to invest time and money, and effective collaboration at all levels, in particular the involvement of industry. It will be challenging and the implementation project will need to be properly resourced.

This report has determined:

- E-Reporting will offer significant benefits to improving both the quality and timeliness of fisheries data, and should be implemented without delay across all fisheries with

significant adoption anticipated within five years. E-Reporting is a critical step towards improving the science and compliance upon which the tuna fisheries depend.

- The use of video and associated sensor monitoring systems is a feasible option to monitor the Commission's Conservation and Management Measures (CMMs). Such technology should be progressively rolled out based on a comprehensive program design phase, which would see staged implementation over a ten year timeframe. Its use should initially be focussed on vessels where observers are not deployed to an adequate level (e.g. longline, pole and line, and carrier vessels), and should further be considered for purse seine vessels operating at certain times and in certain places (e.g. during FAD closures or when risks of interactions with threatened, endangered and protected TEPs are deemed likely).

This report does not recommend any particular hardware or software for either E-Reporting or E-Monitoring. Rather, we recommend the development of standards, specifications, type approvals, and certification as a key basis of the proposed framework. If these processes are done well, the market will respond and the widely available products will be introduced into the fishery.

This report recommends the establishment of E-Project Working Groups (EWGs) for each technology, under the guidance of an Internal Governance Committee. Technical experts and technology providers must be involved in this process. The two technologies are at quite different stages in terms of their development and implementation, and in many ways operate exclusively. They are not the same, they have different requirements, and separate programs should be established for each. Further, given their different stages of development, we believe that including them under a single program would hold back the implementation of E-Reporting.

To make progress with the implementation of E-Reporting and E-Monitoring, the report recommends that the Commission Secretariat lead a substantial part of the implementation process. We also envisage leadership roles will be essential for the Secretariat to the Pacific Community (SPC) with respect to E-Reporting, and for the Pacific Islands Forum Fisheries Agency (FFA) in terms of E-Monitoring.

There are a number of areas of preparation that need to occur prior to any coordinated implementation of either E-Reporting or E-Monitoring. The development of the standards, specifications and type approval process is a critical first step for both technologies, and the process to progress this phase needs to commence as a first order priority. Also, a more detailed and comprehensive analysis of the costs/benefits of implementation needs to be undertaken at the CCM level. Further, and also at the CCM level, there must be a full review of both national and regional legislation to ensure the transition to E-Reporting and E-Monitoring meets all legal obligations and requirements.

Finally, it's important that Pacific Island countries understand that whilst the review recommends a common approach to standards and specifications, and a coordinated approach to implementation, within their jurisdictions, these programs will be under their control.

Strategic Recommendations

Strategic Recommendation 1: To improve quality and timeliness of the data available for science, compliance, and management, to enhance and streamline reporting obligations, and to provide an additional means of effective observer monitoring, this report recommends the Commission, its members, and its partner regional organisation within the WCPO implement both E-Reporting and E-Monitoring programs without delay..... 30

Strategic Recommendation 2: The Commission should adopt an approach of developing standards, specifications, and certification procedures for both E-Reporting and E-Monitoring, against which any provider can seek to be certified, in preference to seeking a single provider. 31

Strategic Recommendation 3: The implementation of E-Reporting for logsheets, observer reports, and CMMs should be undertaken in a phased approach determined by technical feasibility, and practical considerations and constraints. The process for development of E-Reporting standards, specifications and type approvals should be led by the Commission Secretariat as amongst the first and high priority actions..... 44

Strategic Recommendation 4: E-Monitoring be formally recognised and adopted as a legitimate, appropriate and acceptable monitoring tool as both an alternate to human observer programs and a supplement to observer programs, for certain WCPO tuna fisheries. The process for development of E-M standards, specifications and type approvals should be led by the Commission Secretariat as a priority and E-M should be progressively rolled out to support compliance with Commission’s CMMs, improve fishing practices, and increase fisheries knowledge. The use of E-M using sensors alone should be considered as appropriate, based on fishery monitoring goals..... 45

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Recommendation 24: The EWGs comprise a maximum of eight country members with nominations for members with relevant technical skills to be provided to the Commission Secretariat by 31 January 2014.....53

Recommendation 25: The Commission Chair in consultation with the Secretariat appoints independent IWG chairs.53

Recommendation 26: The Secretariat establishes an Internal Governance Committee (IGC) chaired by the Compliance Manager, and with three members.53

Recommendation 27: Project managers should be procured either through engagement of suitably experienced contractors known to the Secretariat, or as a potential secondment from a CCM agency, or as a secondment from FFA or SPC.....55

Recommendation 28: The Commission Secretariat should facilitate E-M demonstration trials and develop a broad communication strategy.55

Recommendation 29: The Commission Secretariat should develop IWG terms of reference based on relevant decisions of the Commission concerning this report, and including the program of meetings.55

Recommendation 30: Planning workshops involving full CCM participation should be held immediately in advance of an initial joint meeting of IWGs.56

Recommendation 31: A detailed study of costs and benefits, as well as the potential impacts on regional employment would be useful projects should resources permit.....64

Recommendation 32: The development of model fisheries legislation, with a focus on supporting Pacific Island Countries, be developed by the Commission Secretariat.66

1. Introduction

The Western and Central Pacific Fisheries Commission (WCPFC/the Commission) was established under the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (the Convention). The Convention draws on many of the provisions of the UN Fish Stocks Agreement (UNFSA), whilst reflecting the special political, socio-economic, geographical and environmental characteristics of the region.

The Convention seeks to address problems in the management of high seas fisheries in its area of competence resulting from unregulated fishing, over-capitalization, excessive fleet capacity, vessel re-flagging to escape controls, insufficiently selective fishing gear, unreliable databases, and insufficient multilateral cooperation in respect to conservation and management of highly migratory fish stocks.

The Commission's members are Australia, China, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Republic of Korea, Republic of Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America, and Vanuatu. The Commission supports three subsidiary bodies that each meets annually: the Scientific Committee; Technical and Compliance Committee; and the Northern Committee.

The Secretariat of the Pacific Community (SPC) is the Pacific Island region's principal technical and scientific organization, delivering technical, scientific, research, policy and training support to its 22 Pacific Island country and territory members. The Oceanic Fisheries Programme (OFP) is part of the Fisheries, Aquaculture and Marine Ecosystems Division of SPC, and is the Pacific Community's regional centre for tuna fisheries research, fishery monitoring, stock assessment and data management. The WCPFC is responsible for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean.

The Pacific Islands Forum Fishery Agency (FFA) has a key role in strengthening national capacity and regional solidarity to support its 17 members to manage, control and develop their tuna fisheries. The FFA plays a lead role in E-Monitoring through its administration of the largest VMS program in the region, covering about 1500 vessels operating over some 30 million square miles

Globally, a great deal of effort is going into the development of E-Reporting and E-Monitoring systems. This is recognised by the Commission, the SPC, and the FFA, and in particular, that the use of E-Reporting and E-Monitoring technology can improve knowledge, efficiency, quality, timeliness, with long-term positive cost benefits. These benefits have seen E-Reporting and E-Monitoring become increasingly popular and in demand from fishing companies, and fisheries management organisations. Given this, the Commission

membership has a common interest in investigating the potential for E-Reporting and E-Monitoring in the region's tuna fisheries.

The consultants engaged to undertake this project are Dr Ian Knuckey and Mr Steve Dunn. Dr Knuckey is a fisheries scientist with extensive experience in research and stock assessment. He has been involved in the development, trial and successful implementation of E-Reporting systems. Mr Steve Dunn is a former senior public servant in Australian state fishery and maritime agencies, and a former Deputy Director General of the FFA. In his current role as an independent consultant he is involved in the implementation of E-Monitoring for the Australian tuna longline fleet.

2. Project Objectives

Objective 1: Develop a common understanding and language of what E-Reporting and E-Monitoring will mean in the WCPFC tuna fisheries.

Objective 2: Document and evaluate current and future E-Reporting technologies that are potentially suitable for collecting information in the WCPFC tuna fisheries, and recommend the best potential options for WCPFC tuna fisheries.

Objective 3: Document and evaluate current and future E-Monitoring technologies that are potentially suitable for WCPFC tuna fisheries.

Objective 4: Propose recommendations for the most practical and efficient framework of E-Reporting and E-Monitoring in the WCPFC Fisheries to guide discussions of a dedicated small working group.

3. Definition of E-Reporting and E-Monitoring

For the purposes of this report the following definitions have been developed:

E-Reporting

Electronic reporting is the combination of hardware and software for recording and transmission of fisheries data. Although there may be some aspects of E-Reporting that are automatically recorded (e.g. position, date and time from GPS), it is generally considered an "open system" that can accept various manual inputs from skippers, observers, port measurers etc. Examples of where E-Reporting has been introduced globally include catch and effort logbooks (catch, species composition, fishing effort, bycatch, discards, area of operations, etc), on-board data collection by scientific observers of target, non-target species, biological and length frequency measurements of the catch, and survey reports. All this information needs to be collected in a formal manner and meet the management and scientific needs of the fishery.

- E-Reporting is generally considered to be “**open system**” because manual inputs are required and accepted, for example from skippers and observers
- Examples of E-Reporting include catch logsheets, observer reports, transshipment reports, and port sampling records
- E-Reporting provides the opportunity to store data for download at the end of a trip, as well as for real time reporting of critical information through satellite transmission or mobile networks

E-Monitoring

E-Monitoring is a combination of hardware and software that collects and transmits fisheries information in an automated manner that is closed to external or manual input. Because it is an automated operation confined within a “closed system”, E-Monitoring data is a significant tool for compliance purposes. Vessel Monitoring Systems (VMS) are a well known example of an E-Monitoring system: time and position data is collected automatically via GPS into tamper-evident hardware on the boat that securely transmits this information automatically to the relevant agency. There is generally no manual data input or external data manipulation throughout an E-Monitoring process. The use of video, electronic and hydraulic sensors, vessel Automatic Identification Systems (AIS), and satellite tracking of fish aggregating devices (FADS) are other examples of E-Monitoring. Within this definition the term Asset Tracking System (ATS) is being used to describe a grouping of E-Monitoring services including FAD tracking, vessel monitoring, observations of fleet support vessels, and tracking of human observers.

- E-Monitoring is generally considered to be “**closed system**” because it does not accept external or manual input
- A commonly used example of E-Monitoring is a Vessel Monitoring System (VMS), where GPS position and time data are collected automatically, and securely transmitted at prescribed intervals to relevant agencies
- There is generally no manual data input or external data manipulation throughout an E-Monitoring process

4. Current Situation

Data collection – paper-based

Nearly all WCPO fisheries information is entered manually into a range of paper logbooks and reporting forms. The range of forms is documented in SPC (2011) and can be broadly categorised as: Catch and Effort; Observer; Unloading and port sampling; Artisanal; and Other (e.g. game fishing, fishing trip, port visit, FAD, MCS).

Logsheets

Catch and effort logsheets are initially filled out by the skipper or another ship’s officer. Most companies like to receive at least daily reports of the catch obtained by their vessels.

To achieve this, one of the ship's officers will use a range of media to transfer this information, depending on the vessel capabilities and position relative to transmission networks. The simplest and cheapest method of transfer is through the use of VHF or HF radio. Obviously, this is unsecure and can be intercepted by other vessels in the region. Another method is to use the ships fax to transfer catch information to the company office. The most sophisticated method of daily catch transfer observed during this project was where a ships officer entered all of the set by set catch and effort data into the approved SPC Excel spreadsheet, and then emailed this spreadsheet to the company office.

Once the paper logsheets are filled out for each set, they are retained on board until the end of the trip. Depending on the requirements of the vessel's owner, the paper logbooks may then be sent directly to the coastal state's fishery management agency, or more often, are sent back to the company so that they can be checked by company officials before being sent to the fishery management agency. There were numerous reports that this second pathway for the paper logbooks can involve significant delays (often months and up to more than a year) in the logsheets reaching the coastal state's fishery management agency.

Data is keypunched once the paper logsheets arrive at the fishery management agency, often after the company has also been keypunched them. Depending on the resources available at the agency, they may be stored for several months. Depending on the coastal state, the logsheets data may be keypunched into an in-house database, or into the country's TUFMAN database. A scanned copy of the logsheets is sent to SPC. If the country's TUFMAN database has been audited, then the digital data is directly loaded into SPC's TUFMAN database. Otherwise, the data are double keypunched into the SPC's TUFMAN database. Thus, depending on the transfer and entry process, keypunching of the same data may occur up to 4 times.

A general schematic showing two models of the current paper-based logsheet data pathways and processing is shown in Figure 1 and Figure 2.

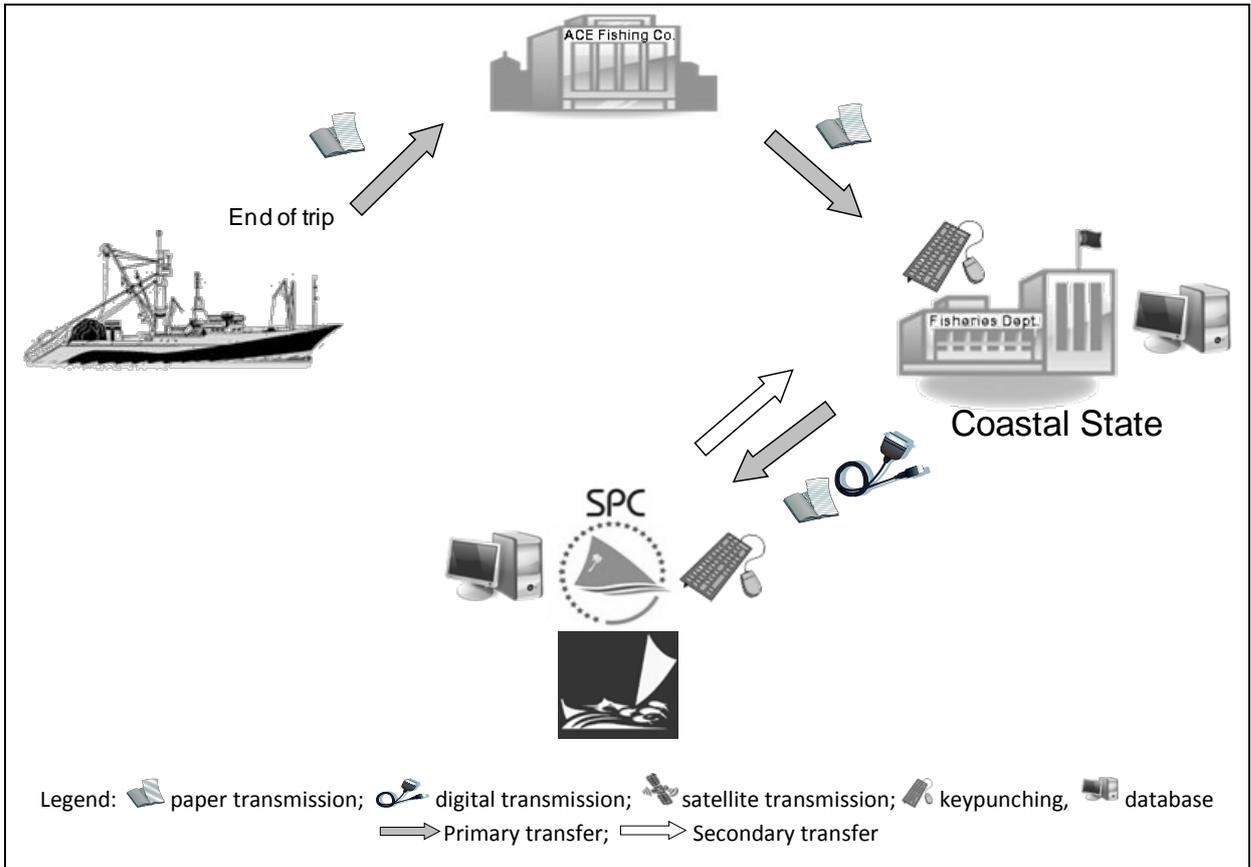


Figure 1. General schematic of data pathways and processing for current paper-based logsheets – Model 1.

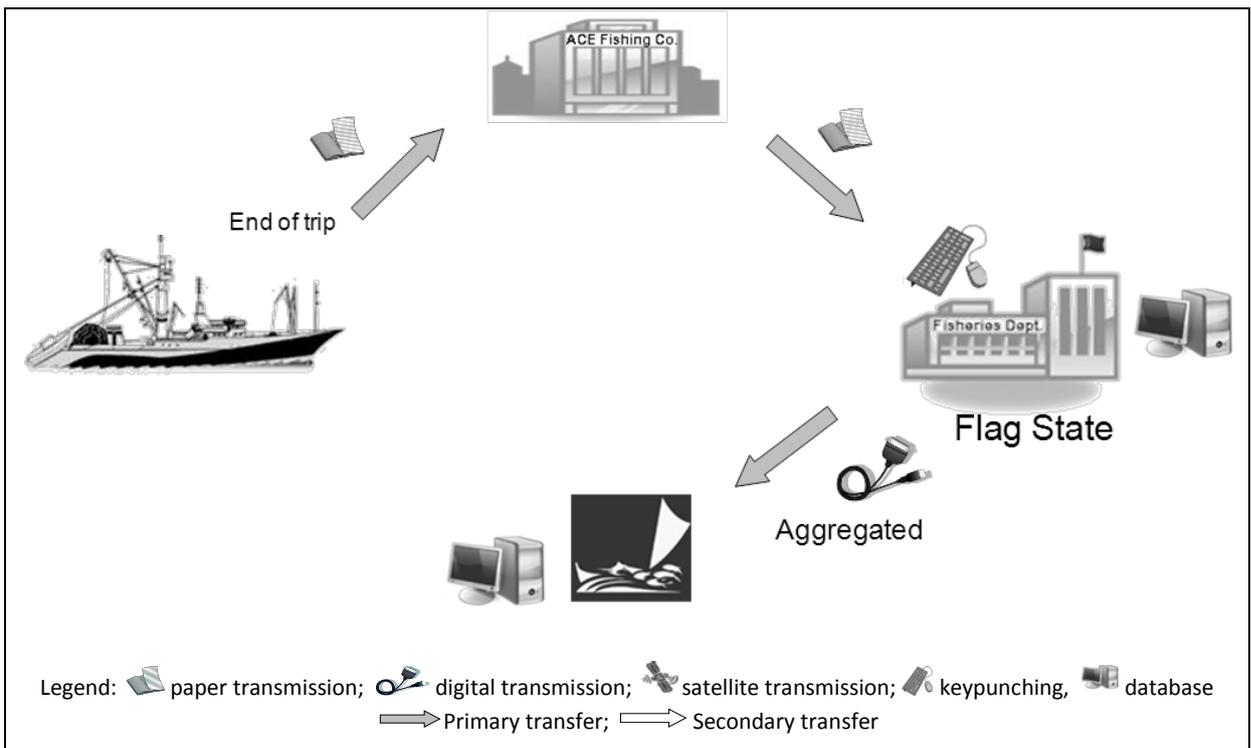


Figure 2. General schematic of data pathways and processing for current paper-based logsheets – Model 2.

Observers

Observer programs are administered by most coastal states for fishing in their national waters, the FFA for vessels operating under the US Treaty, and the PNA Office for vessels operating under the FSM Arrangement. There are more than twenty observer programs operating in the Commission's area of competence. Key challenges are therefore consistency of data standards and operating procedures. To address these challenges a Data Collection Committee meets biennially, and an Observers Coordinators Workshop is convened annually.

Currently, it is a requirement that all purse seine vessels carry an observer 100% of the time they are within the Commission's area of competence. For other fisheries, coverage is patchy and inadequate to meet the Commission's agreed levels of coverage.

Observers enter all of their data into an observer workbook. Different workbooks are required, depending on the fishing method being observed. The example used here is required for an observer on a purse seine vessel. Observers are required to carry one observer workbook for every 30 days at sea as well as sufficient catch monitoring forms (PS - 4) for the entire trip. They are also required to carry a book containing line pages to be used as their diary during the trip. They are required to fill out numerous forms, whilst conducting their work at sea:

- The PS – 1 form is to record information on the trip details, vessel characteristics, fishing gear comment vessel electronics, well contents, and crew details
- The PS – 2 form is a daily log on which information is recorded about the position of the vessel, the EEZ in which its operating, the activity code, and any association of a set with FADS
- The PS – 3 form is to record information at the set level, including the set sequence times, retained and discarded catch of target species and other species, the fate of the catch and whether any tags were recovered. If tags were recovered or there were interactions with marine mammals or turtles, then a further set of forms is required to be filled out
- The PS – 4 form is used to record the sampling method and length frequencies for the catch of different species
- The PS – 5 form is a vessel logsheet and well loading reconciliation form which allows scientists to match vessel logsheets data to observer data and to improve the port sampling strategy

The forms above are specific to purse seine vessels, but a number of generic forms are also filled out by the observers:

- The GEN – 1 form is used to record vessel and aircraft sightings, bunkering, fish dumping and fish transfers

- The GEN – 2 form records information on catches or interactions with species of special interest such as marine mammals, turtles or birds
- The GEN – 3 form must be completed at the end of every trip and is a record of whether the master or crew of the vessel violated any fishing regulations or hindered the work of the observer
- The GE – 6 form is a record of a pollution incident

In addition to all of the above, the observer is required to fill out a comprehensive trip report that includes a written summary of all of the above.

Once observers return from a trip, which can be up to 120 days duration, they undergo one or more debriefing sessions with trained debriefers. The debriefing session covers a range of issues and includes checking the data sheets for missing fields, incomplete reports, possible incorrect data entries, overall data quality, and any issues that occurred on the vessel. When debriefing is completed the observer workbook and all additional data forms are sent to the coastal state fisheries management agency for key punching. Similar to the logsheets, depending on the resources available at the agency, the hard copies of the observer data may be stored for many months prior to keypunching. Again, scans of the hard copies of every datasheet are sent to the SPC.

A general schematic showing a model of the current paper-based end-of-trip observer report pathway and processing is shown in Figure 3.

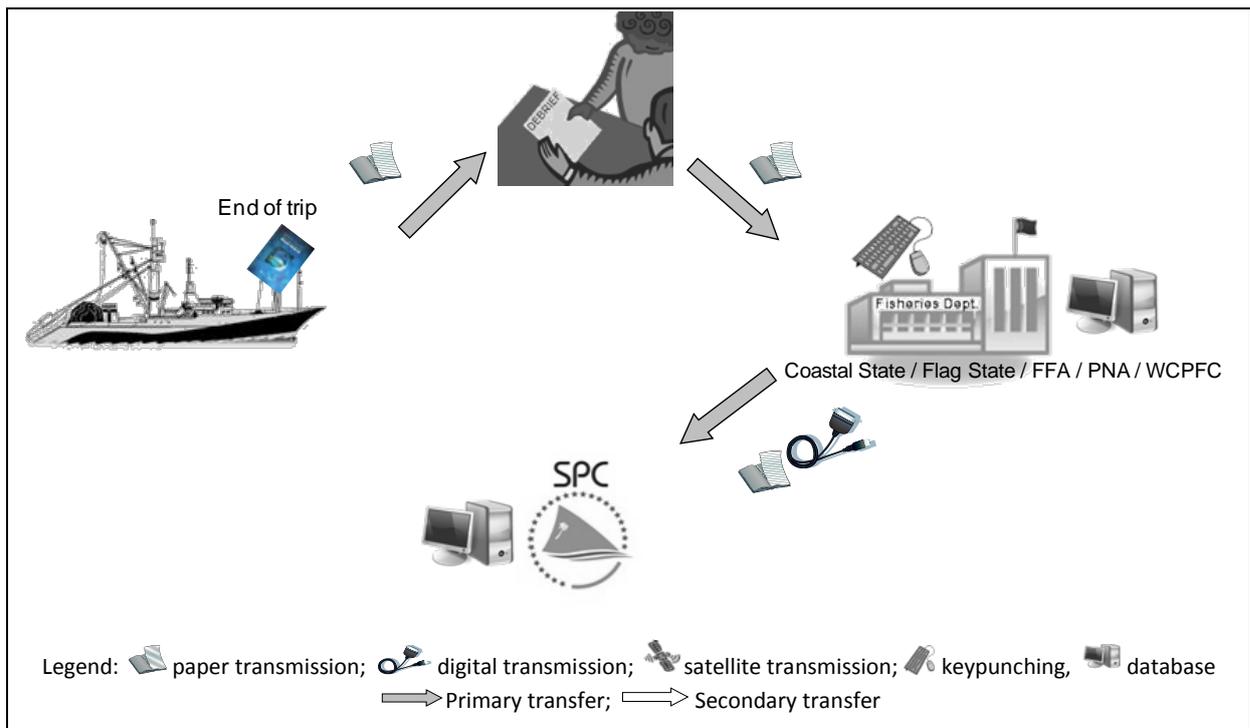


Figure 3. General schematic of data pathway and processing for current paper-based end-of-trip observer report.

Unloading and port sampling

Port samplers record information on unloadings, during which vessels transfer their catch to carrier vessels, air transport, canneries, or other receivers, as well as recording information on the size frequency of the catch unloaded.

Unloading data provides an independent estimate of the trip catch, which can be used to verify logsheets and catch totals for vessels that do not submit logsheets. They also provide more accurate weights associated with the longline fresh sashimi-target longline fishery (WCPFC-SC4-2008/ST IP-4). Over time, unloading data can provide useful estimates of the total catch by the fleet. The unloading form includes general information about the port and the date, information on the vessel, the number and weight of fish landed and whether that fish is being transhipped for export or retained locally. Unloading data must be identified to the “vessel trip” to ensure useful comparisons to other types of data (e.g. logsheets and observer data).

Length frequency information obtained on the main target species is a crucial input for stock assessments. It is important that the port sampler collects random samples and the method of sampling varies depending on the vessel type being unloaded. For sampling the length frequency of the catch from purse seiners, the aim is to identify wells which contain fish that were caught with the same school association, caught in the same month, and caught in the same area, and then to randomly sample five fish from every net that is unloaded from the well. Information collected on the port sampling form consists of general data on the port and date, set details (obtained from the vessel’s logbooks) and species length data.

CMM Reporting

Apart from the logsheets, there are numerous other forms and reports that need to be submitted by vessel operators as part of complying with the Commission’s many CMMs in the fishery or with specific coastal state fishery management agency requirements. Among these are transshipment reports, bunkering activity reports, non-fishing day (NFD) reports under the PNA purse seine vessel day scheme (VDS), refuelling reports, species of interest interaction reports, and zone entry and exit reports. There are specified fields required in each of these reports but the method of recording and transmission is varied. Depending on the requirements of the coastal state and the capabilities of the vessel, the content of these forms may be radioed, faxed or emailed from the vessel to the coastal state management agency where it is recorded.

Data Collection – electronic

Vessel Monitoring System (VMS)

The only well-established form of electronic data collection in the WCPO tuna fisheries is the Vessel Monitoring System (VMS). This is a satellite-based E-Monitoring system that monitors the position, speed and direction of registered fishing vessels. The Commission

Secretariat maintains a list of approved devices based on the VMS Standards Specifications and Procedures.

There are two VMS operating in the fishery, the Commission VMS and the FFA VMS. Whilst these are separate systems, they use the same background system. The system that provides VMS information to the FFA VMS and the Commission VMS systems is referred to as the Pacific VMS. As stated in TCC-03 (2012), the purpose of the Commission VMS is to “cost-effectively monitor the activities of fishing vessels authorized by flag States to fish for highly migratory fish species in the Convention Area in areas beyond jurisdiction of the Flag State” i.e. the high seas. The FFA VMS allows FFA members to track and monitor fishing activities in their own EEZs. The Commission VMS came into operation during 2009 and is provided by FFA under a Service Level Agreement (SLA). The Commission has approximately 1,500 registered vessels that report to the Commission VMS through the Pacific VMS. In addition the Commission VMS receives, through the SLA with FFA, high seas VMS information relating to FFA-registered vessels. Both the FFA and the Commission Secretariat maintain lists of type approved VMS MTUs. The FFA list is attached at Appendix 9.

To ensure compatibility between national and high seas vessel monitoring systems, members that have existing national VMS programs may choose to have the Commission provide the in-zone VMS data for vessels reporting to the Commission VMS who enter waters under their national jurisdiction directly to their national VMS (WCPFC9-TCC04-2013). The combination of the two VMS systems helps to achieve compliance with Conservation and Management Measures (CMMs), provide information for fisheries scientific analysis and enable sound fisheries management decision-making in the Convention Area.

There is 100% VMS coverage in the Commission area of competence. Every vessel either fishing for tunas or involved in fishing for tunas, is captured by someone’s VMS:

- The Commission VMS monitors all fishing and carrier vessels when fishing or transiting international waters, but not in national waters. Some members have included their national waters as part of the Commission VMS including Australia, FSM, New Caledonia, New Zealand, French Polynesia, Wallis and Futuna, Nauru, USA, and Tokelau
- The FFA VMS monitors all fishing and carrier vessels registered with FFA and fishing or transiting the national waters of members
- The FFA VMS enables its members to monitor vessels in high seas areas if the vessel holds a licence from the coastal state
- Other coastal state Commission members generally monitor their fleets when fishing, transhipping or transiting their national waters, as well as in international waters
- The Commission VMS gives coastal states the option to monitor vessels operating in the high seas, up to 100 nautical miles beyond its EEZ
- Many companies monitor their vessels in all waters

VMS helps achieve compliance with CMMs, provide information for fisheries scientific analysis and supports fisheries management decision-making in the Convention area.

In the event of a malfunction or failure of a vessel's VMS, a vessel is required to submit manual position reporting.

Other E-Reporting and E-Monitoring projects

In addition to the established VMS System, there have been only a few instances where electronic capture and reporting of data have been introduced and are operational, but there are several trials of electronic data capture and transmission occurring in different CCMs. Within the Commission area of competence, the following E-Reporting and E-Monitoring projects have been identified by this project:

- AIS – FFA is investigating the value of AIS information to augment VMS information and registration information to support compliance activities
- FIMS – Papua New Guinea (PNG) National Fisheries Authority (NFA) has implemented E-Reporting of port sampling using customised tablet interface. Trials of electronic observer reports are ongoing
- PNA FIMS – The Parties to the Nauru Agreement allow vessels fishing in the purse seine vessel day scheme (VDS) the option of submitting E-reports claims for non-fishing days through a web-based portal
- A subset of observers are trialling the use of DeLorme inReach handheld satellite communicators for daily real time transmissions, focussed largely on safety at sea issues, but moving towards event reporting
- eTunalog – SPC is conducting trials of PDF logsheet data entry by both vessel skippers, and observers
- There have been several trials using video cameras and equipment sensors to record fishing activity in the Commission area, but it currently appears to be mandatory in only one fishery (the Australian Eastern Tuna and Billfish Fishery) where it is currently being implemented
- This project has identified a significant number of larger purse seine fishing vessels already using video monitoring equipment for their own reasons – to monitor fishing and other vessel operations, safety, and crew activities
- The Philippines purse seine fleet is using the CLS Argos Marlin e-log for high seas activity reporting

Vessel Automatic Identification Systems (AIS)

AIS relies on radio signals to provide ship details and position, both from ship to ship, and ship to shore. Vessel AIS is typically visible at distances of around 30 miles, but is also visible to satellites resulting in global monitoring coverage with no transmission cost. Carriage of AIS is an International Maritime Organisation (IMO) requirement on all ships of 300 gross tonnes and upwards engaged on international voyages, cargo ships of 500 gross tonnes and upwards not engaged on international voyages, and all passenger ships irrespective of size. Some ports require other vessels operating within port limits to also carry AIS. Ships fitted with AIS are generally required to maintain AIS in operation at all times.

AIS:

- Provides information — including the ship's identity, type, position, course, speed, navigational status and other safety-related information — automatically to appropriately equipped shore stations, other ships and aircraft
- Exchanges data with shore-based facilities

This means every bunker, carrier, purse seine, and long line vessel greater than around 50 metres, is required by international regulation to have AIS and can be tracked continuously through its AIS signal.

The FFA has done some preliminary work in this area looking at the potential value of AIS to augment VMS and registration information for compliance purposes.

E-form for VDS non-fishing days

Under the VDS, purse seine vessel owners can purchase and trade fishing days in EEZs subject to the Parties to the Nauru Agreement (PNA – Solomon Islands, Tuvalu, Kiribati, Marshall Islands, Papua New Guinea, Nauru, Federated States of Micronesia and Palau). Designed to constrain and reduce catches of target tuna species and increase returns from access fees paid by Distant Water Fishing Nations (DWFNs), the VDS sets an annual total allocation of fishing days that are apportioned between PNA members for one-year periods up to three years in advance.

Beyond of its use by the NFA, the rollout of access to iFIMS by 200 of the 270 purse seine vessels has occurred on the back of the need for vessels to regularly transmit VDS non-fishing days while operating in PNA waters, so they can readily fish their full allocation of days. Vessels and companies can access iFIMS through a web-based portal to submit VDS non-fishing day (NFD) information as well as view their own VMS and FAD tracking data. Once a NFD E-form is submitted to a PNA country, it is reviewed, either accepted or rejected, and notification of such is posted on the database.

Tablet-based port sampling

The other example of a fully implemented electronic data collection and transmission system is that used by the PNG NFA port measurers. This system consists of an Android application developed for Samsung tablets specifically for the collection of port sampling data. All of the fields usually filled out for SPC data have been customised for entry on a touch-screen tablet. A range of drop-down menus is used on the tablet software to ensure data input consistency, and there is range-checking validation of data inputs to reduce spurious data. After entry, the information remains on the tablet until it is in range of mobile network system, at which time it is downloaded to the NFA FIMS database. The data is verified and checked prior to being uploaded into the database.

eTUNALOG

eTUNALOG is an application initially developed for the WCPFC purse seine fishery to be used by vessels to satisfy the logsheet reporting requirements at the national level and sub-

regional level. The software can be installed on the vessel's computer, and uses a smart PDF logsheet into which a skipper can enter catch and effort data directly.

Once data is entered, the vessel can send the PDF logsheet for the trip as an email attachment to either the fishing company or the coastal state's fisheries management agency. It is also possible to send the logsheets on either a daily or weekly basis before the trip is completed. The data that are entered into the PDF logsheets are converted to XML format for transmission. In this format, it is readily loaded into the TUFMAN database. In addition to reports sent to the fisheries management agencies, there are plans for an in-built reporting system that will allow the vessel and the fishing company to produce custom-made reports to suit their business requirements. An important characteristic of the PDF logsheets is that it has been designed to look almost identical to the paper logsheets.

Data can be sent either as a 4kB XML attachment to an email (to multiple recipients), or in PDF format. At this stage only SPC can read the data, although a program is being developed to enable companies to read the XML directly and upload them into their own databases. A range of data checking and validation checks are conducted at the data entry point. TUFMAN has a function to import and load eTUNALOG data, and an audit function in TUFMAN is conducted when data are imported.

Initial trials were held in the Solomon Islands with Trimarine, and it is now being trialled on three vessels operating from Pohnpei (Caroline Fishing Company). It is also installed on one Japanese vessel and immediate plans for trials with one Korean company vessel (Dong Won), and RMI flagged vessels. During these trials, skippers could generally operate the system with a minimum of 2 hours of training. The log is currently only available in English but translation to other languages is envisaged.

There is ongoing development of the smart PDF logsheets. Future versions will include PDF digital signatures and fishing company stamps, if required. A function to collect and populate the form with GPS data automatically is not currently enabled, and although possible, as yet there is no automatic PDF field population (e.g. time and position) that would minimise data input errors or aid in data entry.

Company E-Reporting

A number of commercial fishing vessels have their own system of electronic data recording and transmission back to the company office. This can take various forms, but the most advanced we observed was where the skipper, or ship's officer inputs set by set information into the SPC designed Excel spreadsheets. It would appear that this information remains in Excel format as separate files at company headquarters rather than being imported into a database. It was pointed out that even though companies received such information electronically, the lack of a formal database into which the data could be transferred meant they could not easily query or write reports based on the information.

Video monitoring

A number of purse seine vessels have video monitoring installed for use mainly with workplace safety and efficiency issues in mind. These units generally have a hard drive on which video information from all cameras is recorded and then overwritten on a cyclical basis. These cameras may be installed on the forward and aft working decks, the engine room, companion ways and other areas of the vessel when there is concentrated work by the crew. The control of the system occurs in the bridge and some cameras have tilt-pan-zoom capacity, controlled from the bridge.

Observer safety

Observers work in an inherently dangerous workplace with a moving and unpredictable work platform, wet conditions, and in the vicinity of heavy equipment. Observers are continually placed on new vessels, each of which are different and present unique risks, and they are expected to play a crucial compliance role. This can place them in difficult and often uncomfortable situations with respect to the skipper and crew if a compliance breach occurs. Quick and reliable methods of communication between the observer and employer is highly desirable to help manage emergencies, and to maintain contact with peers and managers.

The FFA, NFA and FSM observer programs are currently trialling the use of the DeLorme inReach satellite communication device. The device offers global SOS capability and real-time tracking. The screen edition has a virtual keyboard for sending and receiving text messages, and pairs wirelessly with iPhone, iPad, and Android devices to access other information such as maps and charts.

Data storage and management

There are a range of databases across the various countries involved in WCPO tuna fisheries. A critical aspect of the introduction and/or expansion of an electronic reporting system is the capacity of the databases to accept the electronic data streams that are being sent to them.

The point at which the data are received is also another stage at which error checking and further verification of data can occur before being accepted into the database.

Tuna Fisheries Database Management System (TUFMAN)

The Tuna Fisheries Database Management System (TUFMAN) was developed by SPC for Pacific Islands Countries and Territories to allow them to manage the range of tuna data (licensing, port sampling, logsheets, unloadings, observer trips, packing lists, vessel activity reports, vessel position reports, VMS) and fishing gear (longline, purse seine, pole-and-line, artisanal) associated with WCPO tuna fisheries.

TUFMAN has evolved and developed over many years from a simple data storage tool to a comprehensive system that provides for data entry, data management, data quality control, administration, and reporting. TUFMAN is network-based and can support any number of concurrent users. Since 2010, the TUFMAN data has been stored in SQL Server 2008 R2 but

the front-end interface has been developed in Microsoft Access 2007. This allows the system to be highly customizable to the differing needs of individual Pacific Island countries. Special reports have been provided that cater for the countries' flag state reporting obligations to the Commission, and produce specific tables and figures defined in the Commission's reporting template. Most of the reports can be exported directly to Microsoft Excel, while the Commission reports, which contain some charts, are exclusively generated in Excel. TUFMAN is used in all but one of the FFA member countries' Fisheries Departments. In some countries, customised versions of TUFMAN are the main fisheries data management system. Some countries have other systems in addition to TUFMAN.

The system's data quality tools can perform reconciliation of the different types of data in the system and can be used to improve the estimates of catch and effort statistics, highlight under-reporting and missing information, assist with calculation of coverage of data, vessel position conflicts, etc.

The system has a mapping component that can produce catch and effort maps as well as tracks of logsheet, position reports, and VMS data. If MapInfo is available to the user, TUFMAN can generate MapInfo compatible files, and then launch the MapInfo application and generated map.

TUFMAN now supports the import of the digital logbook XML data exported from the eTUNALOG application. In the near future TUFMAN will provide more general support in using XML for importing and exporting data and reports, and will provide extra mapping functions based on Google Earth. It is also expected the MapInfo-based mapping will be replaced with an Open-Source mapping tool in the coming years.

Catch and Effort Query System

The Catch and Effort Query System (CES) is a menu-driven system that interfaces with TUFMAN to allow member countries to extract summaries of operational logsheet data, aggregate public-domain catch and effort data, and annual catch estimates.

The CES system also has a comprehensive mapping sub-system (based on MapInfo engine) which allows users to produce maps of catch, effort and catch per unit effort (CPUE) using numerous parameter categories. CES is commonly used to produce tables, graphs and maps for member-country National Fisheries Reports.

eTUBS

eTUBS is a web-based OBSERVER database management system developed by SPC to enter purse seine and longline observer data collected on the standard observer forms. Previous desk-top versions of this system have been used at SPC for more than 15 years. The web-based version is installed and operational in the Commission offices, FFA offices, as well as the offices of PNG NFA and Solomon Islands Fisheries on a trial basis.

Originally developed on Microsoft Access, eTUBS now runs under Google Chrome even when offline. Observers can enter data into eTUBS while at sea and it can then be downloaded into regional databases such as TUFMAN. The system dashboard provides all vessel detail and 80% of the reports the observer would normally enter on paper database. Observers can also write diary and trip report directly into eTUBS. Unlike the eTUNALOG, the entry screen of eTUBS is not intended to match the paper form and has been completely redesigned to facilitate easier and more intuitive screen entry of data. To assist in data entry, eTUBS comes with help tabs, drop down boxes for most of the fields, range checking and error messages. Currently, all position information is entered manually but the potential to upload GPS data from DeLorme to populate position and time fields is being considered.

At this stage, there are three NORMA (FSM) and two MIMRA (Marshall Islands) observers that are trained in the use of eTUBS, and placed on vessels. Training involves about three days per observer. The software is to be amended based on feedback on the trial by the observers. Until the trial is completed, observers are still required to complete their paper books alongside the eTUBS reporting. As part of the data security process, observers are required to conduct manual daily backups of all eTUBS data using a Windows backup, and a copy is transferred to a separate USB key. It is envisaged that the eTUBS data will be downloaded by USB key at the end of the trip, but depending on how large the data file is, it could be sent by email when the observer is out at sea.

ORSE

The Observer Trip Viewer System and the Observer Database Query System (ORSE) allow member countries to view processed observer data and extract summaries of observer data in tabular, graphical or mapping formats via a comprehensive reporting menu. Summary reports can be produced at the observer trip level or by querying their entire member-country observer database.

Regional Information Management Facility (RIMF)

The Regional Information Management Framework (RIMF) is a cloud-based information management system coordinated and run by FFA. It is used to varying extents by FFA member countries. The RIMF is an integration of systems and databases to support national and regional MCS functions, activities and initiatives. Its aim is to strengthen and improve national MCS capacities and maximise the availability, timeliness, quality and usability of secure MCS data and information. The 'core database' of RIMF includes the following data: vessels; licences; VMS; compliance history and Compliance Index (CI); masters; owners/operators; and standard reference data. Some of the core MCS functions include:

- Find and uniquely identify a vessel in the database
- Based on a location, determine if a specific vessel is authorised to fish
- Review the compliance history for any given vessel
- Review the compliance history for a particular vessel master

- Plan for targeted surveillance based on vessel and/or master CI
- Extract information as required by a surveillance operation

The value of the RIMF is that it combines data from various individual sources (such as the national licensing systems and key regional systems) into a comprehensive database that can be shared between stakeholders. Based on its ability to provide compliance related information on vessels and vessel masters, including any history of non-compliance, vessels and masters are evaluated and assigned a Compliance Index (CI). This aims to provide more targeted MCS activities.

FIMS

The Fishery Information Management System (FIMS) is an example of one of the more advanced independent electronic data collection and transmission systems currently operating in WCPO tuna fisheries. It was developed by the Australian company Quick Access for the PNG NFA to manage the wide range of data associated with tuna fisheries management, including: licensing; vessel registrations; crew registrations; monitoring, compliance and surveillance; observer management; observer tracking; FAD tracking; VDS management; and port sampling. But independent databases are now used by the purse seine industry (iFIMS) and the Parties to the Nauru Agreement (PNA FIMS) – iFIMS and PNA FIMS respectively.

FIMS development for NFA has progressed quickly over the last 12 months, with the development of iFIMS (industry FIMS) a subset of the FIMS database adapted for use by industry; and PNA FIMS for use by the Parties the Nauru Agreement in particular for managing day quota for the purse seine vessel days scheme (VDS).

Further development

The FIMS database and iFIMS products are being constantly developed and improved. One of the current challenges facing the FIMS/iFIMS database structure as well as the storage transshipment and unloading processes is the need to demonstrably separate FAD-caught fish from FAD-free fish in order to meet MSC requirements. This can be reasonably straightforward when the unload is from the vessel directly to the processor, but is complicated when the vessel tranships to a carrier vessel before the catch is unloaded to the processor.

The FIMS/iFIMS focus over the next 12 months is on the development of:

- Finalising systems to identify non FAD associated catch
- A FIMS Observer Management Platform for full day-to-day management of observer booking to vessels and tracking at sea
- The catch and effort logsheet
- Tablet software for observer reporting at sea
- Catch decrementation scheme driven by EU compliance requirements

- VDS forms in other languages including Chinese, Japanese and Korean in 2014.

Uses of WCPO tuna fishery data

The data collected in the programs highlighted above have a range of science and compliance uses for WCPO tuna management. Although some data is collected for specific uses, there is not always a clear distinction between what data is used for which purpose. For example, VMS has a central role in compliance, but is also very useful for understanding effort distribution and fleet dynamics in stock assessments; catch composition data from logsheets and observers is critical to stock assessments but also informs compliance. Regardless, underlying the collection of most of these data are the numerous CMM requirements which place obligations on countries to collect and provide information to the Commission in a timely manner.

Under contract to the Commission, the SPC Oceanic Fisheries Programme (OFP) undertakes stock assessments and other related analyses of WCPO Bigeye, Yellowfin, and Skipjack Tuna as well as South Pacific Albacore Tuna. Such assessments are conducted annually and are reviewed by the Scientific Committee of the Commission in August each year. To meet this deadline, the Commission calls for the annual provision of scientific data, and all countries are obliged to provide their data by 30th April to enable the assessments to be completed by July. These data include: annual catch estimates; operational (logsheet) data; aggregated catch and effort data; aggregate size composition data; as well as the Regional Observer Programme (ROP) data. Once received at SPC offices (on behalf of the Commission), the data undergoes a management process that includes: receipt and acknowledgement of data submissions; quality control checking of data; importing data into the Commission databases; and, transmission of Commission databases to the WCPFC Secretariat on a quarterly basis.

In addition to the work on target species, there is considerable research undertaken on the impacts of fishing on non-target catch, and threatened, endangered and protected (TEP) species. Much of the information collected by observers and as part of CMM reporting is used towards this work alongside specific research projects. Such information supports ecosystem modelling of the fishery and ensuring that the fishery is conducted with the sustainability of the ecosystem in mind.

The Commission's Monitoring, Control and Surveillance (MCS) Scheme uses information from a broad range of areas to meet its compliance requirements. Critical information for compliance includes: the Centralised Vessel Monitoring System (Commission VMS, CMM 2011-02); the WCPFC Record of Fishing Vessels and Authorizations to Fish (CMM 2009-01); and the WCPFC Interim Register of Fish Carriers and Bunkers. This information is augmented by extensive reporting requirements and obligations under numerous CMMs, including: Procedures for Cooperating Non-members (CMM 2009-11); Specifications for the Marking and Identification of Fishing Vessels (CMM 2004-03); High Seas Boarding and Inspection Procedures (CMM 2006-08); Regional Observer Programme (ROP, CMM 2007-01, Annex C),

WCPFC IUU List (CMM 2010-06); Prohibition on use of large-scale driftnets (CMM 2008-04); Regulation on Transshipment (CMM 2009-06); Rules for FAD and purse seine catch retention (CMM 2009-02); Charter Notification Scheme (CMM 2012-05); and the Compliance Monitoring Scheme (CMM 2012-06).

One of the emerging uses of fisheries data in the WCPO tuna fisheries is for product traceability and to demonstrate the fisheries meet the criteria expected under various environmental certification schemes such as Marine Stewardship Council (MSC) certification.

Whether it is to be used for stock assessments, compliance or ecosystem modelling, due to current shortfalls in data keypunching, processing and transmission, not all of the data collected is available in time, or is of sufficient quality to meet the requirements for compliance or inclusion into the annual stock assessment process.

5. Current Situation – Global

E-Reporting

There is a wealth of examples of fisheries around the world that have trialled or adopted some form of electronic reporting. These systems range from some very simple generic programs operating on off-the-shelf hardware that transfer minimal information, to highly customised software installed on purpose-built hardware that can transfer encrypted data with digital signatures in multiple formats through multiple transmission pathways. Various versions of these systems have been established for well over a decade, but their complexity and capacity is continually evolving as new technology is developed. Increasing computing power, memory and storage has been fundamental to this evolution, but because a significant proportion of fisheries data is collected on vessels working at sea, cost and capacity of data transmission has remained as the critical consideration in E-Reporting, regardless of the complexity of the system.

Data transmission options range from a virtually no-cost option of manually downloading data collected at sea to a digital storage device (e.g. CD or USB memory stick), through transfer via fixed line or mobile (cell phone) telecommunications systems, Wi-Fi or cable internet, to the most expensive option of digital data transfer via satellite. The quality and capacity of these options can vary from region to region, but this choice is also highly influenced by the distance from shore and duration of trip. Further, there are an increasing number of technical options for each type of data transfer method and a range of costs associated with each option depending on the frequency and amount of data to be transferred. Not surprisingly therefore, the question of what data is needed and whether E-Reporting needs to be made “real time” (immediately), “near real time” (within a day) or at “end of a trip” is critical.

There are simply too many examples around the world of where E-Reporting products have been successfully installed and are currently operational to individually name them in this report. The primary applications of these products are for catch and effort logsheets, on-board observer monitoring and port-based data collection. Details of just some of the range of E-Reporting products, the countries where they are installed, and what they are used for, is provided in Appendix 2. The technical specification of these products are provided in

Appendix 3.

E-Monitoring

Video monitoring in conjunction with winch, engine, and hydraulic sensors, and monitoring using sensors alone, use well proven technology, progressively developed over more than fifteen years and able to provide independent data to support monitoring objectives for science and compliance.

Wherever there is a need for observers, video monitoring can supplement some aspects of human activity. It never sleeps, does not require food or companionship, and can be used in multiple positions on boats where observers cannot be placed.

Whilst observer programs are the traditional and primary method of gathering independent data, a combination of video and/or sensor monitoring can now supplement and support these programs. These can be easily added as monitoring programs grow, and can be targeted at supplementing observer programs to fill gaps or identified limitations. Video monitoring can be used as an audit tool to verify observer and catch logsheet data, can monitor use of mitigation measures and can also free up observers to undertake data collection tasks whilst the video records fishing operations. It has been suggested that in the future, E-M may well be the only way some sectors can remain fishing if they are to comply with future CMMs and certification requirements.

An overview of a range of E-M products and services is provided in Appendix 4.

6. Stakeholder issues and responses

A significant component of this project was the requirement for the consultants to liaise with the broad range of stakeholders. The purpose of this liaison was to develop an understanding of the current status of paper-based data collection and reporting, and to understand the perceptions of stakeholders about the potential introduction of E-Reporting (E-R) and E-M. To this end face-to-face meetings were held with personnel from fishery agencies, and where possible industry in Australia, Fiji, Hawaii, Marshall Islands, Micronesia, New Caledonia, New Zealand, Papua New Guinea, Philippines and Solomon Islands. Details of these can be found in Appendix 8. An interim report was presented at the 8th regular session of the TCC in September 2013. Numerous teleconferences with data base managers and technicians and e-product suppliers were conducted during the course of the project. Based on all these discussions, the following section outlines the main issues that were raised regarding the implementation of E-R and E-M.

Sustainability

Issue

The major overarching issue across all stakeholder groups is that the WCPO tuna fisheries remain economically, environmentally and socially sustainable. There is an underlying

concern from many people that IUU fishing (in all of its various forms) is undermining many of the management controls in place and represents a significant threat to the sustainability of WCPO tuna fisheries. To those individuals, companies, and countries whose future depends on a sustainable fishery, this is their number one issue of critical concern. The current inefficiencies of the paper-based system leave plenty of room for unsustainable practices and IUU fishing to continue.

Response

During our discussions, many of these stakeholders recognise that the introduction of E-R and E-M has the potential to tighten the noose around IUU fishing and improve sustainable practices within the fishery. They recognised that access to timely and reliable fishery information is fundamental to achieving this goal and that this is crucial to future economic returns to CCMs, and the fisheries they support.

Compliance

Issues

The MCS stakeholder group were interested in real time data access for the efficient conduct of their work. Currently, they have access to real time VMS information and near real time information on licensing and registrations from which a compliance index is created to focus MCS activities. They have no access to any real time catch data (species composition and weight) other than when compliance officers board or inspect a vessel and get access to the paper logsheets. Compliance officers highlighted that lack of remote access to real time catch data was a significant shortfall in their office-based assessment of compliance.

Currently, MCS boarding and inspection parties have a limited timeframe on-board a vessel (4 hours) over which they can collect information to form the basis of any compliance action. Within this time they have to access and assess the vessel's entire set of paper logsheets to determine the record of catches against what is on-board the vessel.

A successful compliance operation requires that numerous forms of information support each other in highlighting non-compliant activities. Presently, apart from the real time VMS data, other information that may underpin compliance is received in various formats and at different times, depending on the source of information and the country collecting / transmitting it. This presents a significant logistical hurdle in piecing together the various sources of information that need to be combined to make a strong compliance case. As a result, an extensive amount of manual manipulation and analysis of data is required for a compliance issue to be highlighted, much less prosecuted. Furthermore, visual confirmation of non-compliance is an extremely influential component of this information. Currently, the only form of visual confirmation is that manually recorded by an observer (if present at the particular time) or, if deemed important enough, footage and observations made available from a dedicated compliance "flyover". Obviously, given the huge geographical extent of the fishery, the costs associated with the latter approach can be prohibitive.

Response

Real-time E-Reporting of the on-catch composition and weights of target species will provide a valuable input into a particular vessel's compliance index. Such information could highlight discrepancies in catch composition, progressive vessel catch figures, and determination of vessel non-fishing days.

The improved, timeliness and quality of logsheets, observer reports and CMM reports, offers a breakthrough opportunity to improve compliance in this fishery. Apart from better access to real-time information, there would also be significant benefits if all of the logsheet information, observer reports, catch landings, and port sampling information was available in a consistent electronic format within a week of the end of a trip. Once such a system was in place, there would be the ability to run predetermined data queries that could highlight discrepancies between these various data sources and also between them and the VMS data that has already been collected. Either continued or significant data discrepancies could be used as another factor contributing to a vessel's Compliance Index.

There are already electronic solutions available to compliance officers that could assist in downloading and analysing a vessel's logsheet information during a boarding or inspection. One company has developed a utility program which resides on a compliance officer's USB key to automatically extract certain (predefined) information from the vessel's electronic logbook without the need to give them access to the entire data set. Using the data downloaded to the USB key, compliance officers can quickly run reports that summarise information of interest (e.g. the vessel's hold contents, when logsheet data was entered with respect to undertaking a set, whether any data had been changed and when that change occurred).

Employment

Issues

Throughout the project consultation to date, a key issue raised by many Pacific Island stakeholders was the potential impact for the implementation of further E-Reporting and E-Monitoring on current jobs and employment opportunities associated with the WCPO tuna fisheries.

With particular reference to E-M, the main concern is that observer jobs will be replaced by the use of on-board cameras whilst with E-Reporting, the concern relates to loss of jobs associated with data collation, validation and key-punching. These are considered separately below.

Response

E-Reporting

With respect to implementation of E-Reporting, there will be a loss jobs directly associated with data collation and key-punching but there is a large opportunity to considerably offset this through increased employment associated with data analysis and reporting.

At the moment, there is a huge amount of Pacific Islander employment associated with the collation and keypunching of logsheets and observer data. This single aspect of E-Reporting also represents a significant bottleneck to information flow throughout the system. The use of E-Reporting for both logbooks, and observer data will remove this bottleneck, but in doing so, will make many of the current data entry jobs redundant. However, with the efficiency gains in electronic data entry and transmission comes the opportunity to redirect employment and up skill personnel towards data checking, analysis and reporting. Not only does this mean that there does not have to be any net loss of jobs, this redeployment and re-training will lead to far more effective research, compliance and management outcomes, as mentioned in the efficiency section below.

E-Monitoring

Observers undertake a wide range of tasks whilst on-board commercial fishing vessels, only some of which can be replaced or augmented by an E-M system. Some examples of the range of tasks undertaken by observers and the potential for current E-M technology to undertake that task is indicated in Figure 4. To simply state that the use of on-board video monitoring for example can replace observers is incorrect. The question is rather what level of coverage of the different tasks is required and what the cost effective means of acquiring this data is. This should be considered explicitly with respect to monitoring CMM requirements, and meeting scientific and compliance objectives.

The current mindset may need to change from achieving “*x percent observer coverage*” to “*x percent information coverage*”. For example in the longline fleet, video monitoring offers a realistic option to increase the current 2-3% of observer coverage to 100% information coverage with only 5% of this achieved through the on-board deployment of observers. Rather than a reduction in observer employment, there would be an increase in information monitoring employment. E-M may also resolve some the significant OH&S issues associated with observer coverage for a large proportion of the fleet.

The use of E-M technology does not imply a simple replacement of people with technology. It may, however, mean some level of retraining of people from data collection to data analysis. For example, if a decision was made to monitor say 20% of the longline fleet with E-M, there would be considerable onshore human resources required for the video footage be catalogued, analysed and particular events be scrutinised and reported. The ability for event marking on video footage, and for the analysis of these events to be conducted using fast play technology (where the video footage is viewed at 2x to 10x normal speed) means

that one trained shore-based observer could monitor the activities of many more vessels through E-Monitoring than could be achieved through an on-board observer. Importantly, there will always remain the need to continue to use on-board observers for validation and ground truth in of the data collected by E-M.

There is a real opportunity for E-R and E-M to create additional and better quality employment with advancement opportunities in data analysis and reporting from data collection and entry. This would be likely to result in a net gain in employment, an increase in the quality of employment, and a marked increase in the efficiency and effectiveness of compliance, research and management.

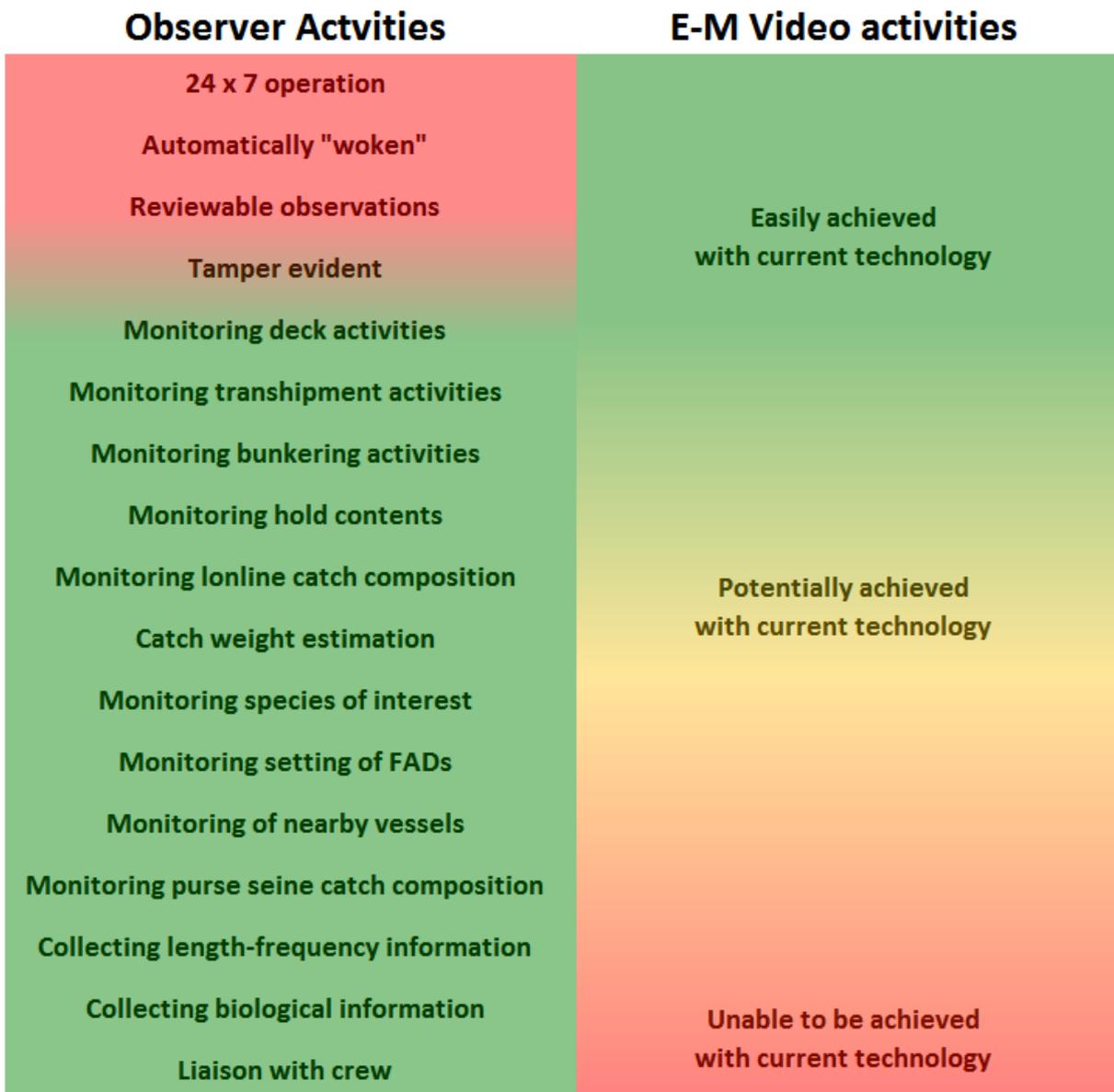


Figure 4. Tasks undertaken by observers and the potential for E-Monitoring to undertake that task based on current technology.

Occupational Health & Safety

Issues

Fishing vessels remain one of the world's most dangerous workplaces due to a moving, unpredictable and often wet and slippery work platform, a harsh and unforgiving environment, and the use of heavy equipment. Despite the extensive safety training that observers receive prior to their deployment on fishing vessels and their ongoing education about developing safe working practices, accidents are still likely in such an environment. Further, observers play a crucial compliance role while working on fishing vessels, that places them in difficult and often uncomfortable situations with respect to the skipper and crew if a compliance breach occurs. Agencies and companies that employ observers for this work have an obligation to make the work environment as safe as possible. Quick and reliable methods of both emergency and routine communication between the observer and his employer are becoming increasingly realistic.

Response

Recent developments in personal electronic communication devices has been both rapid and extensive. There are now a plethora of off-the-shelf devices available that have position fixing (GPS) capacity and either text or voice communication capabilities. Many of these are designed to operate effectively in remote and harsh environments using satellite communication facilities. When provided to an observer, this combination of GPS and communication facilities affords both the employer and the observer a valuable tool for meeting workplace health and safety requirements.

Research

Issues

Amongst the researchers, obtaining real-time information was of less importance than ensuring high quality information from the various data sources. Most of the research information culminates in its use in annual stock assessments and the only time-related issue is that the logsheet data, VMS data, observer reports, catch landings and port sampling from the previous year are available by the time the assessment needs to be conducted. Unfortunately, this is not always the case and significant portions of logsheet data and observer reports are not available in time for the annual assessments. As a result, assessments often need to be made with incomplete data.

The issue of most importance to the scientists is obtaining consistent, high quality data from all information sources. Currently, verification, validation and quality checking of data prior to its use in an assessment accounts for an extremely large amount of work by administrative officers and scientists alike. Debriefing and data checking at the country level undoubtedly picks up numerous data quality issues prior to the information being sent to SPC, but there remains significant need for vetting and checking of the data prior to its use in stock assessment.

One issue of specific concern was the quality of information available on the bycatch of sharks taken by longline vessels. Shark bycatch (and finning) is an extremely topical issue on a global scale and there are a number of CMMs relating to this. Due to the general lack of observer coverage on longline vessels, there is a high degree of uncertainty about the species composition of non-target catch taken by the longline fleet and, more specifically, the species composition of the shark catches.

Response

Implementation of E-R logsheets and E-R observer reports will greatly improve the timeliness of information available prior to stock assessment. It is quite feasible that usually within a fortnight of a vessel ending a trip, the raw, unvalidated data should be available to the SPC. The validation process may mean that this data is changed slightly at the company, fisheries agency, or SPC level subsequent to its submission, but a validated version will then be made available, together with a change audit trail at all levels. Thus, instead of the SPC receiving raw logsheet and observer data any time up to April (and not receiving a certain portion at all), under an E-R framework, it should receive the first digital version of the data almost immediately after the trip has been completed. Such a change in the timeliness of data availability has been reported in a number of fisheries that have moved from a paper-based system to an E-Reporting system. This allows more time for data checking and conducting the stock assessment. Moreover, it also means that a far greater percentage of the data will be available in time for inclusion in the stock assessment.

Another aspect of value to researchers from the implementation of E-R is that the quality of data contained in both E-R logsheets and E-R observer reports will improve markedly. This occurs for a number of reasons: the person collecting the data is the person entering the data into a computer, so there is no issue with difficulties in reading handwriting and remembering or understanding data entry situations as they occur; automatic population of fields (e.g. from GPS) means skippers and observers don't need to manually type in date, time and position fields; there can be automatic population of commonly used operational data entries such as vessel name, gear type etc.; use of drop-down boxes improves data accuracy and reduces keypunch errors; range-checking of numeric data entries begins the validation process; and forced entry of data into mandatory fields minimises unintentional lack of data entry into fields.

Finally, the extensive amount of time spent by scientists verifying, validating and quality checking data will be reduced by the above data quality improvements.

Efficiency

Issue

Some of the most inefficient aspects of the current information regime reported by many countries and agencies is the double handling of data, multiple data entry points and the considerable (and differing) time lags between data collection and data input into databases.

These inefficiencies at the initial stage of the data management process have a flow-on effect that cause further inefficiencies for many of the Commission's research, compliance and management activities.

The current paper-based system is groaning under the weight of tens of thousands of logsheets and observer workbooks that have been either stored after keypunching or are waiting to be keypunched. Key punching of paper-based data is the greatest bottleneck in the entire data acquisition and transition process, and one of the major factors in the inefficiency of the current system. Part of the problem behind this is that the information doesn't come in at a steady rate, but in large batches associated with the end of the vessel's trip. This issue is further exacerbated because many companies wish to check on the vessel logsheet information before its submission to a country, and because the extensive observer information — which can cover up to 3 months of at-sea observations — goes through a briefing validation process before it is available from keypunching.

Response

Use of E-R could significantly improve the efficiency and cost-benefit of the entire system, through more efficient use of all fisheries data and enabling a realignment of resources to optimise the value of the current data that is collected.

Direct on-board input of electronic data into an E-R system by a vessel officer or an observer has immediate efficiency returns. First, many on-board E-R systems have software designed to directly capture date, time and location data from GPS, and to retain the data in repeated fields at either the trip level (e.g. vessel and crew details) or set level (e.g. gear configuration). In addition, at the point of entry the software can ensure that mandatory fields are not skipped, data formatting is correct, data is entered within acceptable ranges, and use of dropdown boxes and lists ensure data consistency in non-numeric variables. This can significantly reduce the observer debriefing time. Further, problems and mistakes associated with post-event transcription from hardcopy to computer during keypunching of logsheets and observer reports is greatly reduced or eliminated. Once entered and transmitted in an electronic form, the process of data validation and verification can begin immediately, including cross-verification of data from multiple sources. For example: real time data from E-Monitoring (e.g. VMS, equipment sensors) can be automatically cross-checked against near real time E-R of observer daily reports or transshipping reports; or at the end of a trip, other observer data (e.g. catch composition) can be cross-checked against the vessel's logsheets. The current situation, where these multiple data sources are not received at the same time and then not keypunched and transferred for many weeks (if not months or years, and sometimes never), undermines timely identification of potential compliance issues and reduces opportunities to improve the quality of some aspects of the scientific data.

E-Reporting and E-Monitoring solutions for CMM obligations

A key issue in both the project terms of reference, and raised by stakeholders is whether E-Reporting and E-Monitoring can assist to satisfy CMM obligations. These obligations are to comply with a CMM for a vessel to report, and for a CCM to report to the Commission. For example:

- In terms of complying with a CMM, it is a requirement that purse seine vessels not undertake a set if a school of fish is associated with a whale shark.
- A vessel is required to report certain events, such as interactions with TEPs.
- And many CMMs contain a provision that CCMs are required to report annually (or more frequently) on implementation with the CMM.

This review concludes that E-M and E-R can make a significant contribution to both complying with, and reporting against CMMs.

An overview table listing each active CMM is attached as Appendix 6. This table uses a cross to indicate that in the opinion of the review, E-M and E-R do not offer a solution; uses a single tick to indicate a partial solution; and two ticks where the review believes a significant contribution can be made. The table was compiled with input from the Commission Secretariat, SPC, and FFA.

In total there are 72 boxes that could be ticked.

- 30 of these boxes, or 42% received 2 ticks
- 22 of these boxes, or 30% received 1 tick
- 20 of these boxes, or 28% received a cross

In short, the review believes 72% of the CMM compliance and/or reporting obligations could be supported by either E-R, or E-M, or both. Whilst this is not a statistically valid method of determining potential contribution, it does in the view of this review, satisfy the key question whether these technologies are worth pursuing.

Table 1. Some examples of CMM assessment process.**CMM 2007-01 FOR THE REGIONAL OBSERVER PROGRAMME**

This CMM establishes the Commission's regional observer program, sets objectives, lays out the obligations of CCMs, and the respective roles of the Commission, Secretariat and coastal States.

This review assessed   for E-M, and   for E-R

This review believes E-M and E-R observer logs both present significant opportunities for improvements in efficiency, effectiveness, quality and timeliness of observer program data and activities, as well as program safety.

CMM 2009-06 FOR REGULATION OF TRANSHIPMENT

This CMM establishes rules for transshipment.

This review assessed   for E-M, and   for E-R

E-M can assist in ensuring compliance. Transshipment activity can be monitored through hydraulic pressure, engine activity and winch rotation sensors on the carrier vessel (and reported in near real time), whilst transshipment volumes can be estimated and fishing vessel details recorded using video. E-R of transshipment can ensure the amount of fish held by a vessel coming into port or undergoing inspection is known in real time and can help ensure reporting obligations are met.

CMM 2009-11 COOPERATING NON-MEMBERS

This measure establishes the process for applying for cooperating non-member status.

This review assessed  for E-M, and  for E-R

Neither technology can make a contribution to this CMM.

CMM 2010-05 FOR SOUTH PACIFIC ALBACORE

This CMM requires CCMs not to increase catches of south Pacific albacore and to report to the Commission on their implementation of the measure.

This review assessed  for E-M, and  for E-R

In a broad sense both technologies would gather information that could assist CCMs to report against the measure, whilst not offering a specific tool for direct compliance. E-M can assist in monitoring whether targeted fishing is occurring and E-R Catch Log can assist to validate catches.

2012-07 FOR MITIGATING IMPACTS OF FISHING ON SEABIRDS

This CMM encourages CCMs to implement the IPOA Seabirds. The measure requires CCMs to report to the Commission, and to require their longline vessels to use mitigation measures.

This review assessed   for E-M, and   for E-R

E-M can provide evidence of compliance with any IPOA requirements, and the use of mitigation measures; E-R can ensure reporting obligations of interactions with seabirds are met.

7. A Future Framework

Whilst there is no shortage of challenges, the potential benefits of E-R and E-M for countries, industries, and fishery organisations are significant: timeliness, quality and accurate data, long run cost savings, efficiency with no duplication of paper logsheet handling and no triple data entry, potential to efficiently integrate multiple sources of data through information management systems, resistance to data sanitisation, improved ability to audit, support for timely decision making, familiar input and support technology (PCs, laptops and tablets), simple processes to update format and data requirements, simultaneous data provided to multiple users, readily adapted to multiple languages, easily backed up and protected data, well proven alternatives to human activities, avoids human issues, doesn't rely on human memory, stands alone as a potential tool to support compliance, driver to change operational practices and changes in compliance approaches and culture, takes the onus off humans as the sole point of compliance, the technology can enable verifiable review, and creates a significant deterrent for non-compliant behaviour.

Using the Australian vernacular, a move to E-R and E-M is “a no-brainer¹”. For decades now the world has adopted new technologies to drive up efficiency, effectiveness, and customer service, and drive down costs. The fishing industry is no exception. Enter the wheel-house of even the most modest international fishing vessel and you will usually find sonar, radar, RDF, mobile and satellite communications, GPS plotters, and VMS — usually integrated at some level with their head office or fish merchants often situated thousands of kilometres away. And yet to date the region has been unable to settle on an electronic solution for data collection and reporting. This **must** change.

Strategic Recommendation 1:

To improve quality and timeliness of the data available for science, compliance, and management, to enhance and streamline reporting obligations, and to provide an additional means of effective observer monitoring, this report recommends the Commission, its members, and its partner regional organisation within the WCPO implement both E-Reporting and E-Monitoring programs without delay.

Selecting a preferred E-R and E-M providers

The field of electronic data collection and communication is extremely dynamic and new products and technologies (often well guarded by patents) are regularly entering the market. As is evident from the previous sections on global developments, there is a wide range of E-R products available (this is much less the case for both E-M video and sensor, and sensor alone products).

¹ “No-brainer”: something that requires little or no mental effort.

Each of these products has differing and evolving approaches to its application of technology to fisheries data acquisition, storage, analysis and transmission. It would be possible to run a selection process by which one of these companies or products is chosen as the preferred option to meet the Commission's needs. We believe, however, that the approach of "picking today's winner" is fraught with a number of unnecessary financial and technological risks.

First, if in the future another company develops technology that is more appropriate for regional needs, the region may find itself locked out of accessing this new technology because of contractual arrangements with a current provider. Second, once it has entered into a contract with the preferred provider, it can be a lengthy and costly process to address any shortfalls if changes in the provider's circumstances mean they no longer have the capacity to meet project expectations. Third, the potential for price and product competitiveness that results from access to the open market is removed. Because of these issues, it is our recommendation that the Commission does not choose a preferred company or product to provide E-R or E-M needs, but rather develop an agreed set of data standards and specifications that technology providers need to meet for their product to be used.

Strategic Recommendation 2:

The Commission should adopt an approach of developing standards, specifications, and certification procedures for both E-Reporting and E-Monitoring, against which any provider can seek to be certified, in preference to seeking a single provider.

Electronic data options

There is already a comprehensive paper-based data collection and reporting program in place, which if timeliness and quality could be improved, would meet the needs of nearly all stakeholders. Prior to the implementation of any further E-R or E-M systems, the major stakeholders (industry, managers, compliance officers and researchers) must agree on which information sources these technologies are going to be applied to and within each, what electronic data is required in real time or otherwise. It is quite plausible, and probably a very effective implementation option, for a decision to be made that there will be no initial change in any of the data requirements associated with a move to electronic technology. This means, for example, that if there is a move to electronic logsheets for purse seine vessels, there is no change to the data collected on the logsheets and no change to when this information is expected to be submitted (at the end of a trip). Once these decisions are made, implementation of E-R and E-M can proceed to the preparation phase — development of data and reporting standards and certification procedures.

Recommendation 1: To facilitate implementation of E-Reporting and E-Monitoring, to the fullest extent possible, use current data requirements and reporting timeframes at this time.

Data standards

To be both effective and efficient, implementation of an E-R or E-M system requires a specification document with an explicit statement of, for example: what data fields are required; whether it mandatory or optional; data format; what is the acceptable data range; etc. Otherwise, the data that will be arriving at the relevant agency's database will be of such poor quality and in such disarray that there will be more effort required in sorting through and fixing the information than if it was just sent through manually in paper format and keypunched in the first place. Some examples of the level of detail required in such a document are provided in NOAA (2009) and AFMA (2008).

Decisions about the data standards should be made with input from management, compliance and research personnel and need to be made *prior* to implementation of E-R. SPC has done much of the above work in determining what data is required in all of the various hardcopy logsheets and observer reports (WCPFC/PrepCon/WP.15). Similar work needs to be done for electronic data.

It is recognised that there may be a need for data requirements and formats to change over time. In such cases, the standards and specifications will need to be altered accordingly and products will need to be re-certified against these specifications.

Recommendation 2:

Agree on the information for which E-Reporting will be applied and fully specify the data formats and protocols for electronic entry, storage and transmission.

Data serialisation

For data storage and transmission, "serialisation" (or deflating) is the process of translating data into a format that can be stored in a file or transmitted before being "deserialised" (or inflated) to the original data on the same or another computer environment. Some sort of serialisation is required to transfer logsheet or observer data from the vessel computer back to the management and research agency databases. There is a large range of data serialisation formats (Appendix 5, Table 4) that are available and it is outside the scope of this project to undertake a review of the pros and cons of each of these. However, Comma Separated Value (CSV), and Extensible Markup Language (XML) formats are commonly used in fishery E-R software and provide a useful comparison.

CSV format

A CSV file stores tabular data (numbers and text) as a sequence of plain text characters with each field commonly separated by a comma or tab. CSV files consist of any number of records containing an identical sequence of fields, separated by line breaks (Appendix 5, Table 5). CSV is a common, relatively simple file format that is widely used to communicate data between programs that operate on incompatible (often proprietary) formats. Although it is very commonly used, CSV files have never been formally

documented or specified, which has led to a wide variety of interpretations of CSV files (Shafranovich 2005).

XML format

In comparison to CSV, XML is a very structured and well documented format. It is a commonly used, free, open standard format that defines a set of rules for encoding data in a document that is both computer-readable and human-readable and designed to be used over the internet. One of the main advantages of XML is that information sent in this form can be automatically validated by an XML processor to ensure it has met all of the data requirements defined in a Document Type Definition (DTD) or an XML "Schema" language. These definitions constrain the set of elements that may be used in a document, which attributes may be applied to them, the order in which they may appear, and the allowable parent/child relationships. These attributes have made XML one of the preferred formats for transfer of fisheries E-R data and many of the existing E-R software products have the ability to produce XML outputs.

One of the main criticisms of XML, however, is that it is a very "verbose" and complex format, in that it takes a lot of script to transfer the actual information (Atwood 2008; Appendix 5, Table 6). Often this is not an issue, but in the case of sending information from a vessel via satellite to a fisheries agency, there can be a large monetary cost associated with the transmission of such a verbose format in real time. For this reason, a more compact serialisation format such as CSV may be required for real time E-R.

Recommendation 3:

Evaluate the use of XML as the standard serialisation format for all E-Reporting not requiring satellite transmission.

North Atlantic Format

Unlike the generic CSV and XML formats, NAF was developed specifically for fishery data transmission. During the 1990's there was considerable work amongst European Communities to standardise data transmission from fishing vessels. A format was developed in which a "two letter coding" system separated by slashes ("/") between each code was used, initially focussed on transmission of VMS data (Appendix 5, Table 7). The main features of the format were that it could be readable both by humans and by computers, and that "vessel to shore" transmission could be done using a reduced number of "bytes" making the transmission affordable. Ultimately, this was consolidated into a standardised format for data exchange and evolved into the "North Atlantic Format" (NAF) by the end of the 1990s. Since 2000, the use of NAF has consolidated as a standard for electronic data transmission in the North Atlantic, and its use has expanded to other fisheries and RFMOs. It has also been used and/or evaluated in fisheries research projects such as IMPAST, SHEEL and CEDER.

Recommendation 4:

Evaluate the most appropriate serialisation format (CSV, NAF or others) for all E-Reporting and E-Monitoring requiring satellite transmission.

Certification

Once the data standards and protocols have been established, there is a need for “certification” of the E-R or E-M systems to ensure that the created data reports meet the agreed data reporting standards. Such certification is usually done by an independent agency or the agency in control of the database into which the data is being transferred.

A typical certification process involves:

- Development of standards, specifications and procedures against which a product can be certified
- Make available the standards, specifications and procedures to product vendors
- Test the product against the standards and provide feedback to the vendors
- Certify (or not) the product
- Provide potential users with a list of certified products

A Future Framework for E-Reporting

Right now, because the paper-based system already exists, there is a significant opportunity for E-R to basically replace the paper-based logsheet and observer reporting system in the purse seine fleet during the next few years.

Recommended Approach

There needs to be agreement on the correct mix of incentives and regulations applied to assist in the timely transmission to E-R. There is a significant amount of preparation required before any E-R or E-M technology can be introduced broadly across the WCPO tuna fisheries. As described above, for each of the components where E-Reporting may be introduced (logsheets, observer reports, CMMs), broad agreement needs to be achieved on the adopted approach, standards for data collection and transmission need to be developed, and a certification process must be developed and implemented. Only then will the Commission be in a position to introduce E-R across the WCPFC tuna fisheries. This is represented schematically in Figure 5, and the reasoning for the phased implementation is described below.

Table 2. A summary check list of preparation activities required prior to implementation of E-Reporting.

Task	Lead Responsibility	
1.	Decision that WCPFC will be transitioning to accept E-R by an agreed date	Commission Secretariat / SPC
2.	Develop formal data entry, storage and transmission standards for E-R with specific agreement on data flow protocols	Recommendation at Commission level
3.	Develop data loader program to automatically accept, validate and load E-R data into the WCPFC operational databases (managed by SPC as data service provider). This tool may be the same as used by national fisheries agencies for their databases. Requires development of offline data testing capability	Contracted at Commission level
4.	If necessary, modify the WCPFC operational databases so that they meets the technical specifications required of the data loader	Contracted at Commission level (e.g.SPC)
5.	Develop standards, specifications and procedures against which E-R products can be certified to meet WCPFC operational data standards	Contracted at Commission level
6.	Develop standards, specifications and procedures for CCM databases so data extraction can be certified to meet Commission Secretariat operational data standards	Contracted at Commission level
7.	Make available the standards, specifications and procedures to member countries and potential E-R product providers	Commission Secretariat
8.	Test the E-R product against the standards and provide feedback to the vendor	3 rd Party certifier
8.	Test the CCM database data extraction against the standards and provide feedback to the vendor	3 rd Party certifier
8.	Certify E-logsheet software	3 rd Party certifier
9.	Certify CCM database data extraction	3 rd Party certifier
10.	Provide fleet with a list of certified E-R products	WCPFC

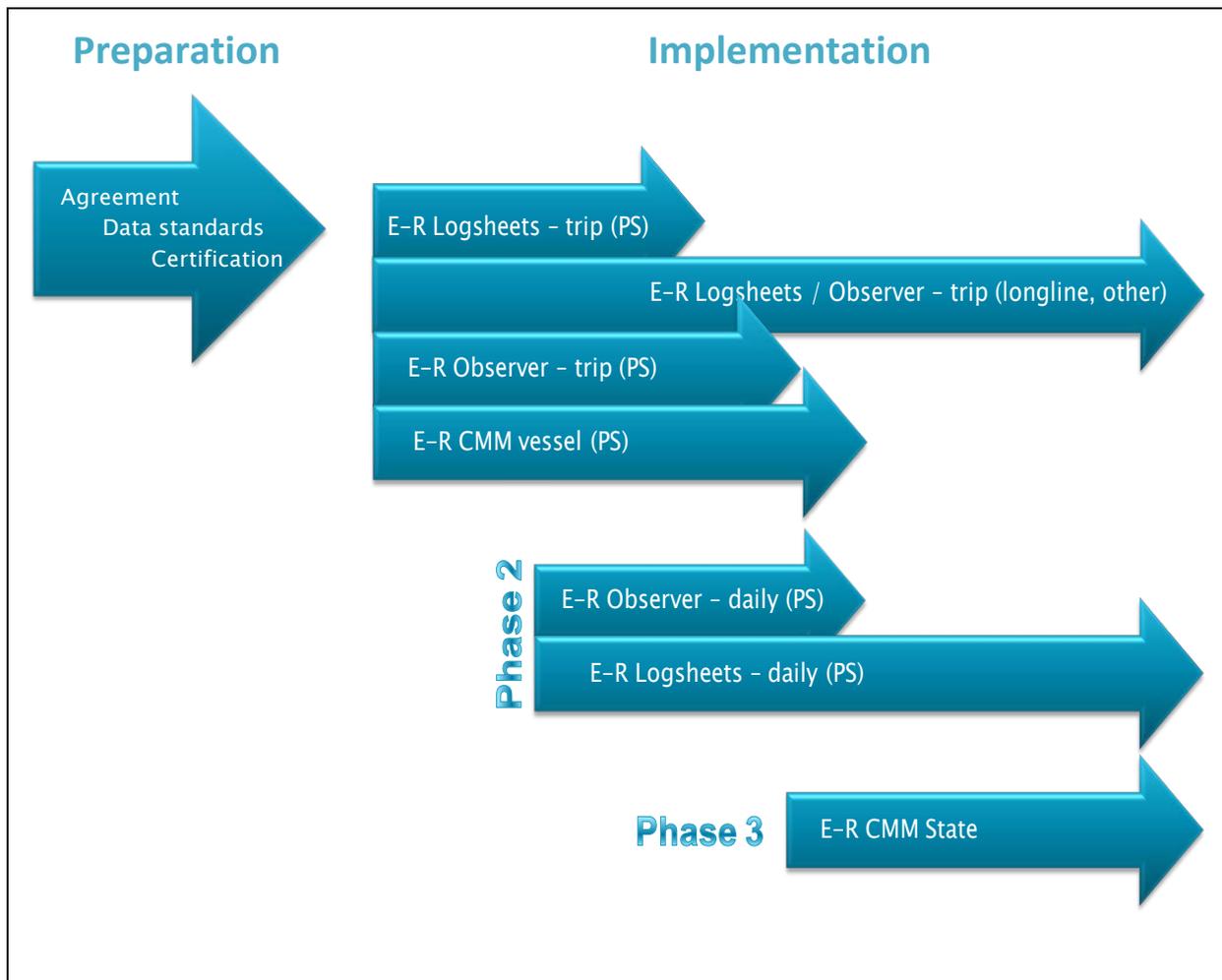


Figure 5. Schematic diagram of the preparation and three phases of introduction of E-Reporting projects, their timing and implementation periods.

Recommendation 5:

Acknowledging that some countries have already instigated E-Reporting trials, preparation work involving development of data standards and certification should be undertaken as a priority to enable coordinated cross-jurisdictional implementation of any E-Reporting process.

E-Reporting logsheets

End of trip reporting

The amount of information collected on current paper logsheets is relatively small and consists of repeated operational fields referring to the vessel, skipper and gear characteristics as well as set by set information on effort and target / non target catch weight and species composition. There is an extensive number of E-R products that are more than capable of replacing the paper logsheets and in doing so, significantly improved the data quality and efficiency by which it is collected. Use of automated data capture from

GPS, pre-populated data fields, drop-down boxes, range-checking on input are just some of the tools that E-R products use in this respect. Furthermore, many of these E-Reporting products have the ability to be tailor-made for the specific fishery and fishing gear to which they are being applied, further improving their efficiency and quality compared to the paper logsheets. Experience both overseas and within the WCPO tuna fisheries indicates that only a few hours of training is required for skippers to be able to adequately use these E-R products.

The WCPO purse seine tuna fleet generally consists of larger vessels with the bridge facilities and technological capacity for the immediate introduction of E-R logsheets. A number of these vessels are already using E-R to report to their own companies on a daily basis, but there is no consistency in how this information is entered or transmitted to the company, or how the company stores this information. There is certainly no electronic transmission of this information from the company or the vessel to the fisheries management agency.

Based on the above, the implementation of E-R logsheets on the purse seine fleet is seen as both feasible and practical, and can occur within a relatively short time frame as part of the first phase of introduction of E-R in the WCPO tuna fisheries.

Rather than the linear data pathway occurring in the current paper-based system (Figure 1 and Figure 2) whereby the data passes from the vessel through the company, onto the fishery agency, and then to SPC or the Commission Secretariat, the E-R logsheet system can facilitate parallel pathways of data flow. Whereas the paper-based linear data flow compounds any delays in transport, data entry and submission at each of the steps, parallel data flow through the E-R logsheet system provides the company, fishing agency, and SPC, with the primary transfer of raw data with minimal delay (Figure 6, Figure 7). There will be some concern about this process because mistakes at data entry by the vessel will be sent out to multiple agencies, but the potential for each agency to correct or query any data remains. Also, a secondary transfer by which the validated data is shared between the agencies means that each agency will have a copy of the original data, an audit of changes, and a final copy of the edited data. This is an extremely transparent process that guarantees the best available information is accessed by each agency.

Some longline vessels have the bridge facilities and technological capacity that could match the purse seine fleet, but this is probably the exception rather than the rule. In contrast to the purse seine fleet, generally speaking, the bridge facilities and technological capacity of a very significant portion of the vast longline fleet has far less capacity for the immediate introduction of E-R. On many vessels there is a lack of even the most basic computing facilities, access to a robust 240 V supply may be questionable, and it is more likely that the skipper and crew have less experience in the application of E-technology to fishing operations. Thus, although the introduction of E-R logsheets can begin immediately on some longline vessels as part of Phase 1, implementation across all of the fleet is likely to take well over a decade.

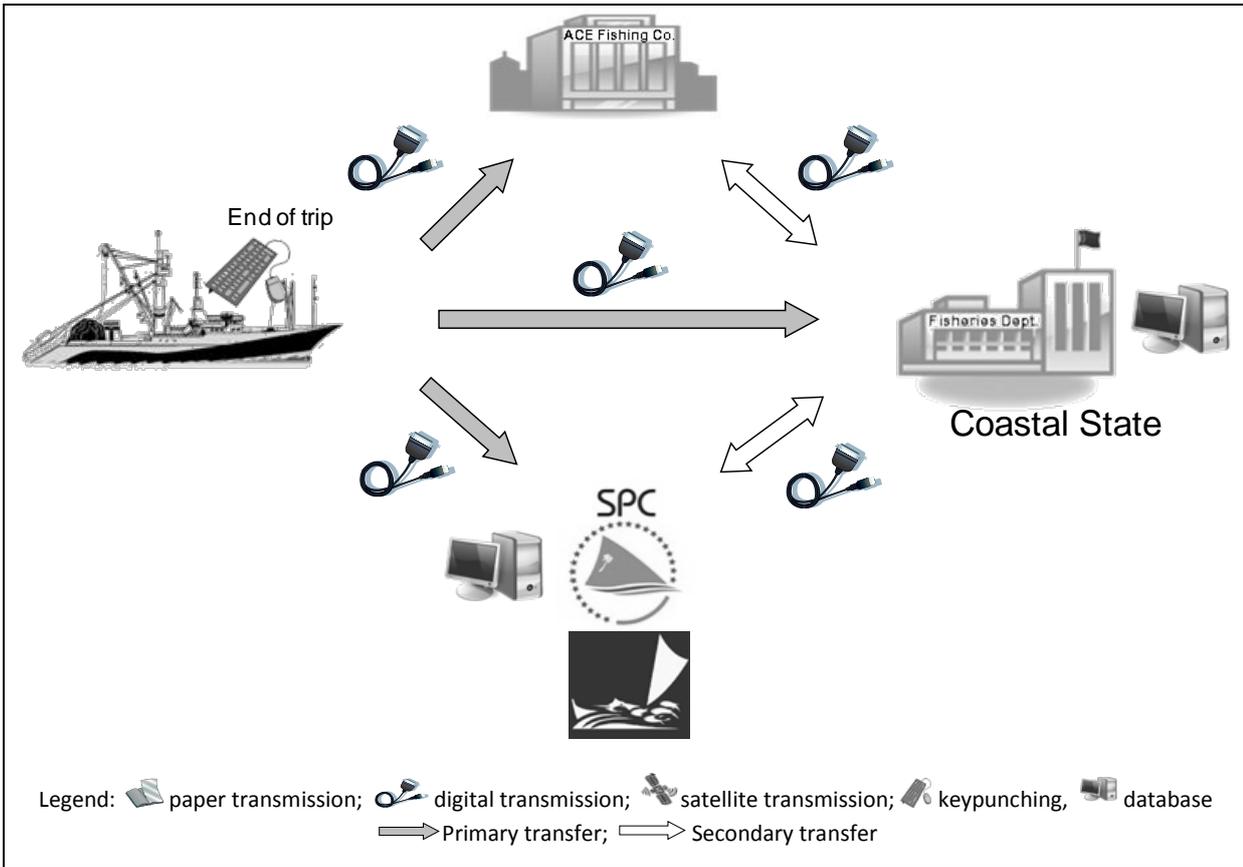


Figure 6. General schematic of data pathways and processing for end-of-trip E-R observer report for FFA/SPC members.

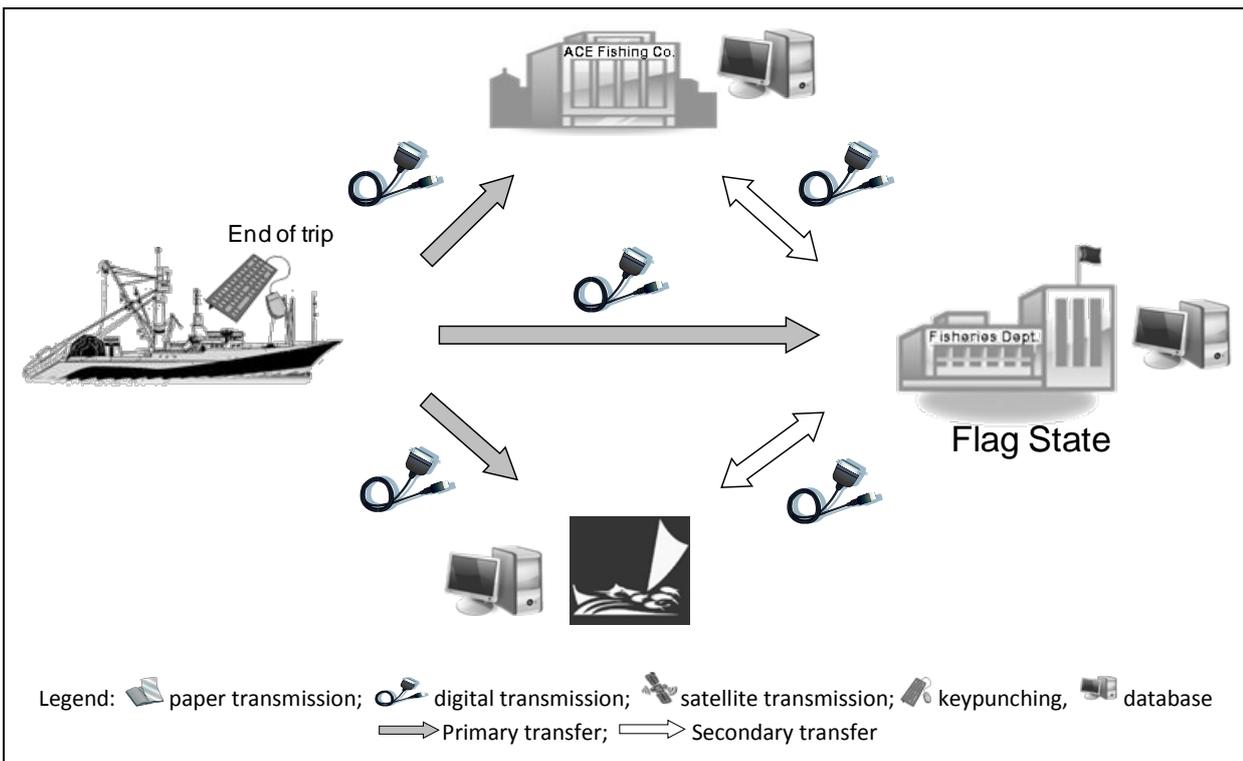


Figure 7. General schematic of data pathways and processing for end-of-trip E-R observer report for non-FFA/non-SPC members.

Recommendation 6:

Establish an E-Reporting logsheet data pathway in which the primary data transfer goes from the vessel in parallel to the fishing company, fisheries agency and SPC (e.g. as the central regional data collection point and on behalf of the WCPFC). A secondary transfer of final edited data together with the change audit will be shared between each of these agencies.

Recommendation 7:

To facilitate buy-in by CCMs and industry, the initial implementation of E-Reporting logsheets should focus on end-of-trip reporting. Technical and practical factors determine that uptake of E-Reporting logsheets will be more feasible in the short term for vessels in the purse seine fleet, and a longer process will be required for the longline fleet.

Real time reporting

The reason that end-of-trip reporting for E-R logsheets can be feasibly introduced immediately is because at the end of a trip, when the vessel is in port, the data can be transferred via a USB stick or through the land-based or cellular phone network. There are no significant technical difficulties or cost implications in doing this. Real time reporting on the other hand, requires transmission of data via satellite, which can have significant cost implications, and there may be a significant proportion of the purse seine fleet that do not currently possess this technological capacity. Also, there is no current system in place on which real time reporting (of logsheet data) can be based, so it is likely that there will be significant hurdles before the agreement on real time E-R logsheet data transmission can be reached.

One of the critical decisions to be agreed on prior to the implementation of real time reporting of logsheet data is exactly what data needs to be reported on a real time basis. For the stock assessment process and environmental modelling, there was no pushing need from scientists or managers to access real time information. In fact, across the stakeholder groups, it was only the compliance officers that put forward any cogent argument for the need to access real time information. They can already access real time VMS information and have access to real time information on vessel registrations. Based on this, they establish a compliance index for each vessel and prioritise and plan their compliance activities. The one piece of missing information that would significantly improve this process is real time catch information (species composition and weight) of what is on board each fishing vessel and carrier vessel. This could be done by either a report of what the vessel has caught each day, or a daily report of what catch is on board the vessel. We don't recommend the former because it requires a full time series of daily catch information to understand what is currently on board whereas the latter provides this in a single transmission.

For real time E-R logsheet transmissions from a vessel via satellite, where there is a cost associated with the amount of data transmitted, we recommend the following data as the minimum to meet compliance requirements: vessel name; date; time; and, position together with species code and weight for Skipjack Tuna; and species code, weight and grade (large/small) for Yellowfin Tuna and Bigeye Tuna. To meet a significant emerging compliance issue, we would also recommend a field stipulating whether a purse seine FAD activity (deploying/retrieving, investigation only, setting, fish aggregation lights, etc) has occurred during the previous day. All of these fields could be easily summarised from within the E-R logsheet program from the set-by-set information entered by the skipper, but agreement on which fields to transmit in real time needs to be reached. For all of the above reasons, we recommend that the introduction of real time E-R logsheet reporting is implemented as a Phase 2 project.

Recommendation 8:

Minimum real time E-Reporting logsheet fields should include: vessel code, date, time and position together with species code and weight for Skipjack Tuna, and species code, weight and grade (large/small) for Yellowfin Tuna and Bigeye Tuna. Fields identified in the CMMs as critical for real time availability for management of the fishery should also be provided.

Recommendation 9:

The introduction of real time E-Reporting logsheet reporting should only be considered as a second phase of E-Reporting to begin once end of trip E-Reporting logsheet reporting is well established.

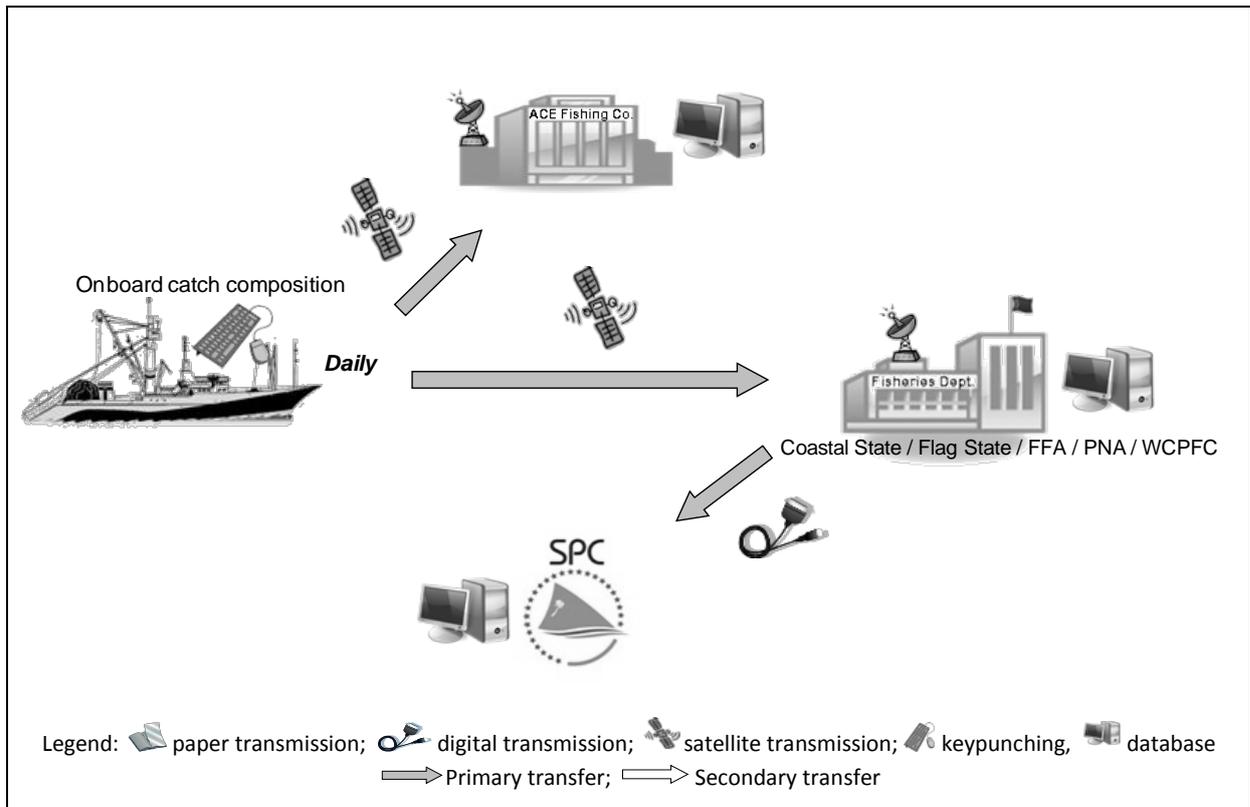


Figure 8. General schematic of data pathways and processing for real time E-R logsheet reports.

E-Reporting observer

End of trip reporting

There is an extensive range of information currently being collected and reported through the paper-based observer reporting system. As detailed previously in this report, within this paper-based system, there are numerous separate but related forms on which separate aspects of the data is collected. Although it is possible to implement E-R observer reports for only particular aspects of data collection, we see no technical reason that the entire paper-based observer reporting system cannot be converted to E-R observer reports, and recommend this as the preferred approach.

Again, there are a range of E-R products that are already well placed to collect observer information, some of which already have proven experience in doing so, including one recently being trialled specifically in the WCPO tuna fisheries (eTUBS). Once the E-R observer product is developed, the observers would require a significant level of training in its use. Due to the complexity of the observer data and reporting requirements, this is likely to take at least a week before they could be considered as prepared to take the E-R product to sea, and is also likely to require some level of at-sea technical support during initial use. Obviously, there will be a need for the purchase of some type of hardware (e.g. laptop, tablet) that the observers will take on board upon which the E-R observer software is loaded. Another option for the purse seine fleet could be to insist that each vessel has a laptop on-board on which the database system installed dedicated to the observer. At the end of the

trip the observer merely backs-up the data before leaving. In this way, both the vessel and the observer has a copy of the initial data entered. Regardless, strict protocols of at least daily backups of data onto a secondary device during the trip will need to be developed to prevent accidents or mistakes from causing irretrievable data loss. These should be developed as part of the preparation of E-R observer data standards.

Similar to E-R logsheets, if only end-of-trip reporting is required (as currently is the case), then the entire observer data can be downloaded to a USB stick or through the landline or cellular telephone network once the trip is completed.

Recommendation 10:

End of trip E-R observer reporting should be introduced alongside E-Reporting logsheets during the introduction of the first phase of E-Reporting.

Real time reporting

Similar to E-R logsheets above, costs in transmission of large amounts of E-R observer data via satellite are the main issue in real time reporting. Much of the observer information is scientific data collected for use in annual stock assessments and is therefore not required on a real time basis. As stated previously, however, real time reporting of a vessel's catch composition has significant potential value for compliance. As such, we again recommend the following observer data as the priority to meet real time compliance requirements: vessel name; date; time; and, position together with species code and weight for Skipjack Tuna; and species code, weight and grade (large/small) for Yellowfin Tuna and Bigeye Tuna. We also recommend inclusion of a field stipulating whether a purse seine FAD set has occurred during the previous day. All of these fields could be easily summarised from within the E-R observer program from the set-by-set information entered by the observer.

The technological hurdle for implementation of real time E-R observer reporting is the process by which the data is transmitted via satellite. Fortunately, emerging technologies being considered by the FFA for ROP Occupational Health & Safety reasons offer a potential solution. There are a number of other off-the-shelf satellite communication devices which have the ability to transmit "short burst data" (SBD) satellite transmissions. The deLorme Inreach SE is one such device being trialled by the ROP that has a \$60/month package that can transmit a maximum of 340 bytes per SBD message via the Iridium network. This should be sufficient to transfer minimal *catch on-board* data if an appropriate serialisation format is adopted.

Recommendation 11:

In addition to any OH&S requirements, minimum real time E-Reporting observer fields should include: vessel code, date, time and position together with species code and weight for Skipjack Tuna, and species code, weight and grade (large/small) for Yellowfin Tuna and Bigeye Tuna. Fields identified in the CMMs as critical for real time availability for management of the fishery should also be provided.

If there is a need to prioritise between implementation of real time reporting of E-R logsheets compared to E-R observer then we would recommend the initial implementation of the latter. Strictly speaking, there is no difference in the real time data transmission we are recommending whether done under E-R logsheet or E-R observer, but we believe the E-R observer pathway will have fewer implementation hurdles.

Recommendation 12:

If capacity to implement real time E-Reporting logsheet reporting is delayed or impractical, then there should be additional focus on the implementation of real time E-Reporting observer reporting.

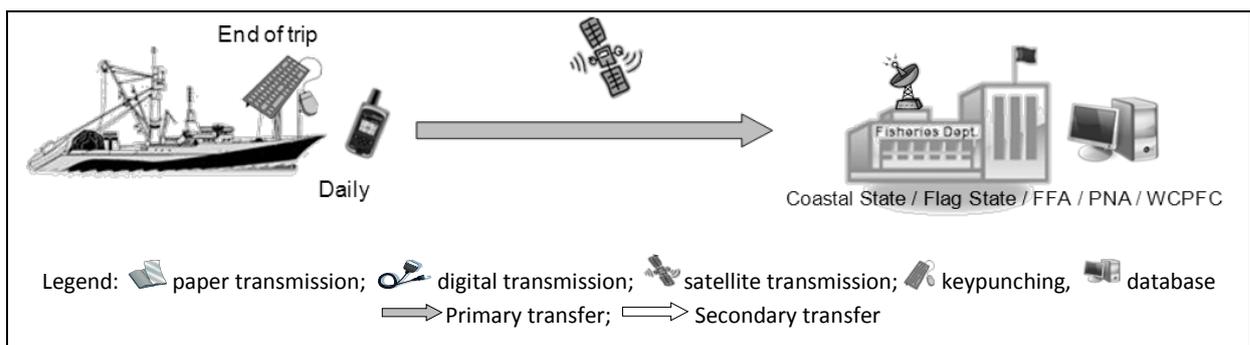


Figure 9. General schematic of data pathways and processing for real time E-R observer reports.

E-Reporting of CMM obligations

E-R has the potential to satisfy CMM obligations to report from the vessel to the national fishery agency, and from the national agency to the Commission. It is reasonably feasible and practical for the purse seine fleet, and some vessels in the longline fleet to provide E-R CMM reports to the national agency in the immediate future. As with E-R logsheets and E-R observer reports, the implementation of E-R CMM reporting at the end of a trip has the potential to begin immediately, whereas the potential for implementation of real time E-R CMM reporting however will require further work and time before it is realised.

Recommendation 13:

The initial implementation of E-Reporting of CMM obligations should focus on transmissions between the vessel and the fisheries agency.

It is not a technical issue preventing E-R CMM reporting from the national agency but more that it just will not be feasible until the bulk of the fleet is complying with this E-R reporting requirements.

Recommendation 14:

Implementation of E-Reporting of CMMs between the fisheries agency and the Commission should be considered only when a large proportion of the fleet is undertaking E-Reporting of CMMs to the fisheries agency.

Strategic Recommendation 3: The implementation of E-Reporting for logsheets, observer reports, and CMMs should be undertaken in a phased approach determined by technical feasibility, and practical considerations and constraints. The process for development of E-Reporting standards, specifications and type approvals should be led by the Commission Secretariat as amongst the first and high priority actions.

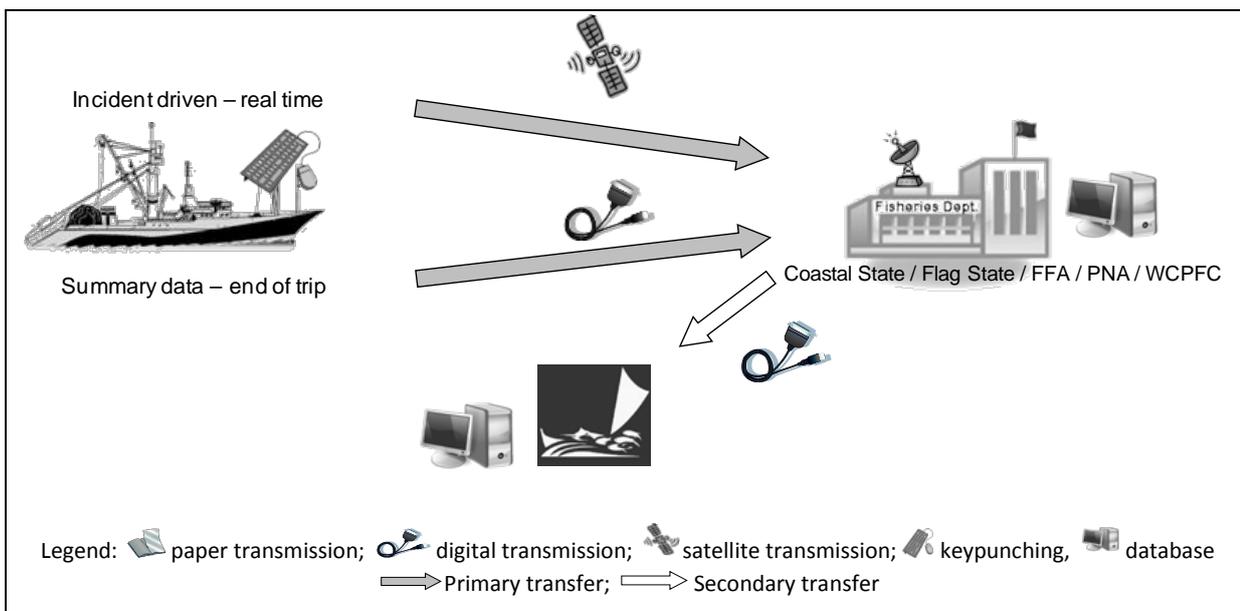


Figure 10. General schematic of data pathways and processing for real time and end of trip E-R CMM reports from vessel to fisheries agency.

E-Reporting port sampling

This is a small but discreet aspect of scientific length frequency data collection that could be easily taken from its current paper-based process and converted into an E-R process. In fact, E-R port sampling is already operational for some of the PNA fleet landing in PNG and these data get validated and loaded into the FIMS database automatically. Because this is occurring in port at the end of a trip, this information can be sent real time via land-based or cellular telephone networks without the issues associated with data transmission via satellite.

A Future Framework for E-Monitoring with Video and Sensors

Recommended Approach

Strategic Recommendation 4: E-Monitoring be formally recognised and adopted as a legitimate, appropriate and acceptable monitoring tool as both an alternate to human observer programs and a supplement to observer programs, for certain WCPO tuna fisheries. The process for development of E-M standards, specifications and type approvals should be led by the Commission Secretariat as a priority and E-M should be progressively rolled out to support compliance with Commission’s CMMs, improve fishing practices, and increase fisheries knowledge. The use of E-M using sensors alone should be considered as appropriate, based on fishery monitoring goals.

This report is required to provide a recommendation to progress a practical and efficient E-M framework. The technology involved in E-M is well established. It comprises cameras, movement sensors for drums and winches, sensors that detect changes in hydraulic pressure, engine revolutions, and a GPS link to monitor position and time. This all provides a wide variety of accurate, time appropriate, and validated fisheries data. Cameras and sensors are linked to a control box where images, sensors, and GPS data are all recorded either for near real time transmission (sensor and GPS data), or for later retrieval (digital images). System checks can be undertaken and reported in real time, and in some cases systems can be interrogated and settings managed remotely. Other features are potentially available such as event recording, remote login, automated fish measurement, and limited real time data transfer. The justification and practicality of such features must be carefully evaluated against potential costs and benefits during the design phase of any program to roll out the technology.

Some of the most common questions raised during this project were: How much will it all cost? Who will pay? And does it have a cost benefit? The answers are not easy. E-M will continue to revolutionise fishery data for both science and compliance. The equipment, over time, will result in significant behavioural changes in fishing operations, high quality data for science, a significant increase in compliance capability, with a concomitant opportunity to focus on high risk compliance targets. This review believes there will need to be a significant investment by Commission members, and donors through regional organisations, in both capacity building and information management systems, but that the recurrent costs of ongoing programs should be fully cost recovered from industry.

Aspects of this technology of key interest to both fisheries managers and industry are the integrity of the data, that it comes in a form that can be readily viewed, the reliability of the equipment, and the ability for E-M to fit in with fishing operations — and certainly not to hinder them.

A small number of fisheries under US and Canadian jurisdictions have now been using this technology for more than a decade with a high level of performance. E-M has been used for

research purposes throughout Europe, in Australia, and in the Asia Pacific region. Countless proof of concept trials have been undertaken almost all of which have demonstrated the success of the equipment, even if particular fisheries' data objectives have not been met. It is fair to say the general concept and technology of E-M is proven.

There are some key challenges around each new use, for example:

- Setting clear goals about what E-M can achieve
- Developing a plan to achieve those goals
- Working with stakeholders from the earliest stage possible in any implementation
- Developing the legislative and policy framework that will give effect to the program
- Initial deployment
- Full deployment
- Program review

The *Fisheries Monitoring Roadmap* (Lowman et al. 2013) describes the five phases of a program as: assessment of goals and objectives, outreach and program design, pre-implementation, initial implementation, and optimal implementation. The *Roadmap* states “while some steps may not be relevant to every fishery, phase one assessment of goals and objectives, will be one of the most important components for ensuring proper program design. Without a clear understanding of what is needed to properly manage and execute a fishery, it will be difficult for stakeholders to agree on the components of a monitoring program”. We agree completely with this statement.

The implementation of E-M is a significant logistical exercise. Whilst there are obvious steps in the process, these can be undertaken either in parallel or series, depending on particular circumstances.

Prior to implementation:

- Standards, specifications and type approvals have to be developed for both hardware and software
- Funding arrangements need to be identified and settled
- Stakeholders must be engaged and brought along with the program
- Governance arrangement established
- Legislation and policy needs to be developed and approved
- New approaches to compliance need to be developed
- Data storage requirements need to be agreed
- Information management systems need to be updated or redesigned
- Video analysis and report preparation training is required
- Human capacity generally needs to be developed across the system

For implementation:

- Infrastructure has to be established (e.g. offices and communications)

- Staff need to be employed and trained
- Local installers needs to be trained and/or accredited
- Hardware needs to be made available at designated ports
- An inventory of equipment needs to be established
- Support, service and maintenance networks need to be established
- Data recovery arrangements need to be designed

During this process, analysis software has to be installed and a decision made on whether data will need to be encrypted. The whole process has to be developed bearing in mind the issue of chain of custody for potential evidence.

Throughout the process a high level governance committee, specifically established for this purpose and with appropriate levels of delegation, will need to address logistical challenges in near real time — simply because some issues will emerge whose resolution cannot wait.

Once the program is established and data starts to flow, more issues will emerge that require careful evaluation, and timely resolution. Within five years a full independent program review should be undertaken.

E-Monitoring Video Structural Elements

E-MV comprises a number of defined structural elements working together. The first element uses sensors to detect particular mechanical operations, trigger cameras, and store sensor data. The second is the capture and storage of video. The third is the software used to check and validate on-board operations. The fourth is data storage and retrieval. And the fifth, the software used to analyse and report on the collected video and sensor data.

All these elements work together but it is worth noting that the use of sensors does provide a stand-alone option. During the course of this project compliance officers noted that sensor data that detected changes in engine revolutions, the activation of hydraulic systems, and the use of drums and winches, would in itself be a valuable regulatory tool, especially because this data could be automatically transmitted in near real time. For example, if fitted to bunkering and carrier vessels it would be possible to detect precisely when a transshipment operation was occurring. Example of sensor only fishery monitoring program were identified in Denmark using the product BlackBox, and in the UK using the product Succorfish.

In a similar vein, the video analysis element could be used to analyse video data collected by on-board observers using portable devices.

E-M Program Recommendations

This report does not make a recommendation for a single provider of E-M services but rather recommends that multiple service providers should be able to meet Commission member's E-M needs, providing their equipment is certified. There are already several providers available, and it is likely others will enter the market. It makes sense for multiple providers

to be engaged and operating, as such an approach will encourage innovation, bundling of E-M services and communication needs, efficiency, and price competition.

One of the critical first steps is therefore the development and approval of standards, specifications and type approvals for hardware and software, as well as an associated certification process. This process needs to be led by one organisation with the involvement of a broad range of others. The aim is to have a single WCPO-type approval requirement, generating a consolidated list of potential providers.

Recommendation 15: It is recommended that the development and approval process for standards, specifications, type approvals; the certification process for hardware and software; and maintenance of standards; should be led by the Commission Secretariat with the participation of representatives with technical expertise from regional organisations, flag States, and coastal States.

Recommendation 16: Certification to standards should be administered by an independent third party.²

Administration of E-M programs

The administration of E-M programs will bring many new challenges. The options considered by this review are to either have a single administrator such as the Commission, a regional administrator such as the FFA, or multiple administrations through existing observer programs and national fishery agencies. Whilst a single administrative arrangement has some attractions, this review considered it would be unlikely to deliver the best outcomes. This will be a large and geographically challenging program and, whilst standards and high level policies and procedures should be established and maintained centrally, there are significant potential benefits from a locally managed program. In particular these benefits relate to program logistics, employment and service.

Recommendation 17: It is recommended that the development and maintenance of high level policies and procedures be led by the Commission Secretariat.

Recommendation 18: It is recommended the focus of E-M administration be through existing sub-regional observer programs, and national fishery agencies.

Procurement, ownership, installation, and maintenance of E-M equipment

This review considered that procurement, ownership, installation, and maintenance of E-M equipment could be done either through the program, or by vessel owners. There are benefits associated with both options but key considerations are whether the program

² The engagement of the fishing industry and technology providers will be critical to program success.

should be bearing the costs of inventory, installation, maintenance, and replacement, and then recovering those costs through fees and charges; or whether it should be the vessel owners' responsibility in the same way as they procure other electronic equipment (including VMS) and any other essential equipment. There are also incentives for the vessel owner to look after and properly maintain the equipment if they either own or direct lease electronic equipment.

Recommendation 19: It is recommended that hardware and software be purchased, installed, and maintained by vessel owners.

Collection of data

A key logistical challenge is the collection of data from the vessel. This review identified two means of data retrieval from amongst existing suppliers. The first is a removable / replaceable hard drive. The second is a data download to a storage device from a fixed hard drive. It is important to note an E-M program will involve many terabytes of data from each vessel trip, and that transmission of this volume of data by satellite or mobile phone network, or by Wi-Fi when in port, are not currently viable options.

This review identified four options for data retrieval from vessels whether by removable hard drive or data transfer:

- Fisheries regulatory officer
- Other authorised officer
- Observer, or
- Vessel master

Each of these options has the potential to be satisfactory and whilst having a regulatory officer recover data on all occasions would be desirable, this is highly unlikely to be a feasible option. It is noted there will be times when data transfer will need to occur during bunkering or transshipping operations.

The decision about which option is required for data retrieval will need to be determined based on the particular circumstances of the vessel. If a vessel has a good compliance record, it could be generally white-listed and the skipper would be authorised to organise data transfer. For black-listed vessels, and under a random collection program, fisheries officers would organise data transfer.

Recommendation 20: It is recommended that procedures be developed to facilitate all four options for data retrieval, based upon a risk assessment of the circumstances of each type and variation of data retrieval.

Data review

E-M programs involve a high volume of data review. The amount of data to be reviewed depends on the objectives of the program, and can vary by fishery, and by vessel. If the

video is being analysed to collect scientific data, the amount of analysis will be determined based on a determination of a statistically valid sample size; if a particular compliance issue is suspected, all video might be analysed. Whilst there is no general rule, it is not atypical to view a sample of between 10 and 20% of all video. This is basically done to provide an incentive for vessel logbooks to become accurate, and the main fisheries data collection mechanism.

The options for data review are through either a centralised data review centre, or at a national fishery agency level. Relevant issues are similar to those for the above discussion about program administration.

Recommendation 21: It is recommended that national fishery agencies, and regional observer programs be responsible for analysis of video and sensor data.

Other matters for consideration

To ensure effective implementation of an E-M program there will need to be a commitment to capacity building and to IMS development across the region. Support for the development and implementation of model legislative provisions will be required. E-M roll out trials should be undertaken to demonstrate the equipment, its operations and potential, and to develop familiarity and confidence with the product. National support will be required for program management, data analysis, reporting and compliance.

Consideration will need to be given to data storage requirements once video analysis has occurred having regard to the large volume of data involved. It is normal practice for data to be overwritten within a few months unless there is a specific need for it be retained for a longer period (for example to support a compliance action). Legislation may be required to allow early disposal of data if this conflicts with record retention legislation.

Ownership of data needs to be clarified and this will need to be done for each regional and fishery agency administering a program. The two models are: 1) that the agency owns the data and the vessel is required to facilitate its collection; and 2) that the vessel owns the data but is required to collect and provide it to the agency for analysis and subsequent disposal.

Video and sensor data can provide unequivocal information that a regulatory breach has occurred. This creates a new stream of data management challenges for compliance officers, firstly to ensure video and sensor can be used as evidence, and then ensuring chain of evidence requirements are understood and met. The following (Table 3) is a summary check list relating to areas of activity for program development and implementation.

Recommendation 22: It is recommended these matters be referred to the EWG tasked with progressing E-M for resolution.

Table 3. A summary check list relating to areas of activity for E-M program development and implementation.

Task	Lead responsibility
1. High level program design and goal setting	Commission Secretariat
2. Development of standards, specifications, type approvals, and certification requirements	Commission Secretariat
3. Certification of hardware and software	Independent third party
4. Development of policies and procedures	Commission Secretariat
5. Development of model legislation	Commission Secretariat
6. Program design* - Commission area of competence	Commission Secretariat
7. Program design– regional	Regional bodies and national fishery agencies
8. Program design - national EEZ	Regional bodies and national fishery agencies
9. Program administration	Regional observer programs and national fishery agencies
10. E-M demonstration trials	Commission Secretariat
11. Capacity building and training for industry	Regional observer programs and national fishery agencies
12. Capacity building and training for in-program	Regional observer programs and national fishery agencies
13. Procurement, installation and maintenance of E-M equipment	Vessel owner
14. Information Management Systems development and support	Regional bodies and national fishery agencies
15. Data retrieval or hard drive exchange	Regional observer programs and national fishery agencies
16. Data analysis and reporting	Regional bodies and national fishery agencies

* It is noted the majority of the expertise in program design, administration, data analysis, and capacity building, lies within the current E-M provider companies. Large parts of this activity should be contracted out.

Implementation Strategy

Strategic Recommendation 5: Implement separate but parallel processes to move E-Reporting and E-Monitoring technologies forward towards implementation. These processes should involve the establishment of an Implementation Working Group (IWG) for each technology, each with a Project Manager, and both under the oversight, direction and control of an Internal Governance Committee (IGC) to monitor project risks, budgets, potential conflicts of interest, and progress against agreed goals.

In advance of these discussions it should be stated that an expansive and inclusive process is proposed as an implementation strategy. This will be expensive in time and resources, but this expense should be weighed against the magnitude of change envisaged, and long term gains and benefits.

The key to successful implementation of E-R and E-M will be an effective, transparent, and clearly understood reporting and control structure, supported by effective project management (Figure 11). The first step is project initiation, followed by planning, execution, and closure as the project moves into program implementation. A monitoring and control process is required throughout the project to ensure risks and conflicts of interest are managed, the project manages its costs, does not go beyond scope, and delivers to targets.

E-R and E-M are in very different stages in terms of their development and implementation.

- E-R relies on well-established technology, trials in the region have been largely successful, there is strong industry support because an efficiency dividend is envisaged, and E-R would replace existing reporting systems. There are challenges to ensure the data arrives in an appropriate format but these are readily achievable.
- E-M is completely new to most agencies and to industry and has significant unresolved (but resolvable) logistical and technology challenges. It is seen by many (including this review) as a potential solution to a range of monitoring challenges either not currently addressed in a coordinated way, or in some cases yet to be addressed.

E-R is ready to go, whilst E-M is not. The implementation strategy therefore needs to run as two processes — running it as a single process would place the potential for rapid progress with E-R at risk. They are separate technologies with different goals and whilst they clearly have touch points, for example around the potential to share communication channels, and for integration of data through fisheries information systems, they are not a single technology. This review has therefore concluded that separate but parallel processes are required to move these technologies forward. It should be emphasised it is important these processes not become silos, and that they collaborate to ensure eventual front end integration is achieved (see section on integration).

The first step towards implementing E-R and E-M is to initiate discrete projects, and establish and fund E-project Working Groups (EWGs) for each. The terms of reference for each group would be built around Commission's decisions in respect of this report.

Recommendation 23: EWGs be established for both E-Reporting and E-Monitoring, with the delegation and resources to call on technical advisers and industry expertise, operating under a strict policy of declaring potential conflicts of interest. SPC should be involved in

some capacity in the E-Reporting Working Group and FFA should be involved in the E-Monitoring Working Group.

It is strongly recommended the composition of these EWGs be limited to no more than eight members, with cross representation from amongst Commission members. This review does not support a larger group because of the significant risk that larger groups can become bogged down, accountability can suffer, and progress can stall.

Recommendation 24: The EWGs comprise a maximum of eight country members with nominations for members with relevant technical skills to be provided to the Commission Secretariat by 31 January 2014.

IWGs should report to the Commission through the TCC. EWGs should be independently chaired. We define independent as a person not currently or recently engaged as an employee by any member or related fishing or technology industries, and with no financial or other vested or potential direct or indirect conflict of interest.

Recommendation 25: The Commission Chair in consultation with the Secretariat appoints independent IWG chairs.

EWG member representatives should have a demonstrated strong technical background to ensure they can make a significant contribution to the project. Membership should include expertise in E-M and E-R, data standards, legal, policy, and communications.

Experts in each technology should be involved as advisers, and providers of each technology should be invited to take part at appropriate times. A strict policy of declaring potential conflicts of interest should be applied.

A high level internal governance committee (IGC) should be established to oversight the process with appropriate levels of delegated power to address emerging issues and challenges in real time. Issues will emerge which will require resolution if these processes are to be delivered in an effective and efficient manner. The IGC Chair should be the Secretariat's Compliance Manager with no more than three other members nominated from amongst Commission members with appropriate experience in project implementation and governance.

Recommendation 26: The Secretariat establishes an Internal Governance Committee (IGC) chaired by the Compliance Manager, and with three members.

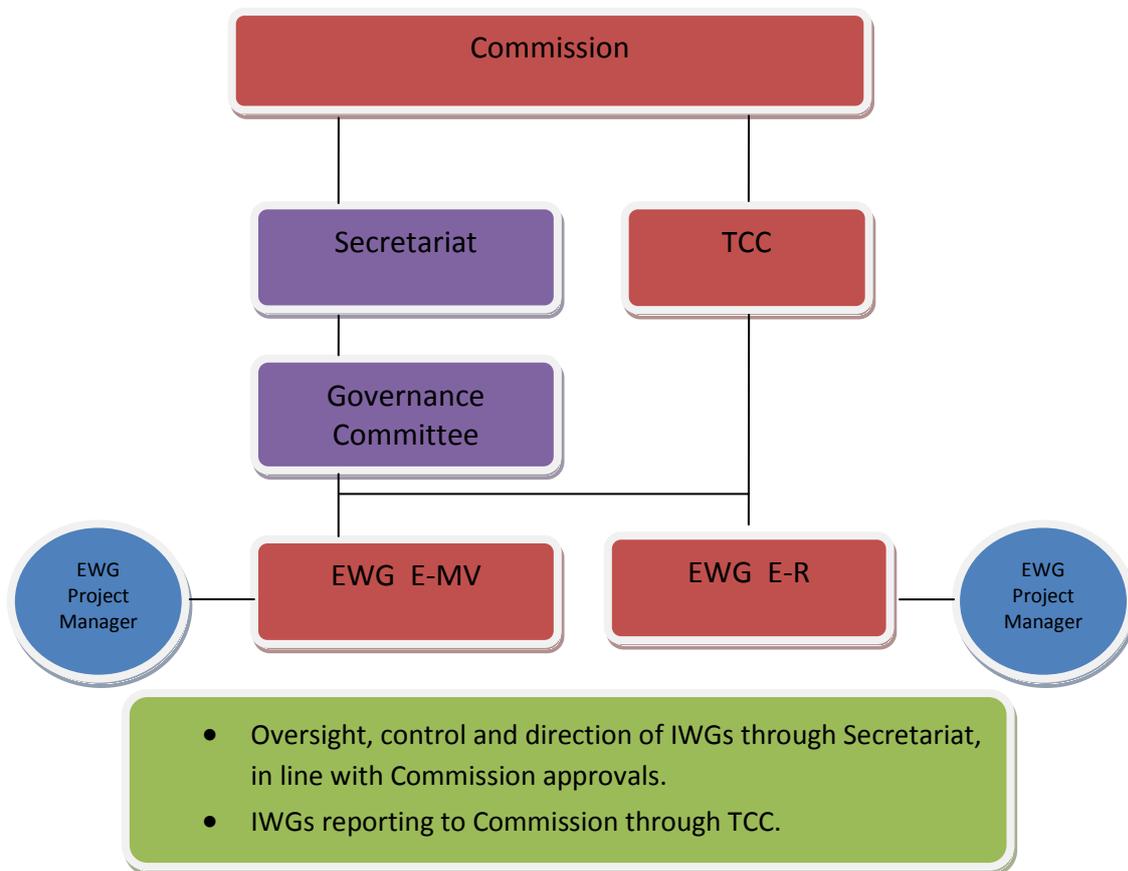


Figure 11. Organisational elements for the proposed implementation strategy.

The Commission Secretariat, through the IGC should lead the monitoring and control element of the project including development of terms of reference for the IWGs based on any decisions of the Commission with respect to this report’s recommendations. The IGC terms of reference should be developed by the Secretariat and include the role of developing and monitoring project risks, budgets, potential conflicts of interest, and progress against agreed goals and output deadlines.

IWGs should commence a program of meetings no later than March 2014 with meetings at a maximum of 6 weekly intervals. Whilst full advantage should be taken to meet often through video- and tele-conferencing, it will be important for these groups to meet face-to-face at regular intervals — at least 4 times before the deadline for TCC reporting.

A project manager should be dedicated to each IWG with agreed outputs to be included in each position description and terms of reference. There are several options for engagement of project managers. These include the use of a known contractor, secondment from a CCM agency, secondment from FFA or SPC, or external recruitment of an employee or contractor. Secondment (especially with funding) from a CCM agency or from FFA or SPC is attractive because the project will be dealing with a known entity and the decision can be achieved within the proposed project time frame. The time frame involved in advertising for direct employees will however almost certainly mean these projects cannot deliver outcomes during 2014.

Whilst the Project Manager will need to spend time at the Commission HQ, the position does not, in the opinion of this review need to be based at the Commission's HQ. A decision that required the position to be HQ based would push out project deadlines.

Recommendation 27: Project managers should be procured either through engagement of suitably experienced contractors known to the Secretariat, or as a potential secondment from a CCM agency, or as a secondment from FFA or SPC.

The initial focus of project officers and the IWGs should be on the tasks to develop:

- i. Specifications and standards
- ii. Policies and procedures
- iii. Model legislative provisions
- iv. Indicative cost models and cost recovery approaches, and
- v. Program resource material

During 2014, it is highly desirable that E-M demonstration trials are undertaken across the region to develop support for, and awareness and familiarity with the project. These trials should be undertaken in as many countries as possible, and involve a cross section of vessels and fisheries.

A single broad communication strategy should be developed, and include as a minimum, regular project updates communicated through a newsletter (including trials), local and regional media, and regular updates of website material. An international database of fishery organisations and technology providers should be developed for distribution of project newsletters. A dedicated website should be developed.

Recommendation 28: The Commission Secretariat should facilitate E-M demonstration trials and develop a broad communication strategy.

These tasks should be substantially complete in advance of the 2014 TCC meeting for endorsement, prior to submission for endorsement by the Commission.

Prior to attempting these tasks, a planning workshop will be required. It is proposed initial high level program design and goal setting workshops be held in advance of but in association with the initial IWG meetings. A broader group should be invited to attend these workshops and they should be held in conjunction with an initial joint meeting of IWGs.

Recommendation 29: The Commission Secretariat should develop IWG terms of reference based on relevant decisions of the Commission concerning this report, and including the program of meetings.

The final role of the IWG is to develop the support material necessary for effective program implementation. This will take the form of published documents for WCPO E-M and E-R programs for:

- Standards and specifications
- Type approval and certification
- Program policies and procedures
- Model legislative provisions
- Operational documents (job descriptions, training standards, health and safety etc)

Recommendation 30: Planning workshops involving full CCM participation should be held immediately in advance of an initial joint meeting of IWGs.

What next 2015+?

There is a high potential for these initial processes to be substantially complete by the 2014 Commission meeting. This will mean operational programs under the approved program could become operational during 2015.

For E-R, the roll out of eLogs will begin quickly, building on the existing momentum. Country and regional databases will need to be actively managed and updated for receipt of electronic data, and capacity building will be required for observers, industry, and office based support staff.

For E-M, the next step will involve the program design for the various fisheries and regions, program by program. Whilst each program will have common characteristics each will also have unique features. A program design team should be developed to work across all programs to provide support and ensure consistency during this phase. It is feasible that early implementation could occur during mid to late 2015. A slow implementation should be anticipated, starting with a subset of vessels.

For all technologies, including VMS, AIS, and FAD monitoring, the focus will now be on integration of data, its use for fishery policy, science and compliance to fulfil reporting obligations, and for communication to members and beyond. The goal of integration must be kept in mind throughout the IWG process.

SWOT Analysis

Methods

This review undertook a Strength Weakness Opportunity Threats (SWOT) analysis of existing approaches against both E-M and E-R. The SWOT analysis was undertaken with the support of staff from FFA and SPC.

SWOT analysis is a tool to help work out the internal and external factors affecting your project. It is a commonly used business analysis and decision-making tool that helps to identify and build on strengths, minimise weaknesses, seize opportunities and counteract threats. A SWOT analysis is conducted with a particular business objective in mind. For example, a SWOT analysis can help decide whether to introduce a new product or service, or change your existing processes. It can help you better understand the options and work out what could be improved without substantial change. It can also help understand the current situation, and help plan to make sure your project is successful. An important aspect of a SWOT analysis is that it can help to identify and understand key issues, but it is limited in that it does not necessarily offer solutions. It is useful for comparing two or more alternatives, and a key advantage of a SWOT analysis is that it tends to concentrate around the most important factors. Using SWOT helps to develop strategies.

SWOT analysis has limitations because it:

- Doesn't necessarily prioritise issues

- Can appear to give equal weight to issues
- Doesn't provide solutions or offer alternative decisions
- Can generate too many ideas — but not help you choose which one is best
- Can produce a lot of information, and not all of it useful

Results

The results of this analysis were useful in helping to develop recommendations. The results are indicative of the issues the Commission will face in leading a program of implementation of these technologies.

Paper-based reporting versus E-Reporting

Current approach

The key strengths of the current approach are the low technical / technology requirements, the readily available human capacity, and the well understood process and requirements. The current system generates employment, is familiar and the outputs are human readable.

The weaknesses are quality control, timeliness, cost, inefficiency due to poor data flow and multiple data entry. It suffers from illegible writing, mistakes, inconsistent coding, inconsistent data formats, and missing fields. It is labour intensive and lacks a consistent process for change audits. There are massive storage requirements and a high carbon footprint. Change management of paper requires long lead time, major expense and waste. It is also easy to sanitise data before it reaches the science provider.

There are no doubt opportunities to streamline processes and standards and opportunities to make current processes more efficient, but having said that, this has been tried over many years, without success. The complexity of the international context seems to generate inertia.

Threats identified included not providing operational data, and decisions and assessments made on the basis of incomplete data. Changes in fisheries environment can create an incentive for misreporting, and changes within fisheries authorities and companies that impact on program management continuity.

Proposed E-Reporting

The strengths of the proposed E-R approach include timeliness, quality and accuracy, long run cost savings, tried and proven technology, efficiency — no duplication of handling and data entry, potential to efficiently integrate multiple sources of data through information management systems, more resistant to data sanitisation, improved ability to audit, and support for timely decision making. The technology is familiar (PCs, laptops and tablets) and the transition to new equipment can be managed quickly. Format changes and changes to data requirements can be easily implemented, data can be provided simultaneously to multiple users, eLogs can be readily converted to multiple languages, and data can be easily backed up on a daily basis.

Weaknesses include the potential time for capacity building at management, local, national, and industry levels, the potential loss of digital data through inadequate storage arrangements, high dependence on technology and implementation costs.

The opportunities include reduced time for data to arrive at SPC, integration of all systems, better access to data for industry, and more certainty and transparency around data processes. There is an identifiable ability for industry to become more efficient in their data handling, as well as to benefit from detailed access to historical fishing patterns. There are flow on benefits for traceability, chain of custody, fishery certification, and chain of evidence.

The threats identified include communication costs, reframing of the employment environment towards a greater skills requirement, initial hardware costs, political will and industry resistance, and vested interests (e.g. existing program employees). There will be a need for coordination of changes to national legislation, and development of enabling Commission CMMs. Changes within fisheries authorities and companies can impact on management continuity for the new program. There is also the risk of technology related effort creep.

Observer Programs versus E-Monitoring

Current approach

The strengths of the current approach include the ability to build human relationships with industry (and therefore between industry and agencies), the low reliance on technology, low communications costs, and no risk of mechanical or electrical failure. Observer programs create regional employment, and generate economic activity. They create regional human capacity building beyond tuna fisheries. Human observers can collect a range of biological and length frequency data and are able to describe situations that may not be picked up electronically.

Weaknesses include increasing costs, the logistics of moving human observers around the region, staff failing to arrive, injury and death risks, and human elements such as sickness, boredom, bribery, conflict, and intimidation. It is difficult to exercise quality control over data. Placing observers on smaller and older vessels creates unacceptable health and safety risks. Observers need down time and cannot be in two places at once. Key observer data can take months to be made available, there are issues with paper recording of data, variations in observer skill and capabilities, a limited pool of potential observers and observer staff turnover is outside direct program control.

An opportunity for an expanded observer program would be to create additional opportunities for regional employment.

Identified threats from a weakened observer program include loss of market access as a result of program failure, decreased standards of catch documentation for fishery certification requirements and turnover of staff.

Proposed E-Monitoring

The strengths of the proposed E-M include that it is a well proven alternative to human observers for some tasks, avoids human issues, and data is stored and doesn't rely on human memory. It stands alone as a potential tool to support compliance for certain CMMs, and in certain fisheries. The new program would drive changes in operational practices, and changes in compliance approaches and culture. Where E-M is augmenting observers, it takes the onus off them as the sole point of compliance, and the technology can repeatedly view events and focus on detail. It creates a significant deterrent for non-compliant behaviour.

The weaknesses include that it is a high user of technology in a harsh marine environment, it is logistically complex and untried on this scale in such a large area with so many remote operations and it would require significant development of human capacity. There would also be significant satellite communication costs, and significant data storage requirements, and the arrangements for hard drive exchange or data transfer will present some significant challenges.

The major opportunities identified (see also section on CMM reporting and compliance) include the longline fleet observer requirements, transshipment monitoring, TEPS interactions, mitigation compliance and proof of transiting closed areas.

The major threats to program success include geographic remoteness, political or industry resistance to a dramatic increase in monitoring, conflict of objectives and the reframing of the employment environment towards greater skill requirements. There is the potential for industry resistance, the vessel has an incentive to tamper with equipment if an offence has been committed and communication costs will increase.

Integration of E-Reporting and E-Monitoring Information

Because a system of paper-based logsheets and paper-based observer reports is already in place, the transition to E-R for these processes is likely to be relatively straightforward. As such, it is expected that E-R logsheets and E-R observer reports will be established across a significant part of the fleet within five years. In contrast, the purpose for which E-M will be applied to the WCPO tuna fisheries, and how it will be applied has yet to be established. As a consequence the development and implementation of E-M will take a lot longer than E-R. Nevertheless, there can be a significant amount of integration between the information obtained from E-R and E-MV sources. With respect to fisheries information, the value of E-M can be considered at two levels: 1) a primary data collection source and 2) as a secondary validation for data collected by another source.

E-M can be used as a primary source of information where there is no other opportunity for such information to be collected. An example of this might be where E-M is used to monitor the catch composition of longline vessels that do not have an observer on board. Similarly, E-M camera mounted on the headline of a purse seine could collect primary information on species of interest encircled by the net.

An example of where E-M is used as secondary validation of data collected by other sources could be where off / on data from E-M sensors located on fishing gear hydraulics, can be used to validate the fishing times entered on vessel logsheets. Similarly, E-M hydraulic sensors on cranes can be used to validate the position, date and time of transshipment activities.

There are also some situations where the division between what is collected by E-R and E-M sources is not clearly defined. For example, an observer would use E-R to record the information that he sees occurring on the vessel and where E-M is installed, this will be recording footage that can be used as a secondary validation of the observer information. However, should that observer be on a different part of the vessel or be otherwise indisposed, E-M takes over as the primary source of data collection.

E-Reporting and E-Monitoring solutions to CMM reporting obligations

A key challenge for E-R and E-M is to be able to satisfy CMM obligations. These obligations fall into two broad categories. The first is the obligation to comply with a CMM; the second is to report about a CMM.

In terms of complying with a CMM, it is a requirement for example, that purse seine vessels not undertake a set if a school of fish is associated with a whale shark. How can E-MV and E-R assist in this?

In terms of reporting about a CMM for example, many contain a provision that CCMs are required to report annually (or more frequently) about their particular efforts.

This review concludes that both E-R and E-M can make a significant contribution to both complying with, and reporting against CMMs.

An overview table listing each active CMM is attached as Appendix 6. This table uses a cross to indicate that in the opinion of this review E-R and E-M do not offer a solution; uses a single tick to indicate a partial solution; and two ticks where this review believes a significant contribution can be made. The table was compiled with input from the Commission Secretariat, SPC, and FFA.

In total there are 72 boxes that could be ticked.

- 30 of these boxes, or 42% received 2 ticks
- 22 of these boxes, or 30% received 1 tick
- 20 of these boxes, or 28% received a cross

In short, this review believes 72% of the CMM compliance and/or reporting obligations could be supported by either E-R, or E-M, or both.

It is fully accepted this is not a statistically valid method of determining potential contribution but it does in the view of this review satisfy the question whether it is worth proceeding with further inquiries.

Discussion on Costs and Benefits

Current situation

The current costs and benefits situation is complex for both E-R and E-M. Certain services are cost recovered either in part or full through specific charges, whilst others are either hidden within a general levy charge, or not recovered at all. It is doubtful whether even those services which are apparently fully cost recovered capture **all** the associated costs.

This lack of transparency and accountability around program costs serves only to create a range of perverse incentives acting against the implementation of E-R and E-M reforms which would involve a cost you're either not currently paying, or which is included in a general levy which is unlikely to change.

For example:

- Observer programs are funded through a range of sources including regional agency funds, fishery management levies and charges to vessels. Why would a longline vessel operating from Hawaii embrace E-M when observers are provided by the Government at no charge?
- Logbook and observer data entry costs at SPC are paid from its budget which comes from both the Commission, and from its core and donor funding. Why would a small Korean longline vessel embrace eLogs when both paper logs and data entry are provided at no direct cost?

None of this is completely transparent, and it is not clear that funds used for the existing approach would transfer to a new approach, or whether industry would be paying the costs of a new approach in full.

In the same way the region has benefited from harmonised minimum terms and conditions for licenses, so too could it benefit from a common and transparent approach to pricing and charging. The associated micro-economic reform would be beneficial in the long run — noting that this review does not hold a view on a States' right to provide subsidies to its industry, other than that subsidies should be transparent.

An example in Australia of a positive cost incentive was created for the adoption of eLogs once the true costs of manual data entry for each log sheet were passed on to industry.

How much does an observer cost?

The following gives an indication of observer program costs both in the region and elsewhere:

- The US Pacific Islands Regional Observer Program received around \$6.5 million in 2012 to support observer coverage in the Hawaii pelagic longline deep-set tuna fishery, the Hawaii pelagic longline shallow-set swordfish fishery, and the American Samoa longline fishery³. The program observed a total of 9,790 sea days across all three fisheries at an average cost per day of around \$650
- The average cost of an observer operating in the Australian tuna longline fleet is around \$1,200 per day⁴
- The cost of an observer in the New England Groundfish Fishery is around \$850 per day⁸
- Indicative costs associated with the US Treaty observer program administered by FFA are around \$220 per day⁵
- For the PNA observer program (for vessels operating under the FSM Agreement) the typical cost of an observer program day is around \$200⁶. The cost recovery structure includes both fixed and variable components which means the costs for vessels operating for only limited periods are higher.

How much will E-Monitoring Cost?

The costs associated with E-M programs have two key components: The program establishment costs involving for example, program design, purchase of equipment, installation, and training; and the recurrent annual costs associated with program administration, repairs, maintenance, data analysis, and reporting.

- The Australian Fishery Management Authority (AFMA)⁷ suggests that for 32 vessels to be fitted with E-M equipment, the year 1 costs would be around \$1 million, with recurrent operating costs of around \$330,000. Over a 5 year period this equates to a per vessel annual cost of around \$10,300 recurrent, or \$14,500 with first year capital costs amortised over the full five year period
- The US West Coast Whiting Fishery⁸ annual cost including either amortised capital, or lease costs for equipment, is \$405,000 for 35 vessels, an average annual cost per vessel of around \$11,500
- The capital cost of Satlink⁹ E-M hardware is around \$10,600

³ NMFS National Observer Program Annual Report (2012)

⁴ Pers comm. various

⁵ Pers comm. Tim Park, FFA Observer Program Manager (Oct 2013)

⁶ Pers comm. Transform Aqorau, PNA (Oct 2013)

⁷ Electronic onboard monitoring pilot project for the Eastern Tuna and Billfish Fishery. (FRDC Project 2009/048)

⁸ Fisheries Monitoring Roadmap (2013)

- A typical multi-camera system and gear sensors can be significant (\$8,000 or more)⁸
- The BlackBox sensor monitoring system has a capital cost of around \$3000; the full E-M system is around \$8500¹⁰

How much does current manual logbook reporting cost?

Globally, there is significant variation around the costs of paper logbooks and whether or not this is a cost borne by the government, subsidised, or totally cost recovered back to industry. As such, it is difficult to get accurate figures on the current costs of paper-based logbook systems. There are costs associated with the design of the logbook, printing of the paper logbooks, updating logbooks and recalling obsolete logbooks, postage of the logbooks through to fishermen and postage back to the management agency. Once received by the management agency, there are costs associated with data checking and validation, which includes obtaining feedback from fishermen. Finally, there are costs associated with the data entry.

Although this information is difficult to obtain, a recent process by the Australian Fisheries Management Authority took the costs for their paper-based logbook system out of overheads and cost recovered it back to industry. Depending on the fishery, costs associated with the paper logbooks system, including data entry, ranged between \$8 and \$12 per logsheet. Different logsheets contain information between 3 to 5 sets depending on the fishery and gear type. Based on a standard vessel working 250 days a year, the costs of the paper-based logbook system could be roughly estimated at \$2,500 per year.

How much will E-R cost?

There are many and varied models by which E-R providers charge for their product. Some companies are paid for the level of data transmission and supply a relatively basic logbook at no charge. Other companies charge a once off fee on purchase of the product, and there are no further charges. An increasing number of E-R providers are charging an annual rental or licence fee for their product which may or may not include a level of training and technical support in the annual fee. As a consequence, it is again very difficult to make general statements on how much E-R products cost. In considering the companies that charge an annual licence fee for their product, these fees may range between \$500 and \$5000 per year depending on the number and level of software components and analysis procedures included with the software package. It would be safe to say, however, that an E-R product that meets all of the requirements recommended in this report as a minimum, could be purchased for an annual fee of less than \$1000 per vessel.

⁹ Pers comm. Leticia Diaz del Rio, Satlink (Oct/Sept 2013)

¹⁰ Pers comm. Ole Skov, AnchorLab (Oct 2013)

Discussion

Electronic solutions are a revolution and offer the potential to streamline and improve practices at every level. E-R would replace tonnes of paper logs each year, all of which have to be distributed, filled out, returned and data entered on multiple occasions. E-M will enable observer style information to be collected from large parts of the unmonitored fleet, improve our knowledge of fisheries, and create a strong compliance incentive, bringing about a once in a lifetime change in fishing practices.

The question of how fisheries administrators either reallocate resources or obtain additional resources to achieve these outcomes using these new technologies is however a matter requiring close attention.

The costs of implementing E-R and E-M are highly likely to result in a long term and positive cost benefit. But in the absence of additional funding it will require a willingness to reallocate resources from existing activities to new ones, and to recover some of the new costs from industry. It is clear that currently, cost recovery is not applied uniformly, and cost burdens are not felt in a uniform way. This should in the opinion of this review be a focus of reform.

Whilst one comment was to the effect of “the question is not so much whether we can afford to implement this, but whether we can afford not to”, the fact is that implementation will require investment.

The potential uptake of E-M and E-R solutions in the WCPO tuna fisheries will be critically dependent on the implementation approach with respect to timing, technology, capacity, a practical understanding of the political and social environment, and adequate funding for program implementation.

Recommendation 31: A detailed study of costs and benefits, as well as the potential impacts on regional employment would be useful projects should resources permit.

Legislative Changes

Prior to implementing E-R or E-M, CCMs should review legislation to ensure current requirements are updated (for example prescribed logbook formats), that the implementation of these technologies is lawful and beyond challenge, that the data can be used lawfully, that data can be used in evidence and to prove offences, to ensure that vessel operators can be required to install the technologies, to comply with rules regarding the operation of the technology (including the transmission of data), and to determine whether equipment has been tampered with or damaged. It is likely that FFA would play a key role in the review of legislation in the E-R and E-M context.

Tsamenyi (2010) presents a study of fisheries legislation for eleven countries in the region to determine capacity to fulfil obligations under the Regional Plan of Action (RPOA) to Promote Responsible Fishing Practices including Combating Illegal, Unreported and Unregulated Fishing. The study presents a draft framework relevant to a range of benchmarks, which includes for example VMS and observer data. Drawing on the general approach in that study, and on personal experience, State legislation should include provisions that enable States to:

- Compile fishery-related and other supporting scientific data from the use of Electronic Monitoring and Electronic Reporting in an agreed format and be able to cooperate and provide such data to relevant subregional or regional organisations and/or States (subject to confidentiality requirements in accordance with national law)
- Require, in accordance with regional, subregional and global programs, that flagged vessels and vessels flagged by other States that fish in its EEZ, install and carry, Electronic Monitoring and Electronic Reporting equipment on board, and operate that equipment when so required
- Include appropriate terms and conditions on fishing licence related to the operation and maintenance of Electronic Monitoring and Electronic Reporting equipment
- Inspect Electronic Monitoring and Electronic Reporting at sea or in port and require data held on equipment to be provided on demand and to be able to seize or detain any component of such equipment where reasonable grounds exist to suspect an offence has been committed
- Investigate and take any action necessary in response to breaches of State legislation, and for alleged breaches of other States' legislation based on and using evidence gathered from Electronic Monitoring and Electronic Reporting equipment
- Take appropriate enforcement action with penalties appropriate to the severity of the offence which take into account the fisheries offence likely to be provable using data from electronic monitoring and electronic reporting programs and which could be avoided by wilful damage or loss of equipment
- Implement a range of fines and other penalties and sanctions (including non court sanctions such as infringement notices, licence suspensions and cancellations, mandatory tie-up days, and catch forfeiture) for offences.
- Classify data from Electronic Monitoring and Electronic Reporting programs as confidential and not generally subject to the provision of freedom of information provisions, to the extent possible
- Manage the issue of electronic data storage. It is important that each program identify its data storage needs and that steps are taken to avoid any default records legislation storage provisions for electronic records which in some cases can be 5 years or longer
- Investigate and prosecute any person who divulges information from Electronic Monitoring and Electronic Reporting programs to an unauthorised person
- Determine ownership of data collected through Electronic Monitoring and Electronic Reporting programs

As a general comment, consideration should be given to offences involving Electronic Monitoring and Electronic Reporting programs being written in such a manner that the

operator be required to prove that an offence involving failure to operate, failure to report, and damage to equipment **was not** committed. Such a **reverse onus of proof** clause shifts the burden of proof onto the individual to disprove an element of the information.

As well as each State being able to enforce its own legislation it is also desirable for it to be able to enforce any Commission CMM. This requires specific recognition of the international agreement. Consideration should also be given to how coastal and flag States will enforce provisions relating to electronic monitoring and electronic reporting relating to offences committed under regional agreements and bi lateral arrangements and by which (either or both) party.

At the regional level, the Commission will need to approve CMMs that provide for and require E-R and E-M programs to be established (including all the associated administrative arrangements), and for CCMs to require their vessels to use them.

Regional organisations such as the FFA and PNA who support their membership with harmonised minimum terms and conditions (MTCs) should update these provisions to reflect the introduction of E-R and E-M programs.

Recommendation 32: The development of model fisheries legislation, with a focus on supporting Pacific Island Countries, be developed by the Commission Secretariat.

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Appendix 1 – Terms of Reference

Objective 1: Develop a common understanding and language of what E-Reporting and E-Monitoring will mean in the WCPFC tuna fisheries.

1. Provide a clear definition and distinction between E-Reporting and E-Monitoring, drawing on relevant examples in the WCPFC Tuna Fisheries wherever possible
2. Describe the potential uses of E-Reporting and E-Monitoring data for MCS, science, and broader fisheries management and policy.
3. Provide an overview of current obligations for collecting and managing scientific and other data in the WCPFC tuna fisheries, highlighting OBSERVER and LOGSHEET DATA (E-Reporting) – i.e. clearly state what the current data requirements and deliverables are.
4. Summarise current WCPFC CMM obligations and other regulatory requirements that could potentially be covered by E-Reporting and E-Monitoring.
5. Provide an overview of the stakeholders in the WCPFC area and their current and perceived roles in:
 - Data collection/management, highlighting OBSERVER and LOGSHEET DATA (E-Reporting), and
 - Management and Compliance (E-Monitoring).
 - And identify whether their respective roles may be expected to change with implementation of E-Reporting and E-Monitoring?

Key stakeholders to include SPC, WCPFC, FFA, PNA, National Fisheries Authorities/Govt. (coastal-state and flag-state), TVM, and the fishing industry.

Objective 2: Document and evaluate current and future E-Reporting technologies that are potentially suitable for collecting information in the WCPFC tuna fisheries, and recommend the best potential options for WCPFC tuna fisheries.

1. Evaluation of each type of E-Reporting product/initiative, including sections on each of the following:
 - A brief description of the product/initiative, the product provider contact details, cost, availability, existence of training/documentation, etc. This section should be concise but refer the reader to any web links and/or publications that elaborate on the technical and non-technical aspects of the product.
 - A description of where the product/initiative has been implemented/trialled, including scale of implementation, duration of implementation, etc.
 - A summary of any evaluations of the product/initiative (indicating whether the evaluation was independent or not). This should include --
 - Specific reference to any opinions of stakeholder(s), particularly noting their opinions on the success or otherwise of the product/initiative.
 - Technical Issues/constraints encountered
 - Non-technical issues/constraints encountered, specifically including but not restricted to legal, logistical, socio-economic issues

- An appraisal of the identified products by the consultant with respect to suitability for large-scale implementation in the WCPFC Tuna Fisheries, including PROS/CONS from both the technical perspective, and the non-technical perspective
2. A table ranking each product/initiative including a descriptive narrative of pros and cons according to the consultant's evaluation which should include: fit with identified requirements; proven track record of implementation; reliability of technology; flexibility to adapt and improve; potential for delivery through PICs.

Objective 3: Document and evaluate current and future E-Monitoring technologies that are potentially suitable for WCPFC tuna fisheries.

1. Evaluation of each type of E-Monitoring product/initiative, including sections on each of the following:
 - A brief description of the product/initiative, the product provider contact details, cost, availability, existence of training/documentation, etc. This section should be concise but refer the reader to any web links and/or publications that elaborate on the technical and non-technical aspects of the product.
 - A description of where the product/initiative has been implemented/trialled, including scale of implementation, duration of implementation, etc.
 - A summary of any evaluations of the product/initiative (indicating whether the evaluation was independent or not). This should include:
 - i. Specific reference to any opinions of stakeholder(s), particularly noting their opinions on the success or otherwise of the product/initiative.
 - ii. Technical Issues/constraints encountered
 - iii. Non-technical issues/constraints encountered, specifically including but not restricted to – Legal, Logistical, Economic issues
 - iv. Could this product also be used for E-Reporting?
2. An appraisal of the product by the consultant with respect to suitability for large-scale implementation in the WCPFC Tuna Fisheries, including PROS/CONS from both the technical perspective, and the non-technical perspective (see above)

Objective 4: Propose recommendations for the most practical and efficient framework of E-Reporting and E-Monitoring in the WCPFC Fisheries to guide discussions of a dedicated small working group.

A report covering this work should include, but not restricted to, the following: (IK)

1. A summary review of the outputs of OBJECTIVES #1 thru OBJECTIVE #3
2. Describe the current system and recommendations for the most practical and efficient FRAMEWORK for OBSERVER and LOGSHEET data E-Reporting and E-Monitoring in the WCPFC Fisheries in the future. For the future framework, include a description of:
 - Processes including data acquisition, data management and data dissemination
 - Expected roles of each stakeholder
 - The potential conflicts
 - What legislation is required to accommodate this scenario at both the national and regional level.

- Anticipated technical support requirements (e.g. equipment and human resources)
3. Cost implications
 4. Present a SWOT analysis of current arrangements and the potential future framework, including consideration of a hybrid approach which might best satisfy WCPFC requirements.
 - Identify the critical factors to be considered in the decision making process including:
 - Describing the interrelationships between E-Reporting and E-Monitoring and how they might be integrated, or where they might operate exclusively
 5. Describing the decision making factors to be considered, for example, costs and benefits to identified stakeholder groups, timely access to data, quality of data, etc.
 6. Identifying which factors are likely to be more important to different stakeholders and how this can be presented and potential conflicts resolved.
 7. For the most practical and efficient future FRAMEWORK identified, list the steps involved and the perceived stakeholder(s) responsibilities in order to proceed with large-scale E-Reporting and E-Monitoring implementation in the WCPFC Tuna Fisheries, highlighting important issues that can be documented now or will need specific attention, such as a detailed breakdown of resource needs, cost recovery, changes to legislation, etc.
 - A short discussion and recommendations section, which should include:
 - Reviewing the information at hand, the pros and cons of current approaches, the potential Framework, and including consideration of a hybrid approach.
 - Providing a summary (with explanation) of what the consultant recommends would be the best way to progress towards the most practical and efficient framework for E-Reporting and E-Monitoring, including a clear recommendation for a preferred approach if it is clear there is one.
 - Describing a potential process for decision making to move E-Reporting and E-Monitoring implementation forward through regional meetings/workshops

Appendix 2 – Global E-Reporting products

Product	<h2>Catchlog</h2>
Contact	<p>Company: Catchlog Trading Pty. Ltd Address: 109 Tills Street, Westcourt, Cairns, Queensland, Australia 4870 Phone: Australia: +61 (07) 4033 132 Email: admin@catchlog.com Web: www.catchlog.com</p>
Description	<p>Catchlog is a touch screen capable electronic reporting system that has been customized for different fisheries in several different countries. It can be installed on Windows based PC, laptop or tablet, and has the facility to record catch and effort information, and an add-on module enables transmission of data in the required format to the management agency. Catchlog has a range of features including integration with GPS, mapping and data reporting. There are some aspects that can be customised by the user, and there are a number of add-ons including Fleet Manager, Quota Manager, and Food Safety Manager.</p> <p>Data can be output in XML, PDF, CSV, XLS or RTF formats, and Catchlog uses PgP and HTTPS encryption. Data transfer can be completed using internet, satellite or email communication. Transmission can be completed using a number of methods including as email attachments, embedded text email, mobile storage device, dedicated FTP or HTTPS connection, VMS or virtually any Iridium and Inmarsat based communication.</p> <p>The usual pricing model is based on a one off cost and subscription. The base unit cost is AUS\$395 and E-log Manager (the add-on used to transmit data to the management agency) costs AUS\$195 per year. There is a dedicated support team that can provide online support to the vessel for free during the first year, and for AUS\$140 per year after that. Online support is conducted using Team Viewer. There is an alternative pricing model, whereby States or organisations buy on bulk, with an annual fee. This would provide a secure server with “Fishery Manager” program, the owners (Concession Holders) of the vessels get “Fleet Manager” program, and the Vessels get CatchLog 2 installed and trained. Instructional videos are also available and can be seen here: http://www.catchlog.com.</p>
Applications	<p>Catchlog is used in Australia and the UK, and is also being trialled in the Maldives and Canada. It has been adapted to suit a number of different fisheries using a variety of gear types including trawl, gillnet, long-line, dredge, seine and trap. It has been used in the Northern Prawn Fishery since 2008, and in the UK since October 2010. There are currently 52 Northern Prawn Fishery (Australia) vessels 43 other vessels in Australia using Catchlog. There are 117 vessels using CatchLog in the UK Fisheries and 6 in Spain.</p>
Feedback	<p>Independent - Northern Prawn Fishery Industry Association have used Catchlog since 2008, and in 2010 wrote that “The system has been in place in the Northern Prawn Fishery for two years and is working well.” and “The Catchlog team work closely with the NPFI, AFMA and individual trawler operators to provide policy and technical support as and when required.” (Source NPFI letter written by Annie Jarrett, CEO of NPFI, sent to us by Catchlog staff).</p> <p>Stakeholder feedback - Feedback from six stakeholders in the Northern Prawn Fishery were supplied to us by Catchlog staff. All feedback was positive, and highlighted the ease of use and follow up technical support. Access to their catch and effort data was also highlighted as a great benefit over traditional paper logbooks.</p>

Product	E-Logbook
Contact	<p>Company: Chartworx Address: Chartworx B.V., Paleiskade 100, 1781 AR Den Helder, The Netherlands Phone: Netherlands: 0031 223 684200, Mobile: 0031 6 532 93985 Email: info@chartworx.com, leeke@chartworx.com Skype: leeke.van.der.poel Web: www.chartworx.com</p>
Description	<p>E-Logbook is a Windows based system for reporting fishing effort and retained and discarded catch data. Reporting of interactions with protected species is not yet included, however this will be available on 1 December 2013. It does include a simple data reporter, and more advanced data analysis capability is in development. E-Logbook can be integrated with GPS to record event locations, and also with fish plotters. Some user customization is available. E-Logbook is not yet touch screen capable, but this is in development.</p> <p>E-Logbook uses PGB encryption in the UK, while in the Netherlands, encryption software on a dongle is employed. It primarily exports data in XML format, but also in PDF, and transmission is via email (GPRS, SatCom). Capacity to transmit via VMS is currently in development.</p> <p>There are two different purchase models; a once off cost with the option to buy upgrades, or an annual license that includes maintenance and upgrades. As an indication, current retail prices are € 1100 for the once off license purchase (incl maintenance) or € 450 per year for subscription. Software support is available on request, and digital documentation (including extensive user manuals and quick start manuals) is provided on installation. “Tool tips” are also built into the software for each input field. A demo version is available.</p>
Applications	<p>E-Logbook is used by over 160 vessels in the Netherlands and UK, and is available for all FAO fishing gears. Chartworx have been supplying electronic logbooks since 2010 in the Netherlands and 2011 in the UK.</p>
Feedback	<p>Independent – Chartworx E-logbook complies with the Electronic Recording and Reporting system (ERS) of the European Union (EU) as laid down in Council Regulation of the European Commission (EC) number 1224/2009 including the latest EC amendments and is type approved by the Netherlands and United Kingdom governmental fishery authorities.</p> <p>Non-independent – not available</p> <p>Stakeholder feedback - not available</p>

Product	Marlin
Contact	Company: CLS France & CLS Argos AU-NZ-South Pacific Address: PO Box 42, South Yarra, Victoria Australia 3141 Phone: AUS: +61 418 368 917 +61 3 9867 3108 Email: guan@clsargos.com.au Web: http://automne-halios.cls.fr/files/pmedia/edited/r83_9_fiche_marlin100_an.pdf
Description	<p>The Marlin is a simple eform system that is distributed on a stand-alone ruggedised, touch screen terminal using a Linux operating system. Marlin can be used to report retained and discarded catch, as well as effort and interactions with protected species. Catch reports are based on the SPC purse seine format. It allows some customisation by the user and is linked to the GPS, and the data can be reviewed by the user after it has been submitted. There is no mapping of catch and effort. Add-ons can be developed depending on user requirements. It is touch screen capable.</p> <p>The Marlin is connected to the FFA type approved CLS MTU (e.g. “Thorium” and/or “LEO”) and hence uses the same VMS channel to transmit catch and effort data (including discards and protected species interactions) and transshipment data to CLS servers. From there can be exported to the fisheries agency in any format required. The system also enables the user to send email and text messages, and receive weather forecasts including typhoon alerts.</p> <p>The purchase model is a once off cost of approximately 350€* for the terminal and eform plus installation cost and data transmission cost (which depends on the size and frequency of transmissions and catch and effort data as well as other data that is sent or received). Cost of the Marlin hardware and VMS unit combined is approximately 1600€*. End user price depends on quantity and other factors, and there are savings offered to bulk purchases. Training can be supplied on request, and recent training course have been provided in the Philippines (Navotas and General Santos) to fisheries staff and fishing industry members.</p> <p>*prices are indicative only.</p>
Applications	<p>There are currently 20 purse seine vessels using the Marlin in the Philippines, and 400-500 other vessels using the system in Vietnam, potentially expanding up to 3,000 units by 2015 (primarily for weather forecasting to warn fishermen of approaching typhoons). The Marlin can also be programmed to suit other activities apart from purse seine e.g. such as longline, pole and line etc...as per SPC logsheet format.</p>
Feedback	<p>Independent – not available</p> <p>Non-independent - not available</p> <p>Stakeholder feedback - not available</p>

Product	eCatch
Contact	<p>Company: Dualog</p> <p>Address: Alkeveien 14 N-9015 Tromsø, Norway</p> <p>Phone: Norway: T +47 77 62 19 00 (D 965), M +47 M 913 07680</p> <p>Email: sb@dualog.com</p> <p>Web: www.dualog.com</p>
Description	<p>eCatch can be installed on PCs, laptops, tablets or smartphone, to report retained and discarded catch and fishing effort as well as interactions with protected species. Functions include data reporting and analysis, mapping and recording position information from connected GPS. User customisation is available, and it is touch screen capable. An add-on called, Dualog Connection Suite, enables the sending of electronic reports to shore. Another add-on is eCatch Management, the shore based version that can be synchronised with eCatch to provide the office with an up-to-date overview of fleet activity.</p> <p>eCatch outputs Wibu-Key and PGP encrypted data in North Atlantic Format (NFL) or EU-XML format. Most common communication systems can be used to transmit data to the fisheries agency including Inmarsat C, Mini-M, Fleet 33, 55, 77, Fleet Broadband, Iridium, Iridium OpenPort, VSAT, GSM, GPRS, EDGE, 3G, UTMS, CDMA 2000, IMAX and WIFI.</p> <p>Dualog normally offer a hybrid purchase model, with a once of purchase cost (~USD\$2000) plus and annual subscription to cover maintenance fee and support. Airtime costs are additional, and depend on the system used and the frequency and size of transmission. 24/7 technical support is available via phone, email and remote login using TeamViewer. A simple user guide is provided with eCatch.</p>
Applications	Dualog has been providing electronic reporting systems since 2006, and there are currently over 530 vessels based in Norway and the UK that use eCatch. All FAO defined gear types are supported.
Feedback	<p>Independent – not available</p> <p>Non-independent - not available</p> <p>Stakeholder feedback – Available on request. Some use feedback can be seen at http://dualog.com/images/stories/Products and Services/Fisheries it solutions/article Dualog_elog.pdf</p>

Product	E-catch
Contact	<p>Company: E-catch Address: Westwal 2, 8321WG, Urk, Netherlands Phone: Netherlands: 0031 527 689 701 Email: pvs@e-catch.eu Web: www.e-catch.eu</p>
Description	<p>E-catch is a touch screen capable electronic reporting system that can be installed on Windows based computers. It has the facility of capture retained and discarded catch, effort and interaction with protected species data. It can be integrated with GPS, and has data reporting and mapping capability. It is customisable, enabling the user to save “favourites”, such as docking sites, fishing gear configuration and regularly caught fish species. It is built in a modular package, with upgrades available including weighing systems and quota management.</p> <p>Data is exported in any format required by the user, and data is encrypted, however details of encryption were not revealed to us. Data can be transmitted using any communication device currently on the market including VMS.</p> <p>E-catch available on a subscription basis for EU\$300 per year (although cost after the first year may depend on requirements for support and upgrades). This includes upgrades, maintenance and 24/7 support via a toll-free helpline. User guides and documentation is provided as part of the installation, and help files are also available within the software. Demonstrations and training sessions are available in all areas, and instructional videos are on their website.</p>
Applications	<p>E-catch began installations during 2010, includes 61 different gear types and is installed on over 1000 vessels in 7 different countries including Netherlands, Belgium, United Kingdom, Scotland and Germany.</p>
Feedback	<p>Independent - ERS 3.1 Technical Audit Report by NCC Group 19 April 2013. The report recommends the e-Catch v3.21 software as an Approved Product.</p> <p>Non-independent - not available</p> <p>Stakeholder feedback - not available</p>

Product	Turbo Catch
Contact	<p>Company: IXBlue Address: 30, avenue de l'Amiral Lemonnier, 78160 Marly le Roi, France</p> <p>Phone: France: +33 1 30 08 88 88, +33 6 84 93 37 74</p> <p>Email: christophe.corbieres@ixblue.com</p> <p>Web: www.ixblue.com</p>
Description	<p>Turbo Catch is a touch screen capable, Windows based electronic logbook system for PCs, laptops and tablets. Effort, retained and discarded catch data can be recorded however reporting of interactions with protected species is not currently included. Latitude and longitude are directly captured from connected GPS. There is some user customization available, and Turbo Catch provides catch summaries by day and fishing trip, and an add-on, SeaXpert (an Electronic Chart Display and Information System based software), enables geolocalized catch statistics to be displayed. An additional add-on, Fish Book, can combine ERS mandatory data with additional data from the skipper (fishing conditions, observations, pictures etc.), and enables geo-statistical analyses and filtering on this combined data set. Turbo Catch can also be integrated with a wide range of optional interfaces and sensors including Marel marine scales.</p> <p>Data is output in proprietary/Access database format, and encrypted using EU type encryption before being transmitted to IXBLUE operated servers via any of a wide range of systems including (but not limited to) InmarsatC, Fleet BB, GPRS, 3G, Iridium SBD, Iridium and Globalstar. Transmission protocols can be customized to suit client needs. It can then be pushed to fisheries agencies in any format required.</p> <p>The purchase model is an up-front fee for purchase of the software, as well as an annual fee. Phone support is split into two levels, Level 1 provides 7/7 support, while Level 2 provides 5/7 support. A demo version is also available on request. There are also transmission costs that depend on the network used, and size and frequency of transmission. As an indication of cost, the retail price for the French system is 2000 € (software plus hardware), and the Vlink beacon transmitter (Iridium SBD based) retails for 1900 €. In order to provide 7/7 service and to maintain servers, a monthly fee is applied to the vessels (about 40 €) in addition to the Airtime (from 20€ to 80 € about per month). Please note that this is an indication only, and would depend on the requirements for the particular application.</p>
Applications	<p>Turbo Catch is used by about 450 vessels in France, including the entire French Ocean Tuna fleet. It is currently configured for use with trawl, net, pot, longline, tuna seiner, and other seine fishing gear. IXBLUE have been providing Turbo Catch since early 2010 to meet French/EU ERS requirements.</p>
Feedback	<p>Independent – This product entirely complies with the European Union statutory order CE1027-2008 officially published on 4 November 2008. (More recent letters of approval were provided by IXBlue)</p> <p>Non-independent - not available</p> <p>Stakeholder feedback - not available</p>

Product	eLogbook	
Contact	National	Marine Fisheries Service Alaska Region
	Address:	PO Box 21668, Juneau, AK 99802-1668
	Phone:	US: 907-586-7010
	Email:	jennifer.mondragon@noaa.gov or suja.hall@noaa.gov
	Web:	elandings.atlassian.net/wiki/display/doc/eLogbook+Users+Guides+and+Instructions
Description	<p>eLogbook is a free, government supported electronic logbook available to longline and trawl catcher processor vessels fishing in Alaskan waters. It is a Windows compatible system that allows entry of catch (including some discards), effort and protected species interaction data on a haul-by-haul basis for fishing operations before transmission via email or directly over the internet.</p> <p>Apart from capture of data, it has limited functionality. Users can export their data to Excel to interrogate their data, and there is some capacity to customise formatting. There is no GPS integration (latitude and longitude must be keyed in) or mapping, no add-on software and it is not touch screen capable.</p> <p>Data is exported in XML format, and there is no encryption. Files are zipped before being transmitted via email or directly over the internet.</p> <p>eLogbook is supported by the Government, and is free to the fishing industry, however vessels must provide the computer, printer and internet connectivity. Agency staff are available to answer questions during business hours (there is a single point-of-contact that the vessel operators all know to contact). They also maintain a 18x7 help desk where users can get some help outside of business hours. An email account is also monitored by agency staff to provide answers to questions. A user guide is available</p> <p>https://elandings.atlassian.net/wiki/display/doc/eLogbook+Users+Guides+and+Instructions</p>	
Applications	eLogbook has been used in Alaska, USA, since January 2011 by the Trawl Catcher Processor fleet, and since 2013 by the Freezer Longline fleet. There are 119 vessels that have registered eLogbooks for 2013.	
Feedback	<p>Independent - not available</p> <p>Non-independent - not available</p> <p>Stakeholder feedback - NOAA hear from stakeholders on a regular basis (via mechanisms described in "follow up support"). They respond to user discovered bugs and, when possible, and incorporate user suggestions into new versions of software.</p>	

Product	Olrac Dynamic Data Logger (DDL)
Contact	<p>Company: OLRAC SPS Address: Silvermine House, Steenberg Office Park, Tokai Western Cape, Sth Africa 7945 Phone: South Africa: +1 303 328 6983 6am-7pm MT Email: clients@olrac.com Web: www.olrac.com</p>
Description	<p>OLRAC DDL is touch-screen capable software that can be installed on Windows based PCs, laptops or tablets for collection, analysis, plotting, mapping, reporting, tracing and transmitting all vessel-related data. It can be customized to suit any commercial fishery, and is currently installed on vessels operating in a wide variety of fisheries, operating in at least 10 different countries around the world. OLRAC DDL can also be customized by the user to add or remove species, set valid data limits, change units, hide/unhide fields among others. Data entry allows capture of retained and discarded catch and effort, as well as interactions with protected species. In addition, there is a wide variety of add-ons such as capture of text or multimedia notes, integration with scales, fleet activity optimizer and a fishing trip advisor.</p> <p>Data can be output in a variety of formats (XML, CSV, HTML, BMP, SQL scripts, normal text). End-to-end transmission protocol allows users to transmit secure XML reports, using X.509 digital certificates and W3C XML security standards. XML reports can be signed using XML signatures and encrypted using hybrid XML encryption prior to transmission. Transmission can be completed using a number of methods including as email attachments, embedded text email, mobile storage device, dedicated FTP or HTTPS connection, VMS or virtually any Iridium and Inmarsat based communication.</p> <p>The pricing model is based on the initial customization, with the cost to be agreed with client after job assessment is completed, and thereafter an annual licence fee per PC per vessel. Discounts are offered on bulk orders. A "Lite" version that does not include the GIS component and some other capabilities can also be offered. Add-on modules are also available on an annual user licence fee basis. User manual is available to licence holders. Distributors also provide training on installation and follow-up support. See the following website for detailed description http://www.waset.org/journals/waset/v67/v67-162.pdf</p>
Applications	<p>OLRAC DDL has been installed on more than 350 vessels, covering numerous gear types including otter trawl, Danish seine, mussel farming, scallop dredging, lobster and crab potting, gillnets, demersal and pelagic longlining, charter boat and reel reef fishing. OLRAC have been providing eLog solutions for about 10 years, and their products have been used in at least 10 different countries including Australia, Netherlands, Namibia, Chile, New Zealand, South Africa, United States, UK. http://www.olsps.com/elog/index.php/company/global-installations</p>
Feedback	<p>Independent - Has successfully passed the UK Fisheries Authorities' approval process run on their behalf by the NCC Group, and has been approved by AFMA for use in Australian fisheries.</p> <p>Non-independent - http://www.waset.org/journals/waset/v67/v67-162.pdf</p> <p>Stakeholder feedback - http://www.olracnae.com/testimonials</p>

Product	<h2 style="margin: 0;">Pole Star eforms and hardware</h2>
Contact	<p>Company: Pole Star Address: Level 2, ITAMS Building, Innovation Campus, University of Wollongong, Wollongong, NSW 2522 Phone: AUS: +61 2 4221 5284 Email: richard.bland@polestarglobal.com Web: www.polestarglobal.com</p>
Description	<p>Pole Star’s electronic logbook solution uses a stand alone, touch screen terminal in the belief that this provides a more stable, reliable system. The terminal is ruggedized, and designed to be mounted on vessels. Pole Star provide eForms for a variety of fisheries, that is easily customized to meet the needs of the client, including capture of retained and discarded species, and protected species. Analysis of data does not come on standard models, but can be included if the client requires. It can be integrated with GPS, and has mapping facility. Add-on software can be included, and depends on the requirements of the client. Updates to software can be installed remotely.</p> <p>Data is exported in any format required by the user including XLS, Opendoc, KML and XML. Encryption is also dependent on the client’s requirements including secure VPN. Data can be transmitted using any common maritime communication system using satellites or mobile networks.</p> <p>The purchase model is usually some payment upfront, as well as cost of airtime on a monthly payment. Cost often depends on the size of the order. Users manuals come standard on the terminals, and there is “near” 24/7 phone support. Additional support is available (e.g. training) depending on the client’s needs. Updates to software can be installed remotely.</p>
Applications	<p>Pole Star’s electronic logbooks have been used since 2006, and cover a range of fishing gears including Danish seine, trawl, longline and scallop dredge. Pole Star have provided eForms for several thousand vessels in the US, while 50-100 vessels are using their hardware systems in Belize.</p>
Feedback	<p>Independent - not available Non-independent - not available Stakeholder feedback - not available</p>

Product	Deckhand
Contact	Company: Deckhand Address: PO Box 370, Port Elliot, SA, Australia, 5212 Phone: AUS: 0427 262 553 Email: tom@real-time-data.com.au Web: http://deckhandapp.com
Description	<p>Deckhand is an app designed for mobile devices (iOS, but is being developed for Android) to record catch and effort information. It is currently available for iPhone 4+ and iPad 2+. Deckhand comes with a large range of functionality including ability for user to interrogate their data, report discards and interactions with protected species, links to GPS, mapping and geo-fencing. Users can also customise the view.</p> <p>SSL encrypted data is transmitted to management agencies via server to server or email. Data output formats are CSV and JSON.</p> <p>The purchase model and costs were not provided by Real Time Data, stating that both are “by negotiation”. There is an instruction manual, but Real Time Data claim that it “is intuitive enough to be proficient within 10 minutes of use”. 24/7 phone support is provided.</p>
Applications	<p>Deckhand has been implemented in the South Australian Rock Lobster pot fishery, but can be converted any other gear type with “low cost customization”. It is currently configured for 3 different Rock Lobster fisheries, and other fisheries including pipi, trap, blue swimmer crab and octopus.</p>
Feedback	<p>Independent – “Commercial in confidence”</p> <p>Non-independent - “Commercial in confidence”</p> <p>Stakeholder feedback - “Commercial in confidence”</p>

Product	eLog
Contact	<p>Company: Seatronics Address: Unit 2, Blackhouse Industrial Estate, Peterhead, AB42 1BN, UK Phone: UK: +44 (0)1779 480600 M: +44 (0)7801 678709 Email: George.Youngson@seatronics-group.com Web: www.seatronics-group.com</p>
Description	<p>Seatronics' eLog is a fully web based electronic reporting system for PCs and laptops. The user interface is through standard web browsers to report catch, effort and discards. It can either be connected to the vessels GPS, or a USB GPS can be supplied. Event location is recorded from the GPS. Although there is no inbuilt mapping functionality, however the user can view the current location via a Google Map, although the system must be connected to the Internet for this link to work. eLog is customisable with the ability to edit species lists, fishing gear and ports. A report function provides the user with a suite of reports including, logbook, previous trips, GPS current location and an audit trail. eLog also allows recording of lost fishing gear and prior reporting of return to port.</p> <p>Encrypted XML data is transmitted to management agencies via email. The email function is built into eLog, and shows a confirmation pass/fail message. Email can be sent via installed satellite communication package or by internet USB dongle.</p> <p>eLog is supplied with a laptop for the once off cost of £2,000, and after the second year ongoing support costs £400 per year. Seatronics supply 24/7 customer support via phone or remote access. A user guide is available.</p>
Applications	<p>Seatronics have been providing eLogs for 3 years, and eLog has been installed on more than 140 vessels in the UK and Jersey. eLog is used by vessels operating a variety of gear types including trawlers, pelagic trawlers, scallop vessels and potters.</p>
Feedback	<p>Independent – Has been successfully passed by the UK Fisheries Authorities' approval process run on their behalf by the NCC Group.</p> <p>Non-independent - "Commercial in confidence"</p> <p>Stakeholder feedback - "Commercial in confidence"</p>

Product	eTUNALOG
Contact	<p>Company: SPC Oceanic Fisheries Programme Address: SPC Headquarters, BP D5, 98848, Noumea, New Caledonia Phone: New Caledonia: +687 260158 Email: EmmanuelS@spc.int Web: http://www.spc.int/oceanfish</p>
Description	<p>eTUNALOG is a free, simple-to-use eForm system for recording catch and effort logbook data in WCPFC tuna fisheries. The data collected through eTUNALOG can be directly imported into the Tuna Fisheries Data Manager (TUFMAN) system. It can be installed on Windows based PCs, laptops and tablets and can easily be adapted for MAC OS. It is not yet touch screen capable. The PDF forms are identical to those used in WCPFC tuna fisheries, which do not require detailed reporting of protected species at this stage, but this can be easily added as required. eTUNALOG is not currently linked to a GPS, but work is underway to connect the system with vessels' existing GPS/mapping software or to small portable GPS devices. At present, it is not customisable by the user, and the user can not generate reports through eTUNALOG, however a basic reporting systems for fishing vessels and fishing companies are planned, and users can generate reports, graphs and maps from the TUFMAN system once the XML data have been imported.</p> <p>Data are exported from the eTUNALOG in XML format, and while there is currently no encryption, options for this are being investigated in addition to support for digital signatures (which is a current requirement for the current hard-copy logbooks). Data are transmitted via email as an attachment.</p> <p>eTUNALOG is free, and it is designed to run on the vessel's computed or tablet. Email is required, and this is the only cost to the user. A Users Manual is included with eTUNALOG, and training can be provided.</p>
Applications	<p>eTUNALOG is currently only used on Purse seine vessels (since January 2013), but trials on longlines are planned for 2014. There are currently 12 vessels using the system from the Solomon Islands, New Zealand, Japan, Korea and the Federated States of Micronesia.</p>
Feedback	<p>Independent - not available</p> <p>Non-independent - not available</p> <p>Stakeholder feedback - NEW ZEALAND: "I have been filling in the data on eTunalog and find it user-friendly." - SOLOMONS: "So far the PDF logsheets are good in that it saves time for the captains to enter data". "This is an excellent program and will receive more positive feedback as the trials continues." (feedback from industry provided by SPC staff)</p>

Product	<h2>Maritime</h2>
Contact	<p>Company: TrackWel Address: Laugavegur 178, 105 Reykjavik, Iceland Phone: Iceland: +354 5100 600, +354 5100 603, +354 8600 603 Email: stein@trackwell.com Web: www.trackwell.com</p>
Description	<p>Maritime is an electronic logbook for Windows based PCs and laptops. Effort, retained and discarded catch and interaction with protected species data can be recorded, and latitude and longitude are captured directly from connected GPS. Maritime has a range of functions including access to catch histories and statistics, and can be connected to sensor devices such as weather sensors and echo sounders. Add-ons are available for product tracing (Product Manager), detailed analysis and mapping (CatchViewer web) and for viewing current positions and past tracks of vessels in a fleet (CatchViewer client).</p> <p>Standard data output is in XML format, but this can be changed depending on the customer requirements. Maritime uses private/public key encryption, and like data outputs, alternate encryption can be used according to customer requirements. Data can be transmitted via all common maritime communication systems (including Inmarsat-C and Iridium based BlueTracker), using satellites or mobile networks that support internet connection.</p> <p>The standard purchase model is once off cost, annual maintenance fee plus transmission fees that depend of size (typical message size is less than 3kB) and frequency of transmission. The Base unit cost is USD\$2,500. TrackWell offers 24/7 secondary service, and a local service can be provided upon request. User guide is available, and a demo version can be provided on request.</p> <p>For more information see http://www.trackwell.com/maritime/fishing-companies/</p>
Applications	<p>TrackWell have been supplying Maritime since 2007, and there are currently about 500 active users in Iceland, Norway, Faroe Islands and Canada. It supports all main fishing types including seine nets, surrounding nets, gillnets and entangling nets, longlines, hooks, trap, lift nets and dredges.</p>
Feedback	<p>Independent – “The system was delivered in time, according to the contract and fulfilled all requirements. TrackWell has maintained a dedicated service team to provide full support to the system with regular updates after request from DoF.” Certification from Icelandic Directorate of Fisheries and Norwegian Directorate of Fisheries (copy of certificate provided by Steingrimur Gunnarsson, TrackWell)</p> <p>Approval for use on Norwegian vessels by Directorate of Fisheries, Norway (copy of notification letter provided by Steingrimur Gunnarsson, TrackWell)</p> <p>Non-independent - http://www.trackwell.com/maritime/wp-content/uploads/sites/2/2013/02/Trackwell_Maritime.pdf</p> <p>Stakeholder feedback - ““We have been using Trackwell eLogbook with excellent results. It simplifies and saves work with respect to logging catch information and helps planning future fishing trips.” Gudjon Thorbjornsson, Operation Manager, Ocean Choice International L.P., P.O . Box 8274, Station A, 1315 Topsail Road, St. John's, NL, Canada, A1B 3N4, Phone: +1 709-699-6006 (provided by Steingrimur Gunnarsson, TrackWell)</p>

Appendix 3 - Summary of E-Reporting Product Specifications

Product Company	Catchlog Catchlog Trading	E-Logbook Chartworx	Marlin CLS France & CLS Argos	eCatch Dualog	E-catch E-catch	Turbo Catch IXBlue	
System requirements	Platform	PC, Laptop, Tablet	PC	Standalone terminal (rugg. tablet) LINUX	PC, tablet, smartphone	Windows	PC or Tablet
	Operating system	Windows XP, 7 and 8	Windows 7/8 32-64 bits		Windows XP, 7, 8	Windows XP or higher	Windows 7, XP, Vista,8
	Minimum RAM	1 GB, rec. 2 GB	2GB	16Mb Flash 32 Mb RAM	2 GB	256MB	1Gb
	Minimum processor	1 GHz	Pentium 2 GHz or faster	ARM920T EP9307 Cirrus 200MHz	I5	P4	I3
	Minimum memory	700 MB disk storage	40GB		10 GB	500MB	300 Gb
	Min screen resolution	1024x768	1024x768, 32bit	7" Wide 800 x 480	1280 x 768	1024 X 768	1280x1024
Other requirements	Yes	Serial port, USB port, ethernet, DVD, RS232 cable	Connection to CLS MTUs - "Thorium" and/or "LEO"	Yes	No	Ethernet, serial comm. port	
Functionality	Data reporter	Yes	Yes	No	Yes	Yes	Yes
	Data analysis	Yes	No. In dev.	No	Yes	Yes	No, needs add-on.
	Offline recording	Yes	Yes	Yes	Yes	Yes	Yes
	Report discards	Yes	Yes	Yes	Yes	Yes	Yes
	Report TEP interactions	Yes	No, in dev.	Yes	Yes	Yes	No
	GPS reporting	Yes	Yes	Yes	Yes	Yes	Yes
Mapping	Yes	No, needs add-on.	No, supports weather maps.	Base version	Yes	No, needs add-on.	
Customisable Add-on software	Yes Fleet Manager, Quota Manager, Food Safety Manager.	Yes Fish plotters	No ,but possible.	Yes Dualog Connection Suite Communication Software	Yes Weighing system, quota management, E-landing.	Yes Seaxpert. Fish Book	
Touch screen capable	Yes	No. In dev.	Yes	Yes	Yes	Yes	
Data transmission	Encryption	PgP and HTTPS	PGB or encryption dongle	VMS	Wibu-Key and PGP	Yes	EU type
	Output formats	XML, PDF, CSV, XLS, RTF	Principally XML, PDF	Via VMS to CLS server, then in any format rqrtd.	North Atlantic Format (NAF) or EU-XML	Any	Proprietary/A ccess database format
	Transmission facilities	Internet, satellite, email	Email (GPRS, SatCom)	VMS	Most comm. systems.	All, including VMS systems	Large variety of comm. systems.
Other communication	Comms. with shore to send operational data.	VMS comm. in dev.	Email, texting, weather and typhoon alerts				

WCPFC E-Reporting and E-Monitoring

eLogbook NMFS Alaska	OLRAC DDL OLRAC SPS	Pole Star eforms Pole Star	Deckhand Real Time Data	eLog Seatronics	eTUNALOG SPC	Maritime TrackWell
PC	PC, Laptop, Tablet	Standalone terminal (rugg. tablet)	iOS devices	PCs and laptops	PC and tablets	PC
Windows XP, 7	Windows XP, Prof., Vista, 7, 8	Windows Embedded CE 6.0 R3 Core, Prof.	iOS / Android in development	Windows	Windows XP, 7,8	Windows XP Prof, Vista, 7, 8
no minimum specified no minimum specified	4GB	RAM: 256 MB Flash: 4 GB Marvell™ XScale™ PXA166, 800 MHz (ARM)	iPhone 4+ / iPad 2+ or later As above	Not supplied Not supplied	1Gb 1.3 Ghz Pentium or higher	128 Mb 90 MHz Pentium or comparable
no minimum specified no minimum specified	150 MB for software 800x1024	800 x 480 WVGA	As above As above	Not supplied Not supplied	5Gb HD XGA (1024x768) minimum for visual comfort	1Ghz CPU, 128 Mb memory 1024x768
No	USB port, GPS receiver USB, internet or thumb drive				Adobe Acrobat Reader version X minimum / .NET 3.5 framework	1 Gb free disk space, serial ports or USB ports, preferable internet
No	Yes	Yes	Yes	Yes	No	Yes
No	Yes	No. But can do.	Yes	Yes	No	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes, tailored to client	Yes	Yes	Yes	Yes
Yes	Yes	Yes, tailored to client	Yes		No, but can be added	Yes
No	Yes	Yes	Yes and geo- fencing	Yes	No, in dev.	Yes
No	Yes	Yes	Yes	Yes, needs internet.	No, in dev.	No, needs add- on.
Yes	Yes	Yes	Yes	Yes	No	Yes
No	Scales Data Logging, Mini- reporter, Fishing Consultant , Fleet Activity Optimiser, other	Depends on specs of client	Yes		No	CatchViewer (mapping)
No	Yes	Yes	Yes		No	
No	X.509 digital cert. and W3C XML security stands. Hybrid XML encryption.	Depends on client. VPN secure connection.	SSL	Yes	No, in dev.	Private/public key encryption or other as rqrd.
XML	XML, CSV, PDF, HTML, BMP, SQL scripts, normal text	XLS, Opendoc, KML, XML, or other	CSV, JSON	XML	XML	XML or as rqrd.
Email or directly on internet	Most comm. systems incl. VMS.	All common maritime comm. systems, using satellites or mobile networks	Server to server or email	Email via satellite communication package or by internet USB dongle.	email	All common maritime comm. systems, using sat. or mobile networks which support internet connection

Appendix 4 – Global E-Monitoring products

Product	<p>EM Observe™, EM Record™, EM Interpret™</p>
Contact	<p>Company: Archipelago Marine Research Ltd Address: 525 Head Street, Victoria, BC, V91 5S1 Phone: +1 250 383 4535 Email: amr@archipelago.ca Web: www.archipelago.ca</p>
Description	<p>Archipelago Marine Research (AMR) has led the design and delivery of E-M programs worldwide for over 20 years. Their products are fully implemented in a number of fisheries, and have underpinned hundreds of scientific projects and E-M trials. EM Observe™ comprises a control centre, video cameras, winch and hydraulic sensors, and GPS receiver. The system runs automatically, mapping the trip track, and recording sensor and fishing activity. A video record is maintained of all fishing activity using either analogue or digital cameras with frame rates for digital at up to 30 frames per second. An uninterruptable power supply is incorporated to allow for orderly shutdown in the event of a power failure. The system includes an hourly “EM Health Statement” via iridium satellite of time, position, speed, heading, detailed sensor activity, time video has run, disk space, function testing, and power failures. This is a duplicate of VMS information and has the potential for type approval. Hardware is managed using the EM Record™ data logging software which sits on the onboard control centre. It organises all the data, and records all sensor and video information for later retrieval and analysis. The system can be integrated with eLogs and VMS data for comparative analysis (noting VMS is redundant when EM Observe™ is fully implemented). EM Interpret™ takes video and sensor data from its primary form to allow review, annotation, and reporting. AMR prefers to offer a full service to its customer but will supply equipment (sale or lease), software (under licence), and training for program staff.</p>
Applications	<p>The British Columbia Groundfish fishery is a line and trap fishery comprising more than 400 longline and trap vessels, and around 140 trawl vessels, targeting more than 60 different stocks of Groundfish. The total TAC for all stocks is around 140,000 tonnes, worth around \$140 million, with about \$85 million of that from line and trap fishing (Turriss, B. Management of the BC Groundfish Fisheries presentation 2009). The Groundfish Hook and Line/Trap Catch Monitoring Program (GHLCMP) launched in 2006 uses E-M for its independent data collection to support fisheries management and enforcement, and provide species specific catch records (including discards), by area. Whilst existing dockside monitoring programs accounted for 100% of landed catch, the fishery lacked at-sea monitoring creating uncertainty about total catch due to unknown at-sea releases.</p> <p>The management plan requires all groundfish to be accounted for; for catch to be managed according to established management areas; for vessels to be individually accountable for their catch; and for at-sea monitoring standards to meet the above objectives.</p> <p>The monitoring program was designed with industry to meet a range of requirements including transferrable quota between all sectors; 100% at-sea and dockside catch monitoring programs; individual vessel quota (IVQ) management for all sectors; 100% retention of all rockfish; implementation of consistent management areas; individual vessel accountability for all catch (retained and released).</p> <p>The program has been designed to be a cost effective alternative to 100% observer coverage with the additional benefits of enhanced compliance, reviewable data, no requirement for human observer needs (food, accommodation and logistics). The E-M program now covers approximately 200 vessels, 1,200 trips, 10,000 sea days, and 20,000 fishing events annually.</p>

Product	BlackBox
Contact	<p>Company: Anchor Lab K/S Address: H.C. Andersens Boulevard 37, 5. mf. 1553 Copenhagen V Phone: (+45) 48 48 15 53 Email: info@anchorlab.net Web: www.anchorlab.dk</p>
Description	<p>Anchor Lab’s Black Box data collection system provides vessel monitoring and remote/isolated data collection. The BlackBox System is a modular system that consists of a small sensor data collection unit (BlackBox R2) that can be used either on its own or in conjunction with a video collection computer (BlackBox VX), which expands the system to incorporate up to 8 high quality digital IP-cameras.</p> <p>The BlackBox R2 is a small and robust aluminum box with a 3.5” TFT screen and numerous connection possibilities (6 versatile sensor ports, Ethernet, USB). It runs on 12 or 24 VDC and uses PNP inductive sensors to determine rotation and direction (in/out) of winches. Current loop sensors (4-20 mA) can be used to record hydraulic pressure or other analog parameters like temperature. GPS position, speed and heading are also recorded with the sensor values at a customizable frequency, down to every second.</p> <p>The internal (expandable) storage can by default hold at least 12 months of data at a logging frequency of once every 10 seconds - the logging frequency is configurable down to once a second. The system is capable of automatic over the air updates of its firmware via the built-in GSM module, which is also used for automatic transmission of data to land. The system can be configured by a build-in SMS service or directly using the ethernet port.</p> <p>The BlackBox VX is a passive cooled compact video collecting computer, which is connected to the BlackBox R2 via ethernet. The VX also runs on 12 or 24 VDC, and includes a small internal battery UPS, to keep the system running during short term power outage. The VX can supply the BlackBox R2 with power from the UPS via passive POE (Power Over Ethernet) through the connecting network cable. A 2TB (Tera-byte) dedicated video storage, ensures at least 3 months backup of video recordings from 4 IP-cameras. A 1TB exchangeable hard drive gives easy access to the data, if the built-in wireless transmission via Wi-Fi or 3G/4G mobile network is not possible.</p> <p>The cameras are connected to the VX via an active POE switch, which minimizes the amount of cables needed for the installation. The VX comes with a small 10” touch screen and a very simple and user friendly interface, that shows both camera and sensor information, for the user to verify that the system is running correctly.</p> <p>Data is analysed using the BlackBox Analyzer software that displays winch and hydraulic activity against the GPS track and vessel information. Video data, if present, is also presented alongside, and is synchronised with the time marker in the graph and the GPS track. The software is capable of automatically estimating where fishing activities have taken place, by analysing the sensor and GPS information, and plotting it on a GIS map, where custom shapefiles can be added to help identify e.g. restricted areas, marine protected areas or other local features. The software also includes an alarm/warning system, where different parameters like period, time of day, position, speed and/or fishing activity are combined with map layers (shape-files) to produce rules for raising warnings and alarms, to help users focus their effort. This could for example be an alarm raised due to: a registered “fishing activity” in a specific “habitat area” within a given “restricted period”.</p>

Applications

In Denmark all vessels fishing for common mussels (*Mytilus edulis*) are required to be fitted with a sensor system. The fishery involves around 51 dredge vessels with a catch of around 30,000 tonnes. The BlackBox R2 system has been installed in the fishery since April 2012 with full functionality and reliability. The system is designed to meet the fishery objective to monitor where and when fishing is taking place, in detail, because mussel fishing is mainly conducted in sensitive marine areas with only 5% of the fishery area fished in a given year. Data is recorded every 10 seconds. In this fishery data is downloaded in near real time through the GSM network.

A number of BlackBox VX systems have been supplied for trials in Denmark, to investigate their potential for “fully documented fisheries” in regards to enforcing a discard ban and also as documentation of bycatch of sea mammals.

Product	<h2>Remote Electronic Monitoring System (REM)</h2>
Contact	<p>Company: DTU Aqua, Technical University of Denmark Address: National Institute of Aquatic Resources, Charlottenlund Slot 2920, Charlottenlund Phone: (+45) 35 88 33 00 Email: mynd@aqua.dtu.dk Web: www.aqua.dtu.dk/english</p>
Description	<p>DTU Aqua has undertaken extensive E-M trials in pelagic and demersal fisheries in support of proposed changes to the European Union Common Fisheries Policy. The program used Archipelago Marine Research (AMR) hardware and software and whilst AMR provided product training on installation, data analysis, and technical support, this was a DTU Aqua project. DTU Aqua staff installed and maintained the equipment, retrieved hard drives, and analysed data. For the case study discussed a four camera array was used, with GPS, hydraulic pressure sensor, and photoelectric drum rotation sensor. The control box contained data storage capability for 30 days of fishing activity. The control box collected and stored sensor and image data.</p>
Applications	<p>Catch Quota Management (CQM) is a results based management scheme where all fish count against the fishers quota, choices about harvesting are left to the fishers, and obligations to document targets are fulfilled using e-log and E-M. CQM was trialed in Danish fisheries from 2010 to 2012 to test whether CQM could provide reliable accounting for all catches of cod, better scientific data, and whether fishing was more selective with reduced accidental catches. 22 vessels fishing took part in the North Sea, the Skagerrak and the Baltic Sea.</p> <p>The Remote Electronic Monitoring (REM) system collected sensor data and images throughout the trial period. The trial was integrated with eLogs. Vessels were at sea for approximately 80,000 hours, carried out 1,114 fishing trips and conducted 9,800 fishing operations during the trial period.</p> <p>The main findings of the program are:</p> <ul style="list-style-type: none"> • The REM system can be applied on almost all types of vessels. Modification to vessel deck setups may be required in some cases. The project demonstrated the system can be applied on almost all types of pelagic vessels, and larger demersal vessels where it can give documentation of 100% of fishing activities. • The REM system has proven its technical reliability. • CQM with full documentation is a feasible management to ensure that quotas can actually be administered with an absolute limit, so that catch limits becomes an exact expression of the set fishing mortality. • Inspection at sea by inspection vessels is not an efficient tool against discarding and it is in any event more costly than inspection of REM results. • It is important that fishermen are given information and guidance. The quality of the detailed recordings declined over time for some fishermen. Feedback may ensure the fishermen perception of full documentation as an integrated part of his business. • In general, the industry has accepted having REM installed on board their vessels. There has been no negative feedback on the issue of having cameras recording the vessels working areas. Most of the fishermen are of the opinion that it is important to show what they are doing and what they are catching. In support of CQM with full documentation they at the same time underline the need to simplify and remove micro management. <p>The cost for documenting the fishery using E-M is significantly lower than using onboard observers.</p>

Product	Saltwater EM Solutions
Contact	<p>Company: Saltwater Inc. Address: 733 N Street, Anchorage, AK 99501 Phone: 907-276-3241 Email: kathryn.carovano@saltwaterinc.com Web: www.saltwaterinc.com</p>
Description	<p>Saltwater EM Solutions uses high-resolution digital IP (internet protocol) cameras designed to withstand extreme environments. These high-resolution cameras provide accurate detail and allow for larger image areas including 360-degree views as an alternative to additional cameras. Data is integrated with independently acquired GPS coordinates. Location, time and date stamps appear on each video frame. The system records all video and data files. Data is downloaded to a portable drive in port. Open source review software allows viewers to: speed review at up to 8 times recording speed, advance review to pre-determined event triggers, and freeze frame. Both moving video and paused frames can be zoomed in for close up detail.</p>
Applications	<p>The North Pacific Fishery Management Council, the National Marine Fisheries Service (NMFS), and industry groups are exploring E-M as a tool for fisheries monitoring in the North Pacific. NMFS and the Council have expressed their support for a high resolution EM system that is capable of providing data for catch estimation. Saltwater Inc. was awarded the pilot project over a 5-year period (2013-2018). The focus of the project is to test an EM system capable of collecting data on catch composition, discard activity, and fishing effort.</p> <p>The initial focus of the pilot project is on the halibut and sablefish longline fishery in Alaska. In the Alaskan halibut IFQ fishery, there are 2,699 individual shareholders of whom 66% are fishing for 4.5 tonnes or less. The majority of these vessels fish with crews of 2-3 people from a variety of small ports around the Gulf of Alaska. Many of these smaller boats are able to catch their quota with between 15 and 40 days of fishing effort per year. Deploying human observers in this fishery is logistically difficult and very costly. The project objectives are:</p> <ul style="list-style-type: none"> • Deploy EM systems on up to 60 vessels per year in 4 ports scattered across Alaska. • Provide high-resolution digital images that would allow for the count of individual hooks and identification of fish to the species level. • Provide GPS and time/date stamps on every video frame. • Develop local infrastructure <p>The project began in April 2013. At October 2013 Saltwater has trained local technicians and completed installations in 5 ports. The project is providing high-resolution digital images of fishing activity that allow for individual hook counts and identification of fish species or species groupings. GPS coordinates and time/date stamps are on every video frame allowing for accurate tracking of fishing effort.</p> <p>Issues to note from this project are:</p> <ul style="list-style-type: none"> • The EM pilot project is voluntary. There are no incentives for fishing vessels to carry an EM system. In 2014, vessels that volunteer to carry an EM system will be excused from the requirement to carry an observer. We expect this change to greatly increase the number of vessels carrying EM systems. • EM systems require an uninterrupted power supply, which can be a challenge, particularly on smaller boats. A variety of solutions have been tested and the issue resolved through a redesign of set-up and data storage systems. • Camera placement, lighting, frame rate, and resolution all affect the quality of the final images captured. It requires testing and experimentation to resolve these issues, which are particular to every fishery. Different cameras, lenses, configurations and placement have been tested in this trial to capture consistent, quality data. <p>Although NMFS is responsible for data review in this project, Saltwater has provided review software that is open-source as favoured by NMFS' national guidelines. The review software allows viewers to: speed review at up to 8 times recording speed, advance review to pre-determined event triggers, and freeze frame. Both moving video and paused frames can be zoomed in for close up detail.</p>

Product	Satlink SeaTube (Tunatube Electronic Observer Onboard); SeaTube View Manager
Contact	<p>Company: Satlink Sociedad Limitada</p> <p>Address: Avda. de la Industria, 53. 28108 Alcobendas. Madrid. Spain</p> <p>Phone: +34 91 327 21 31</p> <p>Email: info@satlink.es</p> <p>Web: www.satlink.es/en</p>
Description	<p>SeaTube is a system for recording and real-time monitoring that enables fishing companies, RFOs and Observer Programs more control over fishing operations.</p> <ul style="list-style-type: none"> • SeaTube comprises: <ul style="list-style-type: none"> • four cameras, two on deck, two in the fish handling area • Satlink video server (NAS / NVR) • VMS with preconfigured EEZs and • FleetBroadband communications system. • Videos are stored onboard in the Satlink SeaTube rack and encrypted. • Videos are extracted locally from HDD for analysis ashore by owner or the Observer Program. • SeaTube incorporates their type approved VMS, making the second facility redundant. • SeaTube View Manager extracts GPS data from video to show vessel position, course and speed for the time of the video, directly from marine chart. <p>Edit mode allows for full viewing control of video, adding notes to video, adding tags for gear activity, and report generation.</p>
Applications	<p>Satlink is a leader in the satellite communications industry. Their partnerships with the main satellite network operators, such as Inmarsat, Thuraya and Iridium, give them the ability to provide global coverage for voice and data services to any kind of user, regardless of its location whether at sea, on land or in aircraft. The fishing sector represents the backbone of the company where Satlink has a strong position in the market.</p> <p>SeaTube is in use by three tuna fishing companies Albacora, Nicra and Inpesca, on 18 vessels fishing in the Indian and Atlantic Oceans. The Spanish Oceanographic Institute (Instituto Oceanografico Español-IOE) also has analysed the data to demonstrate it can substitute for a human observer.</p> <p>The system gives greater control over onboard operations such as fishing, bunkering, and transshipment. Data is visible from a PC in the office or from tablets or smartphones and is accessed through a secure web server. It comprises four cameras and is designed to work via satellite communications. Video is stored on board the vessel (at least 4 months of recording) and can be consulted remotely from the shipowner's office. The system administrator (company) can provide access to other users and share information with fishery bodies. Then system records activity from one hour before dawn to one hour after nightfall (these parameters can be adjusted according to shipowner's requirements). Every 10 minutes, the video server takes and sends a low resolution photogram from each of the cameras to the on-shore servers. These photos give an initial view of what is happening on board the vessel. If more detail is required from an image a corresponding 10 minute video can be ordered remotely. When the vessel comes to port, the recordings can be collected by hard drive exchange. All video data is encrypted. Each photogram is 13KB. The total volume of data for a month's photograms is 33MB. 10 minutes of video are approximately 12MB in low quality and 35MB in medium quality.</p>

Product	Seatronics Sea Observer CCTV system.
Contact	<p>Company: Seatronics Ltd Address: Unit 2, Blackhouse Industrial Estate, Peterhead, AB42 1BN, UK Phone: +44 (0)1779 480600 Email: peterhead@seatronics-group.com Web: www.seatronics-group.com/fishing-division</p>
Description	<p>The Sea Observer system provides video footage at up to 25fps via HD cameras. Video is triggered by proximity sensors to monitor drum and winch activity, and hydraulic pressure sensors. The system has an independent GPS. The system has remote secure desktop sharing which enables management agency officers to log onto a system to check it remotely.</p> <p>Sea Observer can be linked with a vessels Scanmar catch control system. Data input is received from catch sensors mounted in the net. This gives the management agency the ability to log the catch through the Scanmar system and monitor when the catch leaves the trawl and boards the vessel. This technology has the potential to look at catch composition in tuna purse seine nets, and especially to catch interactions with non target catch such as cetaceans, dolphins, and turtles.</p> <p>The system cost is around \$16,000 plus delivery. Installation costs are around \$1100 per day and may vary based on the origin of installation. From December 2013, the Sea Observer Analysis software will be available for purchase. The cost of the software has not been finalised but is envisaged to be around \$8,000 per license with an annual fee of around \$3200.</p> <p>When logged onto our system remotely, the management agency will be able to stream video (4 cameras) see pressure, proximity and catch sensor data values along with GPS.</p> <p>A related is the Trawlcam system that might be useful for underwater monitoring for example in purse seine nets. Trawlcam video camera system is mounted on the head rope of the net. The system provides video footage of all species entering the trawl while towing.</p> <p>The performance and condition of the net can also be monitored.</p>
Applications	<p>Trials have been completed in Scotland. The system will be fully operational in December this year. After working with Marine Scotland regulatory officers the system will replace the observers and also include functions unique to onboard vessel monitoring. One function being the sole licensee of integration into Scanmar catch control systems for the presentation of the vessels existing Scanmar catch sensors. We also have the capability to add our Seatronics elog book into the Sea observer to provide a all in one compliance system.</p>

Product	Western Australian Fisheries
Contact	<p>Company: Western Australian Fisheries and Marine Research Laboratories Address: PO Box 20 North Beach, Western Australia, 6920 Phone: +61 (08) 9203 0111 Email: Through website contact page Web: www.fish.wa.gov.au</p>
Description	<p>Western Australian Fisheries undertook a trial of E-M using readily available products. The trial involved the use of a Mobotix Q24 camera connected to a Mac Mini. The camera was mounted on the edge of a canopy frame that covers the back deck, looking over the gunwale of the vessel. The single camera had a 360° view of the back deck and the water from the bow to the stern of the port side of the vessel. In the trial the computer saved everything from the moment the vessel power was turned on until it was turned off. Files were stored in one-hour blocks. An alternative was to use motion sensors. The data was stored using “SecuritySpy” software. The data storage requirement was 200 MB per 1-hour file (a 1 Terabyte drive would hold 5,000 hours of data). Data was downloaded manually for this project although internet transfer was claimed as feasible. Images were recorded at 1 frame per second for this trial.</p>
Applications	<p>. Gillnet fisheries in Western Australia (WA) have come under scrutiny because of uncertainty over interaction with marine mammals such as sea lions, interaction with other TEPS, and perception of net “dropouts” of demersal scalefish. To address these concerns a pilot evaluations of electronic monitoring was undertaken on a demersal gillnet vessel as an alternate to human observers.</p> <p>Data analysis took about 1 hour for 10 hours of fishing. The ability to determine whether and animal was alive or dead was limited because of the low frame rate. About 80% of species could be correctly identified with reviewer inexperience, low light images, blurry images, obscured images, and glare from the deck or water the reasons cited for failing to identify the remainder. Dropouts were rare, and identification was difficult and only to higher taxonomic levels. Logbook records indicated two grey nurse shark interactions (TEPS) but these could not be identified from video.</p> <p>Towards the end of the study images were obscured by condensation, partially and then fully. The report states this could have been detected earlier if the data had been downloaded and reviewed more frequently .</p> <p>Cost for 4 week study was \$20,000 compared with an observer cost of \$55,000 noting the study was note designed to evaluate comparative costs and benefits. The report concludes the proof of concept aim was achieved, and the results provided valuable information on the efficacy of E-M in the fishery.</p> <p>Two further trials have been undertaken but no reports yet released.</p>

Product	Succorfish SC2
Contact	<p>Company: Succorfish Address: The Barracks Building Phone: +44 191 447 6883 Email: support@succorfish.com Web: www.succorfish.com</p>
Description	<p>Succorfish is a leading provider of intelligent M2M data transfer technology, next generation telematic communication systems and GSM/GPRS asset tracking products</p> <p>The SC2 monitoring unit uses mobile phone GPRS/GSM technology, with Iridium satellite reporting as well as bespoke online software to offer a monitoring solution. The system includes sector specific features including e-log data reporting, SOS emergency alarm, radio frequency identification (RFID), crew safety systems, and deep sea thermal sensor attachments for fishing gears.</p> <p>The system offers 100% data security and allows users to access information through a password protected online interface. Information is available via Iridium satellite and mobile devices allowing users to monitor activity in real time. An RFID scanner fitted to winches and fishing gear allows SC2 to monitor activity across all areas of the vessel's operations.</p> <p>A geofence facility manages area access and alerts the operator, agent or compliance authority by email or text whenever a vessel enters or exits such waters.</p>
Applications	<p>SC2 is currently in use in the UK to monitor marine protected areas to an accuracy of 2 metres providing an exceptional level of confidence in knowing the exact location of their vessel at any given time.</p>

Appendix 5 – Data serialisation formats

Name	Creator/Maintainer	Based on	Standardized?	Specification	Binary?	Human-readable?	Supports references?	Schema/IDL?	Standard APIs
ASN.1	ISO, IEC, ITU-T	N/A	Yes	ISO/IEC 8824; X.680 series of ITU-T Recommendations	Yes (BER, DER, PER, or custom via ECN)	Yes (XER, GSER, or custom via ECN)	Partial ^a	Yes (built-in)	N/A
Bencode	Bram Cohen (creator)	N/A	Yes	Part of BitTorrent protocol specification	Partially (numbers and delimiters are ASCII)	Partially	No	No	No
BSON	MongoDB	JSON	Yes	BSON Specification	Yes	No	Yes	No (Candle Pattern Reference)	Yes (XQuery, XPath)
Candle Markup	Henry Luo RFC author:	XML, JSON, JavaFX	Yes	Candle Markup Reference RFC 4180	No	Yes	(XPointer, XPath)	Yes	(XQuery, XPath)
Comma-separated values (CSV)	Yakov Shafranovich	N/A	Partial (myriad informal variants used)	(among others)	No	Yes	No	No	No
D-Bus Message Protocol	freedesktop.org	N/A	Yes	D-Bus Specification RFC 4627	Yes	Yes (Type Signatures)	No	No	Yes (see D-Bus)
JSON	Douglas Crockford	JavaScript syntax	Yes	(ancillary: RFC 6901 , RFC 6902) MessagePack format specification netstrings.txt	No, but see BSON	Yes	Yes (JSON Pointer (RFC 6901); alternately: JSONPath, JPath, JSPON, json:select())	Partial (JSON Schema Proposal, Kwalify, Rx, Itemscript Schema)	Partial (Clarinet, JSONQuery, JSONPath)
MessagePack	Sadayuki Furuhashi	JSON (loosely)	Yes		Yes	No	No	No	No
Netstrings	Dan Bernstein	N/A	Yes		Yes	Yes	No	No	No
OGDL	Rolf Veen	?	Yes	1.0 Working draft	Yes (Binary 1.0 Working draft)	Yes	Yes (Path 1.0 Working draft)	Yes (Schema WD)	
OpenDDL	Eric Lengyel	C, PHP	Yes	OpenDDL.org	No	Yes	Yes	No	No
Property list	NeXT (creator) Apple (maintainer)	?	Partial	Public DTD for XML format	Yes	Yes ^b	No	?	reFoundati on, OpenS
Protocol Buffers	Google	N/A	Partial	Developer Guide: Encoding	Yes	Partial ^d	No	Yes (built-in)	
S-expressions	Internet Draft author: Ron Rivest	Lisp, Netstrings	Partial (largely <i>de facto</i>)	"S-Expressions" Internet Draft	Yes ("Canonical representation")	Yes ("Advanced transport representation")	No	No	
Sereal	Yves Orton, Steffen Müller et al.	N/A	Yes	Sereal Specification	Yes	No	Yes	No	No
Structured Data eXchange Formats	Max Wildgrube Facebook (creator)	N/A	Yes	RFC 3072	Yes	No	No	No	
Thrift	Apache (maintainer)	N/A	No	Original whitepaper	Yes	Partial ^c	No	Yes (built-in)	
eXternal Data Representation	Sun Microsystems (creator) IETF (maintainer)	N/A	Yes	RFC 4506	Yes	No	Yes	Yes	Yes
XML	W3C	SGML	Yes	W3C Recommendations: 1.0 (Fifth Edition) 1.1 (Second Edition)	Partial (Binary XML)	Yes	(XPointer, XPath)	Yes (XML schema)	Yes (DOM, SAX, XQuery, XPath)
XML-RPC	Dave Winer⁽¹⁾	C, Java, Perl, Python, Ruby, Email, HTML, MIME, URI, XML, SAX, SOAP, JSON ⁽¹⁾	Yes	XML-RPC Specification	No	Yes	No	No	No
YAML	Clark Evans Ingy dot Net, and Oren Ben-Kiki	C, Java, Perl, Python, Ruby, Email, HTML, MIME, URI, XML, SAX, SOAP, JSON ⁽¹⁾	Yes	Version 1.2	No	Yes	Yes	Partial (Kwalify, Rx, built-in language type-defs)	No

- a. The current default format is binary.
- b. The "classic" format is plain text, and an XML format is also supported.
- c. Theoretically possible due to abstraction, but no implementation is included.
- d. The primary format is binary, but a text format is available.
- e. Means that generic tools/libraries know how to encode, decode, and dereference a reference to another piece of data in the same document. A tool may require the IDL file, but no more. Excludes custom, non-standardized referencing techniques.
- f. ASN.1 does offer OIDs, a standard format for globally unique identifiers. However, there is no standard for "marking"/"tagging" an arbitrary piece of data in a document with an OID. There is also no standard format for locally unique identifiers within a document. Therefore, a generic ASN.1 tool/library can not automatically encode/decode/resolve references within a document without help from custom-written program code.

Table 4. Range of serialisation formats used for data storage and transmission (from Wikipedia Comparison of data serialization formats (Accessed 08/10/13)).

CALLSIGN	SHOTDATE	SHOTNU	RETPORT	LATSTART	LONGSTART	CSIROCODE	RETWHOLE	DISWHOLE	PROCESS
LET001	16-Mar-97	1	"LAKES ENTRANCE"	380235	1489971	31006	0	12	X
LET001	16-Mar-97	1	"LAKES ENTRANCE"	370437	1491963	120001	0	5	X
LET001	16-Mar-97	1	"LAKES ENTRANCE"	380435	1491954	228002	5	1	W
LET001	16-Mar-97	1	"LAKES ENTRANCE"	393434	1492084	232004	0	1	X
LET001	16-Mar-97	1	"LAKES ENTRANCE"	370435	1493376	232010	0	1	X
PT002	18-Jul-97	3	"PORTLAND"	393660	1421210	228002	10	3	G
PT002	18-Jul-97	3	"PORTLAND"	373657	1401230	232000	0	135	X
PT002	18-Jul-97	3	"PORTLAND"	403663	1411670	255001	0	1	X
PT002	18-Jul-97	3	"PORTLAND"	384540	1431290	264003	20	0	W

Table 5. Examples of CSV field headings and line records with each field separated by commas.

Name	Displayed Type	Minimum Occurrences	Maximum Occurrences
ActivityEndTime	xs:dateTime	1	1
ActivityStartTime	xs:dateTime	1	1
ActivityTypeNonFishing		1	1
ActivityTypeTrip		1	1
ApplicationHash	xs:string	1	1
ApplicationName	xs:string	1	1
ApplicationVersion	xs:string	1	1
BinSize	xs:int	0	1
BRDDescription	xs:string	1	unbounded
Catch		0	unbounded


```

- <TripActivity>
  <ActivityStartTime>2010-10-29T15:55:00</ActivityStartTime>
  <ActivityEndTime>2010-10-29T21:24:00</ActivityEndTime>
  - <ActivityTypeTrip LookupValue="Activity Type Trip">
    <LookupValueCode>Deploying and retrieving fishing gear</LookupValueCode>
  </ActivityTypeTrip>
  + <Fishery LookupValue="Fishery">
  - <Shot>
    + <FishingMethod LookupValue="Fishing Method">
      <ObserverOnBoard>false</ObserverOnBoard>
      <ShotDate>2010-10-29</ShotDate>
      <ShotNumber>17</ShotNumber>
    + <TypeOfFishing LookupValue="Type Of Fishing">
      <WildlifeInteractionOccurred>false</WildlifeInteractionOccurred>
    + <TargetSpecies>
    + <TrawlBRD>
    + <FinfishandScampiTrawlShot>
  - <Catch>
    <CSIROSpeciesCodeCatch>37288006</CSIROSpeciesCodeCatch>
    - <RetainedCatch>
      <NumberOfBins>1</NumberOfBins>
      <BinSize>32</BinSize>
      <EstimatedProcessedWeight>30</EstimatedProcessedWeight>
      - <Form LookupValue="Form">
        <LookupValueCode>Whole</LookupValueCode>
      </Form>
    </RetainedCatch>
    </Catch>
    + <Catch>
    + <Catch>
    + <Catch>
    + <Catch>
    + <Catch>
  </Shot>
</TripActivity>

```

Table 6. Examples of XML field specification and syntax with actual “information” highlighted in bold black.

Field-code	Data-element	Syntax	Contents	Examples
AC	Activity	Char*3	See code list	//AC/HAU//
AD	Address destination	Char*3	3-Alpha code (ISO-3166)	//AD/RUS//
AE	Area of Entry	Char*6	ICES/NAFO Codes of Division entering into	
AF	Apparent infringement			
AI	Assigned inspectors	Char*3 Num*4	3-Alpha code (ISO-3166) 1-9999	//AI/NOR333// or //AI/NLD4425 CEC29 RUS12//

Table 7. Examples of NAF field-codes, data-elements, syntax, contents and examples.

Appendix 6 – Potential of E-Reporting and E-Monitoring to support CMM reporting

The legend below describes the scoring used in the following CMM tables.

Legend: Potential relevance of E-M and E-R to Resolutions and CMMs	
Yes (significant potential to contribute to program outcomes)	
Yes (potential for reporting obligations to be met or enhanced)	
No	
Replaced Resolution/CMM	

Table 8. Potential of E-Monitoring and E-Reporting to support CMM reporting – Current Resolutions (Non-binding)

Resolution	Title	E-Monitoring	E-Reporting
2005-03	<p>RESOLUTION ON NON-TARGET FISH SPECIES</p> <p>Resolution requires CCMs to encourage their vessels to avoid non-target captures and to release unharmed non target catches that are not to be retained.</p> <p>E-M can support analysis of fishing operations and targeting, and assist to provide evidence for compliance; E-R observer can provide enhanced reporting capacity for non-target species.</p>	✓✓	✓✓
2008-01	<p>RESOLUTION ON ASPIRATIONS OF SMALL ISLAND DEVELOPING STATES AND TERRITORIES</p>	✗	✗
2012-01	<p>RESOLUTION ON THE BEST AVAILABLE SCIENCE</p> <p>Resolution requires improved collection and submission of data, including on by-catches.</p> <p>Both E-M and E-R offer the potential for a quantum leap in the quality and timeliness of scientific data.</p>	✓✓	✓✓

**Table 9. Potential of E-Monitoring and E-Reporting to support CMM reporting
– Current CMMs (Binding)**

CMM	Title	E-Monitoring	E-Reporting
2004-03	<p>SPECIFICATIONS FOR THE MARKING AND IDENTIFICATION OF FISHING VESSELS</p> <p>Measure requires CCMs to ensure their vessels are marked with international radio call sign or international telecommunication union characters.</p> <p>E-Monitoring can assist in identifying whether vessels are appropriately marked. E-R observer can report on sightings of other vessels (Gen-1).</p>	✓	✓
2004-04	RESOLUTION ON CONSERVATION AND MANAGEMENT MEASURES	✗	✗
2005-03	<p>CONSERVATION AND MANAGEMENT MEASURE FOR NORTH PACIFIC ALBACORE</p> <p>Measure requires CCMs to ensure fishing effort does not increase, report North Pacific Albacore catches every 6 months, report all catches of albacore and all fishing effort directed at albacore north of the equator annually.</p> <p>E-M can assist to ensure CMM obligations are monitored in particular to establish whether targeted fishing is occurring (if albacore targeting can be defined); E-R catch can assist with catch and effort reporting obligations. E-R CMM potential reporting to Commission.</p>	✓	✓
2006-04	<p>CONSERVATION AND MANAGEMENT MEASURE FOR STRIPED MARLIN IN THE SOUTHWEST PACIFIC</p> <p>Measure requires CCMs to restrict effort applied to striped marlin, and requires annual reporting to Commission.</p> <p>E-M can assist to ensure CMM obligations are monitored in particular to establish whether targeted fishing is occurring (if marlin targeting can be defined); E-R catch can assist with catch and effort reporting obligations. E-R CMM potential reporting to Commission.</p>	✓	✓

CMM	Title	E-Monitoring	E-Reporting
2006-07	CONSERVATION AND MANAGEMENT MEASURE FOR THE REGIONAL OBSERVER PROGRAMME		
2006-08	<p>WESTERN AND CENTRAL PACIFIC FISHERIES COMMISSION BOARDING AND INSPECTION PROCEDURES</p> <p>Measure establishes procedures for high seas inspection and established priorities for inspection on certain vessels.</p> <p>E-M can be reviewed by inspectors during boarding; video can assist in prioritising vessels for inspection. E-R logsheet and E-R transshipment can assist in identifying IUU catch on board inspected vessels.</p>		
2007-01	<p>CONSERVATION AND MANAGEMENT MEASURE FOR THE REGIONAL OBSERVER PROGRAMME</p> <p>Measure establishes regional observer program, sets objectives, lays out obligations of CCMs, role of the Commission, Secretariat and coastal States.</p> <p>E-M and E-R observer logs present opportunities for significant improvements in efficiency, effectiveness, quality and timeliness of observer program data and activities, as well as safety.</p>		
2008-03	<p>CONSERVATION AND MANAGEMENT OF SEA TURTLES</p> <p>Measure requires CCMs to implement FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations, and to report to Commission.</p> <p>E-M can provide evidence of interactions, as well the use of mitigation measures and handling and release; E-R observer (E-R logsheet) can provide enhanced reporting capacity for sea turtle interactions and handling and release. ER-CMM state annual report to commission.</p>		
2008-04	<p>CONSERVATION AND MANAGEMENT MEASURE TO PROHIBIT THE USE OF LARGE SCALE DRIFTNETS ON THE HIGH SEAS IN THE CONVENTION AREA</p> <p>Measure prohibits the use of large scale drift nets and requires CCMs to report on MCS relevant activities.</p>		

CMM	Title	E-Monitoring	E-Reporting
	E-M offers the potential to support enforcement of this measure (particularly in Nth Pacific), and with E-R observer can also validate reported sightings of illegal fishing.		
2009-01	<p>RECORD OF FISHING VESSELS AND AUTHORIZATION TO FISH</p> <p>Measure requires CCMs to ensure fishing only by vessels flying the flag of a member, that vessels hold appropriate authorisations, and that both numbers of authorisations and effort are managed.</p> <p>E-R observer can assist to ensure obligations are monitored.</p>		
2009-02	<p>CONSERVATION AND MANAGEMENT MEASURE ON THE APPLICATION OF HIGH SEAS FAD CLOSURES AND CATCH RETENTION</p> <p>Measure clarifies FAD closure and catch retention requirements and requires CCMs to ensure their flagged vessels comply.</p> <p>E-M can assist in identifying FAD sets. E-R observer and E-R logsheet can assist in meeting reporting obligations. E-R observer reporting of FAD sets. E-R CMM PS vessel to report discards to Commission (within 48 hours).</p>		
2009-03	<p>CONSERVATION AND MANAGEMENT FOR SWORDFISH</p> <p>Measure requires CCMs to not increase fishing vessel numbers, to limit catch levels, and to not increase effort in waters north of 20°S.</p> <p>E-M can assist in monitoring whether targeted fishing is occurring. E-R logsheet can validate vessel numbers and locations and to monitor quotas.</p>		
2009-05	<p>CONSERVATION AND MANAGEMENT MEASURE PROHIBITING FISHING ON DATA BUOYS</p> <p>Measure requires CCMs to prohibit their fishing vessels from fishing on data buoys.</p> <p>E-M can assist in ensuring compliance; E-R observer can assist in event reporting.</p>		

CMM	Title	E-Monitoring	E-Reporting
2009-06	<p>CONSERVATION AND MANAGEMENT MEASURE ON REGULATION OF TRANSHIPMENT</p> <p>Measure establishes rules for transshipment.</p> <p>E-M can assist in ensuring compliance by monitoring all transshipment events initiated through hydraulic sensors; E-R CMM vessel transshipment can assist to ensure reporting obligations are met. E-R observer recording of transshipment events.</p>	✓✓	✓✓
2009-09	<p>CONSERVATION AND MANAGEMENT MEASURE FOR VESSELS WITHOUT NATIONALITY</p> <p>Measure declares fishing vessels without nationality and operating within the Convention area are presumed to be operating in contravention of the Convention.</p> <p>E-M has the potential to support incident reporting of fishing and transshipment sightings of vessels without nationality. E-R observer can capture digital image of vessel in their reports.</p>	✓	✓
2009-10	<p>CONSERVATION AND MANAGEMENT MEASURE TO MONITOR LANDINGS OF PURSE SEINERS AT PORTS SO AS TO ENSURE RELIABLE CATCH DATA BY SPECIES</p>	✗	✗
2009-11	<p>COOPERATING NON-MEMBERS</p>	✗	✗
2010-01	<p>CONSERVATION AND MANAGEMENT MEASURE FOR NORTH PACIFIC STRIPED MARLIN</p> <p>Measure places catch limits on flag/chartering CCMs, requires management measures to be applied, with reporting to the Commission.</p> <p>E-M could assist in ensuring obligations are monitored in particular to establish whether targeted fishing is occurring; E-R observer and particularly E-R logsheet can assist to validate catch levels and monitor quota. E-R CMM State reports to Commission.</p>	✓	✓✓
2010-02	<p>CONSERVATION AND MANAGEMENT MEASURE FOR THE EASTERN HIGH-SEAS POCKET SPECIAL MANAGEMENT AREA</p> <p>Measure requires flag States to require their vessels to</p>	✓✓	✓✓

CMM	Title	E-Monitoring	E-Reporting
	<p>report entry and exit from EH-SP, and requires CCMs to encourage their flagged vessels to report sightings. VMS is used as a means for monitoring and verifying the reporting and nature of the activities occurring in the pocket. VMS and email reporting is the current method of monitoring this measure.</p> <p>Both E-M of hydraulic sensors on fishing equipment and video can indicate fishing in EH-SP. E-R observers have the potential to support reporting and compliance with this measure and ER logsheet can use geo-fencing tools to automatically log vessel movement into these areas.</p>		
2010-05	<p>CONSERVATION AND MANAGEMENT MEASURE FOR SOUTH PACIFIC ALBACORE</p> <p>Measure requires CCMs not to increase catches and to report to the Commission.</p> <p>E-M can assist to ensure CMM obligations are monitored in particular to establish whether targeted fishing is occurring (if SP Albacore targeting can be defined); E-R catch can assist with catch and effort reporting obligations. E-R CMM potential reporting to Commission.</p>	✓	✓
2010-06	<p>CONSERVATION AND MANAGEMENT MEASURE TO ESTABLISH A LIST OF VESSELS PRESUMED TO HAVE CARRIED OUT ILLEGAL, UNREPORTED AND UNREGULATED FISHING ACTIVITIES IN THE WCPO</p>	✗	✗
2010-07	<p>CONSERVATION AND MANAGEMENT MEASURE FOR SHARKS</p> <p>Measure encourages CCMs to implement the FAO International Plan of Action for the Conservation and Management of Sharks, and to report to the Commission. NPOAs to include key species, minimize waste and discards from shark catches, encourage live release of incidental catches of sharks, fully utilize retained catches of sharks.</p> <p>Measure requires fins to total no more than 5% of the weight of sharks on board, prohibit their fishing vessels from retaining on board, transshipping, landing, or trading any fins harvested in contravention.</p> <p>E-M can ensure obligations are monitored, in particular</p>	✓✓	✓✓

CMM	Title	E-Monitoring	E-Reporting
	in respect of handling (particularly finning and life status) and discard requirements; E-R observer can assist to ensure reporting obligations are met. E-R CMM State reporting of catches to Commission.		
2011-02	<u>CONSERVATION AND MANAGEMENT MEASURE FOR THE COMMISSION VMS</u>	✘	✘
2011-03	<p>CONSERVATION AND MANAGEMENT MEASURE TO ADDRESS THE IMPACT OF PURSE SEINE ACTIVITY ON CETACEANS</p> <p>Measure requires CCMs to prohibit flagged vessels from setting a purse seine net on tuna schools associated with a cetacean, and to report incidents to the Commission.</p> <p>E-M can assist to ensure obligations are monitored. E-R observer reporting of event. E-R CMM vessel real time reporting of catches to State. E-R CMM State reporting of catches to Commission.</p>	✓✓	✓✓
2011-04	<p>CONSERVATION AND MANAGEMENT MEASURE FOR OCEANIC WHITETIP SHARKS</p> <p>Measure requires CCMs to prohibit flagged vessels from retaining oceanic whitetip shark, and require any caught to be released without harm.</p> <p>E-M can assist to ensure obligations are monitored, in particular in respect of handling (finning and life state) and discard requirements; E-R observer reporting of event. E-R CMM State to provide report of discards and releases to Commission.</p>	✓✓	✓✓
2012-01	<p>CONSERVATION AND MANAGEMENT MEASURE FOR BIGEYE, YELLOWFIN AND SKIPJACK</p> <p>Measure aims at a minimum to maintain stocks at MSY, requires CCMs not to undermine measure through transfer of effort, implements FAD management controls, limits purse seine effort, implements catch retention requirements, limits longline catch of bigeye tuna, and requires more frequent reporting from CCMs.</p> <p>E-M and E-R logsheet, observer, transshipment and port monitoring could all play a significant role in supporting obligations and compliance with this measure, in</p>	✓✓	✓✓

CMM	Title	E-Monitoring	E-Reporting
	particular the regular reporting requirements. Two most important areas will be FAD monitoring for purse seine vessel and Bigeye longline catch.		
2012-02	<p>CONSERVATION AND MANAGEMENT MEASURE FOR COMPLIANCE MONITORING SCHEME</p> <p>Members receive a draft compliance monitoring report developed in IMS, delivered to members for their review and response. Member annual reports on implementation of measures then received directly into Commission IMS.</p> <p>Data from E-M and E-R logsheet , observer and transshipment used in conjunction with VMS to review and validate assessments by CCMs of their CMM and data provision obligations.</p>	✓✓	✓✓
2012-03	<p>CONSERVATION AND MANAGEMENT MEASURE FOR IMPLEMENTATION OF THE ROP BY VESSELS FISHING NORTH OF 20N</p> <p>Measure requires ROP to be expanded to 5% coverage of vessels fishing for fresh fish north of 20° north.</p> <p>E-M and E-R observer logs present opportunities for significant improvements in efficiency, effectiveness, quality and timeliness of observer program data and activities, as well as safety.</p>	✓✓	✓✓
2012-04	<p>CONSERVATION AND MANAGEMENT MEASURE ON THE PROTECTION OF WHALE SHARKS FROM PURSE SEINE OPERATIONS</p> <p>Measure requires CCM to <i>prohibit setting of purse seine on a tuna associated with a whale shark</i>, with reporting obligations.</p> <p>E-M can assist to ensure obligations are monitored. E-R observer reporting of event. E-R CMM vessel real time reporting of catches to State. E-R CMM State reporting of catches to Commission. Use of guidelines for safe release can be monitored by E-R and E-M and improved if necessary.</p>	✓✓	✓✓
2012-05	<p>CONSERVATION AND MANAGEMENT MEASURE ON CHARTER NOTIFICATION SCHEME</p> <p>Measure requires each chartering member or</p>	✗	✓✓

CMM	Title	E-Monitoring	E-Reporting
	<p>participating territory to notify the Commission of the charter vessel details in advance of fishing.</p> <p>Because reporting by Flag States is aggregated data there are potentially issues of double counting and the consequent uncertainty in data integrity. This could be readily addressed through E-R logsheets.</p>		
2012-06	<p>CONSERVATION AND MANAGEMENT MEASURE FOR PACIFIC BLUEFIN</p> <p>Measure requires CCMs to limit fishing effort, to reduce catch of juvenile fish, and report to the Commission.</p> <p>E-M can assist to ensure CMM obligations are monitored in particular to establish whether targeted fishing is occurring (if Pacific Bluefin targeting can be defined) or if juvenile fish are caught; E-R catch can assist with catch and effort reporting obligations. E-R CMM reporting to Commission.</p>	✓	✓
2012-07	<p>CONSERVATION AND MANAGEMENT MEASURE FOR MITIGATING IMPACTS OF FISHING ON SEABIRDS</p> <p>Measure encourages CCMs to implement IPOA Seabirds. The Measure requires CCMs to report to the Commission, and to require their longline vessels to use mitigation measures.</p> <p>E-M can provide evidence of seabird interaction and compliance with the use of mitigation measures; E-R observer can ensure incident reporting obligations are met. E-R CMM State annual reporting to Commission.</p>	✓ ✓	✓ ✓

**Table 10. Potential of E-Monitoring and E-Reporting to support CMM reporting
- Replaced and expired resolutions**

Resolution	Title	E-Monitoring	E-Reporting
2005-01	RESOLUTION ON THE INCIDENTAL CATCH OF SEABIRDS (Replaced by CMM 2012-07)		
2005-02	RESOLUTION ON REDUCTION OF OVERCAPACITY		
2005-4	RESOLUTION TO MITIGATE THE IMPACT OF FISHING FOR HIGHLY MIGRATORY FISH SPECIES ON SEA TURTLES (Replaced by 2008-03)		

**Table 11. Potential of E-Monitoring and E-Reporting to support CMM reporting
- Replaced CMMs**

CMM	Title	E-Monitoring	E-Reporting
2004-01	RECORD OF FISHING VESSELS AND AUTHORIZATION TO FISH (REPLACED BY CMM 2009-01)		
2004-02	COOPERATING NON-MEMBERS (REPLACED BY CMM 2008-02)		
2005-01	CONSERVATION AND MANAGEMENT MEASURES FOR BIGEYE AND YELLOWFIN TUNA IN THE WESTERN AND CENTRAL PACIFIC OCEAN (REPLACED BY CMM 2008-01)		
2005-02	CONSERVATION AND MANAGEMENT MEASURE FOR SOUTH PACIFIC ALBACORE (REPLACED BY CMM 2010-05)		
2006-01	CONSERVATION AND MANAGEMENT MEASURES FOR BIGEYE AND YELLOWFIN TUNA IN THE WESTERN AND CENTRAL PACIFIC OCEAN (REPLACED BY CMM 2008-01)		
2006-02	CONSERVATION AND MANAGEMENT MEASURE TO MITIGATE THE IMPACT OF FISHING FOR HIGHLY MIGRATORY FISH STOCKS ON SEABIRDS (REPLACED BY CMM 2007-04)		
2006-03	CONSERVATION AND MANAGEMENT MEASURE FOR SWORDFISH IN THE SOUTH WEST PACIFIC (REPLACED BY CMM 2009-03)		
2006-05	CONSERVATION AND MANAGEMENT MEASURE FOR SHARKS IN THE WESTERN AND CENTRAL PACIFIC OCEAN (REPLACED BY 2008-06)		
2006-06	COMMISSION VESSEL MONITORING SYSTEM (REPLACED BY CMM 2011-02)		
2006-09	CONSERVATION AND MANAGEMENT MEASURE TO ESTABLISH A LIST OF VESSELS PRESUMED TO HAVE CARRIED OUT ILLEGAL UNREPORTED AND UNREGULATED FISHING ACTIVITIES IN THE WESTERN AND CENTRAL PACIFIC OCEAN (REPLACED BY CMM 2007-03)		

CMM	Title	E-Monitoring	E-Reporting
2007-02	CONSERVATION AND MANAGEMENT MEASURE ON THE COMMISSION VESSEL MONITORING SYSTEM (REPLACED BY CMM 2011-02)		
2007-03	CONSERVATION AND MANAGEMENT MEASURE TO ESTABLISH A LIST OF VESSELS PRESUMED TO HAVE CARRIED OUT ILLEGAL, UNREPORTED AND UNREGULATED FISHING ACTIVITIES IN THE WCPO (REPLACED BY CMM 2010-06)		
2007-04	CONSERVATION AND MANAGEMENT MEASURE TO MITIGATE THE IMPACT OF FISHING FOR HIGHLY MIGRATORY FISH STOCKS ON SEABIRDS (REPLACED BY CMM 2012-07)		
2008-01	CONSERVATION AND MANAGEMENT MEASURE FOR BIGEYE AND YELLOWFIN TUNA IN THE WESTERN AND CENTRAL PACIFIC OCEAN (REPLACED BY CMM 2012-01)		
2008-02	COOPERATING NON-MEMBERS (REPLACED BY CMM 2009-11)		
2008-05	CONSERVATION AND MANAGEMENT OF SWORDFISH (REPLACED BY CMM 2009-03)		
2008-06	CONSERVATION AND MANAGEMENT OF SHARKS (REPLACED BY CMM 2009-04)		
2009-04	CONSERVATION AND MANAGEMENT FOR SHARKS (REPLACED BY 2010-07)		
2009-07	CONSERVATION AND MANAGEMENT MEASURE FOR PACIFIC BLUEFIN TUNA (REPLACED BY CMM 2010-04)		
2009-08	CONSERVATION AND MANAGEMENT MEASURE FOR CHARTER NOTIFICATION SCHEME (REPLACED BY CMM 2011-05)		
2010-03	CONSERVATION AND MANAGEMENT MEASURE FOR COMPLIANCE MONITORING SCHEME (REPLACED BY CMM 2011-06)		

CMM	Title	E-Monitoring	E-Reporting
2010-04	CONSERVATION AND MANAGEMENT MEASURE FOR PACIFIC BLUEFIN TUNA (REPLACED BY CMM2012-06)		
2011-01	CONSERVATION AND MANAGEMENT MEASURE FOR TEMPORARY EXTENSION OF CMM 2008-01 (REPLACED BY CMM2012-01)		
2011-05	CONSERVATION AND MANAGEMENT MEASURE ON CHARTER NOTIFICATION SCHEME (REPLACED BY CMM 2012-05)		
2011-06	CONSERVATION AND MANAGEMENT MEASURE FOR COMPLIANCE MONITORING SCHEME (REPLACED WITH CMM 12-02)		

Appendix 7 – Acronyms

Acronym	Full description
APFIC	Asia-Pacific Fishery Commission
CAE	Compliance Analysis Engine
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources Commission Members, Cooperating non-Members, and participating Territories of the WCPFC
CCM	
CCRF	Code of Conduct for Responsible Fisheries
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CDR FFA	Corporate Data Resource
CFP	Coastal Fisheries Programme
CI	Compliance Index
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CMM	Compliance and Management Measure
CPUE	Catch Per Unit Effort
CROP	Council of Regional Organisations in the Pacific
CSV	Comma Separated Values
EEZ	Exclusive Economic Zone
EEZ	Exclusive Economic Zone
E-R	Entity-Relationship Modelling Technique
ERD	Entity-Relationship Diagram
ETBF	Eastern Tuna and Billfish Fishery
EU	European Union
EVR	Electronic Vessel Registration
FAD	Fish Aggregating Device
FAL	Fisheries Agreements and Licenses
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FFA	Pacific Islands Forum Fisheries Agency
FSM	Federated States of Micronesia
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ICLARM	International Center for Living Aquatic Resources Management
IFC	International Fisheries Commission
IFF	International Fishers Forum
IOTC	Indian Ocean Tuna Commission
IRD	Institut de Recherche pour le Developpement
ISSF	International Sustainable Seafood Foundation
IUCN	The World Conservation Union
IUU	Illegal, Unreported and Unregulated Fishing
LARS	License Information and Associated Reports Database System
MCS	Monitoring Control and Surveillance
MCSWG	MCS Working Group
MPA	Marine Protected Area
MRAG	Marine Resources Assessment Group
MSC	Marine Stewardship Council
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	Northeast Atlantic Fisheries Commission
NGO	Non-governmental Organisation
NMFS	National Marine Fisheries Service (United States)
NOAA	National Oceanic and Atmospheric Administration
NPOA	National Plan of Action
OFF	Oceanic Fisheries Programme

OPM	Observer Program Management System
OPRT	Organisation for the Promotion of Responsible Tuna Fisheries
PICT	Pacific Island Countries and Territories
PIFSC	Pacific Islands Fisheries Science Centre
PIOFM	Pacific Islands Oceanic Fisheries Management
PNA	Parties to the Nauru Agreement
POD	People and Organisations
PTTP	Pacific Tuna Tagging Programme
REG	Regional Register of Fishing Vessels
RFMO	Regional Fisheries Management Organization
RFV	Record of Fishing Vessels
RIMF	Regional Information Management Facility
RMCC	Regional MCS Coordination Centre
SEAFDEC	Southeast Asian Fisheries Development Center
	South East Atlantic Fisheries Organization SIOFA South Indian Ocean Fisheries
SEAFO	Agreement
SOLIC	Solomon Islands Licensing System
SPC	Secretariat of the Pacific Community (formerly South Pacific Commission)
SPRFMO	South Pacific Regional Fisheries Management Organisation
SUR	Surveillance and Vessel Sightings System
TAC	Total Allowable Catch
TDW	Tuna Data Workshop
TUBS	TUFMAN Observer Module
TUFMAN	Tuna Fisheries Database Management System
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	UN Fish Stocks Agreement
VAP	Violations and Prosecutions System
VBI	Vessel Boarding and Inspection System
VMS	Vessel Monitoring System
VMS	Vessel Monitoring Systems
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WPRFMC	Western Pacific Regional Fishery Management Council
XML	eXtensible Markup Language

Appendix 8 – Acknowledgments

This project was driven by Glenn Hurry, Executive Director of the WCPFC Secretariat, and Peter Williams, Principal Fisheries Scientist with SPC's Oceanic Fisheries Program. They, and their staff, were a pleasure to deal with throughout. During this review we spoke with a great many people who gave their time freely, often giving advice and information that went beyond their products or interests. A lot of this information did not end up in this report because at the end of the day we were constrained by resources, time, and the terms of reference. The topic: *the history and evolution of fisheries monitoring and reporting technology* deserves to be published.

Some of the people who spent more time than they needed to support this project, and their respective organisations, are mentioned below:

- Howard McElderry from Archipelago Marine Research is undoubtedly the world's expert on E-M.
- Dorothy Lowman is the Chair of the Pacific Fisheries Management Council and lead author of the "Fisheries Monitoring Roadmap".
- Guan Oon from CLS Argos has been working in the region mainly providing VMS services for over a decade. His level of historic knowledge and understanding of the region, its issues and challenges, and the limitations of technology to solve them is excellent.
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- David Karis from the PNG National Fisheries Authority was generous with his time and with information, a passionate advocate for the PNG developed product FIMS.
- Peter Harpin and Mark O'Brien from Faria Watchdog who provided surprisingly unbiased appraisals of a range of technologies and providers.

We appreciate the time provided by the following people and organisations in meetings to discuss the potential of E-Reporting and E-Monitoring.

Honiara, Solomon Islands		
4, 5 and 6 June 2013		
Organisation	Name	Position
Forum Fisheries Agency (FFA)	Mr James Movick	Director General
	Mr Wez Norris	Deputy Director General
	Ms Alice McDonald	Fisheries Management Adviser
	Ms Pamela Maru	Fisheries Management Adviser
	Mr Fraser McEachan	MCS Policy analyst
	Mr Mark Young	Director Fisheries Operations
	Mr Filimoni Lutunaika	System Analyst
	Mr Henry Salonica	Network Administrator
	Mr Kenneth Katafono	Database Administrator
	Mr Nicholas Reese	IT Manager
	Mr William Edeson	Legal Adviser
	Mr Dennis Yehilomo	MCS Analyst
	Mr Timothy Park	Observer Manager
	Ms Agnes Arahauta	MCS Officer
	Mr Daniel Koroi	VMS Liaison Officer
Mr Fred Aleziru	MCS Officer	
Mr Mike Pounder	Surveillance Operations Officer 2	
Mr Peter Graham	Surveillance Operations Officer 1	
Mr Steve Masika	VMS Officer	
SolTuna, Trimarine	Mr Adrian Wickham	Managing Director

Manilla, Philippines		
15 and 16 July 2013		
Organisation	Name	Position
Bureau of Fisheries and Aquatic Resources (BFAR)	Atty Asis G. Perez	National Director
	Atty Benjamin F.S. Tabios	Assistant Director for Administrative Services
	Dr Noel Barut	NFDRI Deputy Executive Director
	Dr Alma C. Dickson	BFAR Agriculture Center Chief IV
	Mr Rafael Raminascal	Chief Aquaculturist, Chief Scientist MV/DA
	Mr Marlo Demo-os	National Fisheries Observer
	M. Phillipe	Assistant Coordinator
	CLS ARGOS	Courrouyan

Pohnpei, Federated States of Micronesia		
17, 18 and 19 July 2013		
Organisation	Name	Position
Western and Central Pacific Fisheries Commission (WCPFC)	Prof Glenn Hurry	Executive Director
	Mr Donald David	Data Quality Officer
	Mr Albert Carlot	VMS Manager
	Dr Lara Manarangi-Trott	Compliance manager
	Dr Sung Kwon Soh	Science Manager
	Mr Sam Taufao	ICT Manager
National Oceanic Resource Management Authority (NORMA)	Mr Patrick Mackenzie	Executive Director
	Mr Eugene Pangelinan	Deputy Director
Dongwon Industries Co. Ltd.	Mr Park Taeson	General Manager
	Mr Gu-hyun Kang	Pohnpei Office Manager
Caroline Fisheries Corporation Inc.	Mr Marko Kamber	Operations/Fleet Manager

Majuro, Marshall Islands		
20, 21 & 22 July 2013		
Organisation	Name	Position
Parties to the Nauru Agreement (PNA) Office	Transform Aquorau	Chief Executive Officer
	Maurice Brownjohn	Commercial Manager
	Herman Kisokau	VDS/VMS Data Officer
	Patricia Jack-Jossien	VDS Manager
Marshall Islands Marine Resources Authority (MIMRA)	Samuel K. Lanwi, Jr	Deputy Director
	Bernard Fiubala	Observer Program Manager
	Dike Poznanski	Information Management Specialist
	Ron Allan V. Doloroso	IT Personnel
Marshall Islands Fishing Venture Inc.	Jin Liang	Base Manager
Pan Pacific Foods (RMI) Inc.	WanJun Yang	Fleet Coordinator

Honolulu, Hawaii		
23, 24 & 25 July 2013		
Organisation	Name	Position
National Oceanic and Atmospheric Administration (NOAA)	Dr Charles Karnella	WCPFC Chair / International Fisheries Coordinator
	Mr Raymond Clarke	Fisheries Biologist
	Ms Valerie Chan	Fishery Policy Analyst
	Mr Terry Boone	VMS Program Manager
	Mr Larry Li	Information Technology Specialist
	Mr John D. Kelly	Program Manager Observer Program
Western Pacific Regional Fisheries Management Council (WPFMC)	Mr Eric Kingma	NEPA Coordinator
	Dr Paul Dalzell	Senior Scientist/Pelagics Coordinator
POP Fishing and Marine	Mr Jim Cook	Co-owner

Noumea, New Caledonia		
28, 29 & 30 July 2013		
Organisation	Name	Position
Secretariat of the Pacific Community (SPC)	Peter Williams	Principal Fisheries Scientist
	Simon Hoyle	Senior Fisheries Scientist
	Dr Graham Pilling	Fisheries Scientist
	Mr Joel Rice	Senior Fisheries Scientist
	Tim Adams	Fisheries Scientist
	Tim Lawson	Principal Fisheries Scientist
	Peter Sharples	Observer Support and Development Coordinator
	Deirdre Brogan	Fisheries Monitoring Supervisor
	Siosifa Fukofuka	Observer Training and Support Officer
	Ferral Lasi	Data Collection Officer
	Dr Simon Nicol	Principal Fisheries Scientist
	Mme Valerie Alain	Fisheries Research Scientist
	Bruno Leroy	Fisheries Scientist
	Sylvain Caillot	Tagging Database Developer
	Manu Schneider	Fisheries Database Analyst/Developer
	Corey Cole	Observer Data Manager
	Colin Millar	Fisheries Database Analyst/Developer
	Mr. Bryan Scott	Fisheries IUU Liaison Officer
	Bruno Deprez	Fisheries Data Audit Officer
	Colley Falasi	Observer Data Audit Officer
Malo Hosken	Consultant E-Monitoring Trial	
Service de la marine marchande et des pêches maritimes, New Caledonia	M. Regis Etaix-Bonin	
	M. Hugues Gossuin	Tuna Coordinator

New Zealand		11-12 September 2013
Organisation	Name	Position
Ministry for Primary Industries	Joanna Anderson	Senior Policy Analyst
	Stephan Brouwer	Principal Scientist (Pacific)
	Justin Clement	Observer Development Officer
	Kim George	Data Management Team Leader
	Matt Hooper	Principal Advisor
	Andy Wright	International advisor – (MCS)
Sanford Limited	Martin De Beer	Pacific Tuna Manager

Nadi , Fiji		13-14 September 2013
Organisation	Name	Position
Ministry of Fishery and Forests	Jone Amoe	
	Sainaila Naqali	Director
	Suresh Chandra	PFO Management Services
	Hilda Lobendahn	Compliance and Enforcement
	Apenisa Sauturaga	Observer Trainer
	Timoci Tavusa	Observer Co-ordinator
	Leba Raketekete	
Fiji Revenue and Customs Authority	Netani Tavaga	
	Manikam	
	Kelana	
Solander Pacific	Semesa B	
Golden Ocean Fish	Tom Mayo	
Sea Quest (Fiji) Ltd	Ma Jingi Kui	
Services Marine Ltd	Brett Haywood	
Gillett, Preston & Associates	Peter Shi	
Fiji Fish Marketing Group	Robert Gillett	Senior Consultant
	Grahame Southwick	Executive Chairman

Papua New Guinea		
Organisation	Name	Position
National Fisheries Authority	John Kasu	Deputy Managing Director
	Ludwig Kumoru	Executive Manager Fisheries Management
	David Karis	Manager - VMS
	Alois Kinol	Coordinator, Audit and Certification
	Brian Kumasi	Fisheries Management Officer - Tuna Fisheries
	Phillip Lens	Observer Manager
	Gisa Komangin	Acting Executive Manager MCS
Quick Access Computing	Mark Oates	Program Manager

Australia		
Organisation	Name	Position
Australian Fisheries Management Authority	Jeremy Richter	Senior Manager Service One
	Josh Davis	Manager, Electronic Services
	Peter Venslovas	General Manager Operations
	Jim Neely	Manager, Foreign Compliance Policy

Other contacts		
Organisation	Name	Position
Te Vaka Moana	David Marx	Manager and Coordinator
Pew Charitable Trust	Tony Long	Director, Ending Illegal Fishing
Pew Charitable Trust	Adam Baske	International Policy
Japan Far Seas Purse Seine Fishing Association	Minoru Honda	Managing Director
Overseas Fisheries Development Council of the Republic of China	Joseph Fu	Secretary
WWF South Pacific Programme	Alfred "Bubba" Cook	Western Central Pacific Tuna Program Officer
Faria Watchdog Inc	Mark O'Brien	General Manager
	Pete Harpin	Business Development Manager
Western Australian Fisheries and Marine Research Conservation of Albatrosses and Petrels	Brett Molony	Supervising Research Scientist – Finfish Branch
	Warren Papworth	Executive Secretary
US Pacific Fishery Management Council	Dorothy Lowman	Chair
Archipelago Marine Research	Howard McElderry	VP Electronic Monitoring Technologies
Electronic Monitoring Services	Dawn Mann	Director,
	Katherine Archibald	Data Technician
FAS Seafood Producers	Michael Derry	Operations Manager (Victoria BC)
Dept of Fisheries and Oceans	Rick Stanley	Former Biologist British Columbia
Saltwater Inc.	Tim Carroll	Chief Executive Officer
	Kathryn Carovano	Program Manager
Satlink	Leticia Diaz del Rio	International VMS/ERS Manager
UK Seafish Industry Authority	Richard Caslake	Project Manager
CLS Argos	Guan Oon	Director, CLS Australia
Taz-e Australia	Nesh Petrovic	Director
DTU Aqua Secretariat for Public Sector Consultancy	Jorgen Dalskov	Senior Fisheries Advisor

Our apologies if we missed your name. Please let us know and the final published version can include anyone we missed.

Appendix 9 - FFA Approved MTU List 2013

List One: units that are no longer approved but may be used until 30 June 2014, provided the vessel operators meet certain conditions that the vessel is already using a MTU from List One and the MTU must be reporting normally, consistently and automatically to the FFA VMS at all times. List One units are:

Model Name	Model N°	Software Version
Thrane and Thrane (Sailor) Capsat Transceiver	TT-3022D	3.11
Thrane and Thrane (Sailor) Capsat Transceiver	TT-3022D	3.24
Thrane and Thrane (Sailor) Capsat Transceiver	TT-3022D	3.28 non SOLAS Fishery DistFn-1
Thrane and Thrane (Sailor) Capsat Transceiver	TT-3026S	2.12
Japan Radio Company Limited Inmarsat-C Transceiver	JUE-75C	8.0
Japan Radio Company Limited Inmarsat-C Transceiver	JUE-75C	6.1
Trimble Galaxy Transceiver	TNL 7001	5.10a
Trimble Galaxy Transceiver	TNL 7005	5.10
Trimble Galaxy Transceiver (Sentinel)	TNL 8001	5.10
Trimble Galaxy Transceiver (Courier)	TNL 8005	5.10
Furuno Inmarsat-C MES Transceiver	Felcom 15	DCE F15 V02+FFA
Furuno Inmarsat-C Transceiver	Felcom 12 (IC-2112)	DCE Version 07+FFA
Furuno Inmarsat-C Transceiver	Felcom 12 (IC-2112)	DCE Version 08+FFA
Sailor Inmarsat-C MES Transceiver (SAT-C)	H1622D	TT-10202A Version 3.21 non-SOLAS

The units contained on List One may gradually be removed from the list of FFA type approved units as the units become either no longer supplied, the software version is outdated or the units themselves are outdated and there is no vendor support.

List Two: units that meet new specifications and are approved (refer list of type approved units on www.ffa.int) for continued use after 30 June 2009. This list has been updated on 4-May-2013.

Type	Model Name	Model N°	Software Version	E-MTU terminal	Additional Comment
E-MTU	Thrane and Thrane (Sailor) Capsat Transceiver	TT-3026D Mini-C	2.21 using FFA 3026 configuration guide Version 3026-1.0	Thrane and Thrane 3036XP Terminal	
E-MTU	Faria Watchdog (Iridium)	750VMS		V-TERM Terminal	
MTU	Thrane and Thrane (Sailor) Capsat Transceiver	TT-3022D	3.32 using FFA 3022 configuration guide Version 3022-1.0	N/A	
MTU	Thrane and Thrane (Sailor) Capsat Transceiver	TT-3026S Mini-C	2.26, 2.21 using FFA 3026 configuration guide Version 3026-1.0	N/A	
MTU	Thrane and Thrane (Sailor) Capsat Transceiver	TT-3026D Mini-C	2.26, 2.21 using FFA 3026 configuration guide Version 3026-1.0	N/A	
MTU	Thrane & Thrane Sailor 6140 (with 6194 TCU)	TT-6140 Mini-C	TT3027D Mini-C Non-SOLAS - 1.03. TT6194 Terminal Control Unit - 1.03. Using FFA/Thrane configuration guide version 1.0	N/A	
MTU	Thrane & Thrane Sailor 6150	TT-6150 Mini-C	TT3027D Mini-C Non-SOLAS - 1.03. TT6194 Terminal Control Unit - 1.03. Using FFA/Thrane configuration guide version 1.0	N/A	
MTU	Japan Radio Company Limited Inmarsat-C Transceiver	JUE-95VM	3.0, 1.0	N/A	
MTU	Furuno Inmarsat-C MES Transceiver (includes the Nera Mini-C model)	Felcom 16	DCE F16 V02+FFA DCE F16 V03+FFA	N/A	
MTU	Faria Watchdog (Iridium)	750VMS		N/A	
MTU	CLS Thorium	TST-100+FFA		N/A	
MTU	CLS LEO	LEO+FFA		N/A	