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PRELIMINARY REPORT ON THE SOLOMON ISLANDS LONGLINE E-MONITORING PROJECT

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1. EXECUTIVE SUMMARY

This paper presents the preliminary results of a Video Electronic Monitoring project on tuna longline fishing vessels operating in the Western and Central Pacific Ocean launched in March 2014 and expected to be completed in October 2014.

- The project aims to investigate how E-Monitoring works for collecting accurate information on the fishing activities of tuna longline fishing vessels.
- The Video Electronic Monitoring system, or 'E-Monitoring', installed onboard uses high-definition video cameras, GPS and a central computer to record all events and video footage.
- This information, including catch number and type, is critical in providing the best scientific and management advice to ensure sustainable fishing.
- Two CT-4 freezer longline tuna vessels were equipped with video electronic monitoring systems before fishing in the Solomon Islands EEZ for around 80 days.
- The E-Monitoring data collected from these first trips is now being analysed by experienced longline fisheries observers.
- The 'dry observers' are recording all aspects of the fishing activity, including identifying fishing locations, the catch composition, and the fate of any bycatch taken.
- Two independent fisheries observers were also assigned to each vessel to carry out their regular task of observing and recording the catch.
- A basic comparative analysis between the observer data and the E-Monitoring data is presented in this paper.
- In the scope of implementing E-Monitoring technology in all or parts of the Western and Central Pacific Ocean fisheries, logistical and legal frameworks will be required at national and regional levels.
- The Secretariat of the Pacific Community's (SPC) knowledge and experience in managing observer data and the Pacific Islands Forum Fisheries Agency's (FFA) expertise in fisheries legislative mechanisms mean that an SPC/FFA partnership will be paramount if the decision is made to advance E-Monitoring in the region.
- The project partners are Tri Marine, National Fisheries Developments (NFD), Yi Man Fishing Company, Satlink (the service provider), SPC, FFA, and the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR). The International Seafood Sustainability Foundation (ISSF) is also a major contributor through support of the Regional Electronic Reporting Coordinator position contracted by SPC.

2. INTRODUCTION

The Western and Central Pacific Ocean is the world's largest tuna fishing ground, with over 3 000 registered longline vessels fishing in this region.

The Western and Central Pacific Fisheries Commission (WCPFC) calls for five per cent observer coverage onboard longline vessels operating in the region. However, challenges such as limited space onboard smaller vessels, logistics, and high costs have limited human observer coverage to around two per cent. Observer data is therefore lacking on longline target catch, non-target catch, and overall operations. This data is necessary to improve the scientific understanding of these fisheries, strengthen management tools, and to promote better enforcement of existing national and regional conservation measures. Use of E-Monitoring technology to supplement human observer monitoring offers real opportunities to overcome these challenges in tuna longline fisheries, making this an important and pioneering project.

This highly collaborative project was developed and launched by Tri Marine, National Fisheries Developments (NFD), Yi Man Fishery Company, Satlink, FFA, SPC and the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR). Tri Marine and NFD are contributing to project management, installation, maintenance, and other costs of the systems. FFA, via the EU-funded DevFish 2 project, shares the equipment costs. Satlink provides and covers partial costs of the system, while also designating staff to installation, data monitoring and review. Yi Man Fishery Company volunteered two vessels, allocating valuable time to facilitate installation along with some vessel space and resources to accommodate the equipment and human observers. MFMR has provided human observers to overlap with the electronics, while SPC assigned a project coordinator to assist with observer placement, data review, and project evaluation and reporting.

A memorandum of understanding was signed between the project parties in February 2014. The MOU stated the aims of the project as well as the parties' roles. The project's aims were:

- *Assessing whether E-Monitoring, using video and other equipment can accurately collect at-sea fishing activity and catch data onboard tuna longliners.*
- *In addition, the goal is to see if, when combined with information from at-port vessel inspections by fisheries agents, this data will fulfill the requirements of the WCPFC Regional Observer Programme minimum data fields.*
- *If successful and deemed cost effective, the project could be expanded to help increase the level of obs. Coverage onboard tuna longliners operating in the region to, or beyond, the 5% requirement of the WCPFC.*

It was planned the Yi Man 2 and Yi Man 3 vessels to conduct two trips each using the E-Monitoring systems as well as embarking an independent fisheries observer.

Each vessel has so far conducted one trip and the analysis of the E-Monitoring data from both vessels has begun.

This paper provides preliminary results of a comparative analysis between the E-Monitoring data and the observer data for 16 sets (from a total of 60) for one of the two vessels only.

The project is expected to be completed by November 2014. A full report will be published upon project completion.

3. METHODOLOGY

From March 10 to March 14, the project partners were in Noro port in the Solomon Islands. E-Monitoring systems were installed on the Yi Man 2 and Yi Man 3 tuna longline fishing vessels and an MFMR observer was placed onboard each vessel.

On Yi Man 2, three High-Definition wide angle, water and shock proof cameras were installed. On Yi Man 3, four similar cameras were installed. On both vessels, a central unit housing a computer and eight solid state hard drives were installed. The cameras were linked to this central unit via internet protocol cables. The system on each vessel also included a GPS antenna which is used to track the vessels' positions every 10 minutes. Satlink also installed a fleet broadband communication system on both vessels to allow remote maintenance of the systems. After discussion with the vessels' owner, it was decided that the cameras would record the vessels' activities 24 hours a day. Satlink would have been able to install hydraulic sensors that would have triggered the cameras to record only when fishing activities started (setting the long line and hauling the long line), however, the hydraulic systems on both vessels were already fine tuned and time constraints prevented installation of such sensors. The systems were tested before the vessels departed from Noro.

The two MFMR observers were contracted by FFA to carry out a regular monitoring trip. The FFA observer programme funded all costs of the observers' travels. A placement meeting was conducted with all parties to the project. FFA had provided the two observers with a two-way satellite communication device (Delorme Inreach) with which shore parties were able to communicate with the observers at sea. These devices were very useful for communicating with the observers and had positive effects on observer morale.

The vessels returned to Suva port, Fiji after having fished in the Solomon Islands EEZ for 81 and 84 days. During the week the vessels were in port, after the unloading of the catch was completed, a technician from Satlink removed the hard drives containing the E-Monitoring data and replaced them with blank ones. Minor adjustments were made to the E-Monitoring equipment, including changing one camera position and changing camera angles. The two MFMR observers disembarked and were replaced by two other MFMR observers (also each equipped with a Delorme Inreach unit). Another placement meeting was conducted with all project parties.

On 2 September, each vessel had each conducted the two trial trips (with a human observer onboard). A the completion of the second trip, the E-Monitoring system onboard the Yi Man 3 was maintained and the vessel departed for a another trip, without an observer this time. At the completion of the second trip, the E-Monitoring system onboard the Yi Man 2 was uninstalled.

4. PRELIMINARY ANALYSES OF DATA GENERATED FROM E-MONITORING

4.1 Methodology

The analysis of the E-Monitoring data was conducted at FFA headquarters in Honiara, Solomon Islands. Satlink was provided with an office room and set up a control center consisting of a central unit with a computer and racks to read the hard drives and two 24 inch screens.

The two MFMR observers were debriefed on their trips' workbooks by the FFA observer coordinator. The two workbooks were then sent back to SPC in Noumea, New Caledonia where data control technicians entered the data into the regional observer database system.

The same two observers and a Satlink technician conducted the analysis of the E-Monitoring data from the Yi Man 3 vessel.

The analysis of the E-Monitoring data was achieved using specific reviewing software called View Manager (VM) developed by Satlink. The VM extracts the data from the hard drives. The data consists of the GPS data monitoring the vessel's position every 10 minutes and the footage record from each camera. The VM allows fast forwarding the footage at two times, five times or ten times the normal speed of the recording. The footage can also be reviewed at half the normal speed of recording for more details. The software finally allows zooming into the footage without losing definition quality.

From the raw data, the 'dry observer' first isolates the sections where the vessel is engaged in fishing activities only (setting the longline and hauling the longline). This process takes about 15 minutes. Once the section has been isolated, the 'dry observer' begins reviewing the setting operations. The review of the setting operation allows determining: the positions, start and end dates and times of the setting, the species of bait used, the amount of bait used and the branchline interval time. This process takes around 15 minutes.

The 'dry observer' then moves on to reviewing the hauling operation. This review consist of determining: the positions, dates and times of the start and end of the hauling, the average number of hooks between each floats, the species code for each animal landed or discarded, its approximate size, its fate code and the hook number on which it was caught. On average, for a 3 000 hooks set, this process takes between three and four hours depending on how many species are caught (compared to an average of about 12 hours of actual hauling).

The VM features an input system which allows the 'dry observer' to record data for each event. Each time a species is landed, the 'dry observer' inputs a coded text line which records the hook number, the species, caught condition code, discard condition code, length, length code, fate code, and sex. Where a field cannot be recorded, a dash (-) is inputted instead. The ship's time for when the species is landed is not inputted in the note as this information is obtain directly from the GPS data. Each time when the footage is stopped and a note is inputted, a still thumbnail image is also recorded. Illustrations 1, 2 and 3 show the analysis process and report.

At the end of the set's analysis, the reviewing software produces a detailed report. The report format is similar to the observer's data entered into regional observer database system at SPC and both data sets can be compared.

4.2 Comparative analysis of observer catch data

The overall objective of this project is to ensure that all required data fields normally collected by an on-board observer can be generated by the analysis of Video E-Monitoring data and made available in the regional observer database and thereby used for both regional and national scientific and related work.

The images and data entered by the 'dry observer' can be exported by the Satlink VM software into XPS or TXT files (basically the XPS files without the images) for each fishing set. The text files have a relatively standard format and therefore a data loader was developed to import the TXT files into a database that is compatible with the regional standard observer database (TUBS) developed and maintained by the SPC, which is used by WCPFC, FFA and the national fisheries offices of FSM, RMI, PNG, Fiji and Tonga. At this stage, the data loader supports the generation of data into the database format for the CATCH MONITORING data only but will be extended to support the other observer database tables. The conversion of the data output from the Satlink VM software into the regional standard observer database format facilitated the preliminary comparison of data collected by the on-board observer and the data generated through the E-Monitoring video analysis by the independent 'dry observer' (see Section 4.3).

4.3 Preliminary comparison with on-board observer data

A preliminary comparison of the data generated from the video analysis and the data collected by the on-board observer was undertaken as a means of evaluating the most important aspect of the E-Monitoring trial. Due to limited time in receiving the data (which includes data from only one third of the trip) and preparing this paper, the following comparison concentrates on what we consider to be the most important data – the catch monitoring data, with some basic comparison provided for the other types of data. A more comprehensive comparison and analysis will be undertaken in the coming months when more data is available. Data for 16 sets only were available for this preliminary analysis (the Yi Man 3 deployed 60 sets during an 81 day trip).

Table 1 shows some descriptive statistics on the comparison of the data from the on-board observer and data generated from the E-Monitoring video analysis ('dry' observer). Table 2 shows an example of the comparison of the individual fish catch for one set (Set #9) on-board the Yi Man 3. Tables 3(a) and 3(b) provide a comparison of the catch species composition (all sets combined) from the available data and Figures 1(a) and 1(b) provide a comparison of the species composition of the main catch species from the available data. Figure 1 shows an example of the set and haul track according to data collected the on-board observer and the Satlink VM system.

Comments and preliminary observations from the video analysis and the comparison with the data collected by the on-board observer are highlighted below.

1. The data normally collected by the on-board observer on the Regional SPC/FFA Observer LL-1 form and some of the LL-2 form are static during the trip, so this information was collected by the 'dry observer' through a pre-trip port inspection before the vessel departed.
2. The 'free-format' entry of the individual fish information into the notes field of the Satlink VM software meant that there were some data entry errors, but surprisingly only a few obvious errors. The addition of the new module in the Satlink VM software that will provide an interface and online data validation for each field will resolve the issues encountered in this first trial.
3. While data for only 16 sets was available from the E-M video analysis, the on-board observer was only able to collect data from 13 of these 16 sets, due to rough conditions which prevented him from monitoring three sets, so this comparative analysis is based on the 13 sets where both on-board observer data and E-M video analysis data are available. The lack

of data from the on-board observer in these situations is understandable and unavoidable, and highlights the potential benefit of the video E-Monitoring to capture information from ALL sets, even in situations that make it difficult for an observer to operate at sea.

4. The comparison of overall effort and catch information (Table 1) shows close correlation. Reasons why the video analysis did not achieve full observation include (i) very minor fault with the loss of video, (ii) potential reporting errors by both the on-board and 'dry observer' (e.g. recording hooks between floats at the basket level). The differences in the total estimated catch of target tuna species, after accounting for coverage of the hauling (about 95 per cent and 97 to 99 per cent for the on-board and 'dry observers', respectively) were
   - 46 to 51 per cent for yellowfin tuna;
   - 29 to 31 per cent for bigeye tuna;
   - 25 to 18 per cent for albacore tuna;
5. In regards to the comparison of individual fish catch (see Table 2), we noted the following:
   - The duration of the haul is long (the average for 13 sets was 11.4 hours) and it is normal for the on-board observer to take breaks during this period. This information is captured by the data collection protocol and in the database so estimates of observer effort and catch can be determined (i.e. the baskets set and baskets observed are recorded).
   - The fish-by-fish comparison in Table 2 shows that a total of ELEVEN tuna (7 yellowfin tuna, 2 albacore tuna and 2 bigeye tuna) recorded by the on-board observer were not picked up in the E-Monitoring analysis; many of these 'missing' fish appear to have come on-board immediately after (i.e. the following 1-2 hooks) another catch and so may have been confused with the preceding fish in the video analysis. Fish on successive hooks ("clumping") is common and further review of the E-Monitoring analysis procedures will be undertaken to ensure this problem is resolved in the future.
   - The fish-by-fish comparison in Table 2 shows that the only other fish missed in the E-M video analysis were unwanted by-catch LONGSNOUTED LANCETFISH (3), BRILLIANT POMFRET (1) and SNAKE MACKEREL (1) which were "discarded, struck off". It is possible that the available video cameras were unable to pick-up these events, although a number of other events with fish "discarded, struck off" were picked up with the video analysis. Further review of the video at the time when the 'missed' events occurred will be undertaken to determine why they were not recorded by the cameras which may result in better video camera placement in the future.
   - The "hook number" values rarely matched. The reasons for this are not clear at the moment and are subject to further investigation.
   - The comparison of FATE codes in this set shows that 84 per cent of the fish had exact matches for FATE codes. When considering that more than one FATE code could be used to describe what happened to the fish (e.g. "Discarded, struck off" / "Discarded, cut free" and "Retained, shark damage"/"Retained, Partial"), then subsequent review of each of the non-matches in FATE shows that the differences in each case were simply the different interpretations of what happened to the fish by the on-board observer compared to the 'dry' observer. FATE matches could be considered to be 100 per cent under these circumstances.
   - The comparison of CONDITION codes in this set shows that 81 per cent of the fish had exact matches for CONDITION codes. When considering that there may be different interpretations of the "dry" observer's evaluation of CONDITION to the on-board interpretation of CONDITION (e.g. between "A1"/"A2" and "A3"/"D"), then the correspondence for CONDITION could be considered as high as 95 per cent. The

instances where CONDITION were different will be investigated to improve the E-M Video analysis in the future.

- The comparison of GENDER (SEX) codes in this set shows that there were only 37 per cent matches, but only 13 per cent matches (3 out of 23) when only considering those fish that were identified as Male or Female. Further, the "dry" observer only identified the gender of FEMALE pelagic stingray (there were no shark in this set catch). This demonstrates the difficulties of the video to provide sufficient viewing of the fish to identify GENDER, although one would expect that the GENDER of Sharks/Rays would be possible in the video.

6. In regards to the comparison of total catch by species for the 13 sets between the on-board observer and the E-M video analysis (see Tables 3(a) and 3(b), and Figures 1(a) and 1(b)), we noted the following in the preliminary review:
   - The order of the top six species was the same for the two sources of data (pelagic stingray, yellowfin tuna bigeye tuna, long-snouted lancetfish, albacore tuna and lancetfish);
   - Very few shark species were taken, with Silky shark predominating. For example, only 2.3 per cent of the total catch (according to the E-M video analysis) were shark species.
   - The overall proportion of retained versus discard (derived from FATE code) were generally very close for each species, as would be expected and already noted in the more detailed comparison of Set #9 in point (4) above.
   - There are several species with minor catches mentioned in one source of data (e.g. Black Marlin and Silky Shark) that do not appear in the other source of data, and vice-a-versa. This will require further comparison between the on-board observer data and the EM data.
   - There are very few differences between the overall species composition of the main species between the two sources of data (see Figures 1(a) and 1(b)), which confirms that the E-M video is providing sufficient information to identify to the species level in most instances. One benefit of the E-M video is that it provides a means of reviewing footage of the video where there are differences between the on-board observer's record and the original E-M video analysis record to determine where the problem lies.
   - There were 17 more albacore tuna in the on-board observer's records than the EM video analysis but 18 less yellowfin tuna. This suggests a species identification problem. However, there may be other additional problems, for example, it also suggests that there may have been several instances when fish came on-board very close to each other and the second fish was missed by the EM video analysis. Further investigation is required to verify this hypothesis and review the video analysis procedures to resolve any potential problems.
7. The positional data from the SATLINK VM software is generated directly from Vessel Monitoring GPS data so there is no need for the "dry" observer to be concerned with these data other than to identify the time of start/end set and start/end haul– it is then automatically generated from the system. The positional data from the SATLINK VM software position is also much higher resolution than the positional data recorded by hand by the on-board observer (see Figure 2). For example, the on-board observer only needs to record the position of start/end during the setting phase.

4.4 Future work

The following are what we consider to be future work at this stage.

1. A second review of E-Monitoring video analysis to check on each of the differences between the on-board observer's record and the original E-M Monitoring video analysis record to determine the level of error from each source of data.
2. Satlink will enhance their VM software to provide an interface and online data validation for each field in the catch monitoring section, the basket/hook count and the bait data.
3. Enhance and develop the Satlink VM output data loader to support set details data and the set/haul log information.
4. Investigate the proposed methodology and software enhancements to support the digital measuring of fish with the Satlink VM software.
5. Develop a detailed set of procedures/protocol for the 'dry observer' to conduct the analysis of the E-Monitoring data.

5. DISCUSSION

These preliminary results reveal that that video E-Monitoring can be used onboard tuna longline vessels to accurately obtain effort and catch data for scientific and management purposes in line with the minimum data fields set by the WCPFC ROP.

The analysis of the E-Monitoring data was conducted by observers with previous at-sea experience on longline vessels. This is an important consideration as experienced observers are able to accurately determine the operations recorded by the E-Monitoring systems, including the ability to accurately identify species caught.

Observers also noted the benefits of E-Monitoring, particularly being able to work from the office without spending long periods at sea, away from their families.

Benefits are also evident for the fishing industry that would prefer to use video E-Monitoring system than, for example, having to find space on-board for an observer.

6. FUTURE ANALYSIS OF OBSERVER CATCH DATA

The analysis of the E-Monitoring data from the four trips conducted the Yi Man 2 and Yi Man 3 will continue to be conducted until completed. The 'dry' observers are now familiar with the VM software and the analysis rate of the E-Monitoring data will be improved as they spend more time continuing analysing this data and other efficiencies are investigated. Once the analysis of the E-Monitoring data from each vessel has been concluded, a more comprehensive comparative analysis with the on-board observer data will be possible.

At the time of publication (2 September), a total of 48 sets from the Yi Man 3 E-Monitoring data had been analysed. The slower than expected analysis rate can be attributed to the following circumstances:

- Only one Satlink View Manager unit has been allocated for analysing the E-Monitoring data, this limitation restricted the time available for the 'dry' observers' to analyse the data (i.e. only one observer could analyse data at a time). Further, it is now evident that E-Monitoring data analysis is time-consuming work and it is unlikely that we would expect one person to maintain the same rate of analysis during an eight-hour work day. This will mean

consideration of establishing a “team" of observers and how to best structure the work to analyse the E-M video;
- Satlink technicians spent a total of 5 days updating the View Manager software, time during which no analysis was conducted, the slow internet connection in Honiara also meant that this updating process was longer than usual;
- The analysis of E-Monitoring data has been a new and challenging task with a steep learning curve for the ‘dry’ observers;
- As protocols for analysing E-Monitoring data had not previously been established, significant adjustments had to be made over the first five weeks to fine-tune the process to ensure it produced complete and valid data;

In light of a slower than expected analysis rate, FFA have recently agreed to purchase a second Satlink View Manager unit which will allow for two full time ‘dry’ observers to conduct the analysis of the remaining E-Monitoring data.

Some important updates to the View Manager, including a fish size measuring tool and data entry tab specific for recording LL-4 data are scheduled for late September 2014 and should result in improvements to the quality of the data and time to upload the data into the national and regional observer databases.

7. LESSONS LEARNT AND FUTURE WORK

These first two of four trials provide the proof of concept that video E-Monitoring can be applied to monitoring the operations of tuna longline vessels operating in the WCPO. There are some issues to resolve, but considering this is the first analysis of previously untested software and procedures, these issues are minor when compared to the general quality of output generated. These issues should also be easily resolved with minor adjustments to procedures in undertaking the E-Monitoring video analysis.

While there have been some delays with this first trial, it is clear that the E-M-video analysis by ‘dry observers’ will be at least 50% faster than the time spent by the ‘on-board’ observer data collection.

Should E-Monitoring be pursued beyond the trials in the Solomon Islands and in the other member countries, the establishment of appropriate legal and technical frameworks will be required at the regional and national levels.

E-Monitoring data could also be very useful for the fishing industry, for example, it coevrs to some extent the traceability of the catch. Video footage could also be used for vessel managers to review, adapt or improve the fishing practices.

It is important to note that the analysis of the E-Monitoring data is being conducted by experienced longline observers who have spent many days at sea and can immediately identify species and have a very good understanding of longline fishing operations in general. At this stage however, this skill alone is perhaps not sufficient to conduct the analysis of E-Monitoring data. Indeed, the ‘dry observers’ are assisted by technical staff from Satlink with expertise in computer and IT technology. Implementing E-Monitoring will also require training ‘dry observers’ to conduct the analysis work with limited or remote assistance from an IT expert.

Finally, a detailed cost and benefit analysis will be included in the project’s final report to draw conclusions on the financial feasibility of implementing E-Monitoring to a fleet of vessels.

TABLES

Table 1. Descriptive statistics of comparison between on-board observer and E-M video analysis data

Data item	On-board Observer	E-M Video Analysis ("Dry" observer)
Total sets	13	13
Total Baskets set	1,568	1,568
Total Baskets observed	1,493	1,541
% Baskets observed	95%	99%
Total Hooks sets	40,354	40,354
Total Hooks observed	38,438	39,292
% hooks observed	95%	97%
Range of Hooks between Floats (HBF)	25-27	25-27
Average HBF	26.38	25.5
Total Observed Yellowfin tuna	123	141
Total Observed Bigeye tuna	76	84
Total Observed Albacore tuna	67	50
Total Estimated Yellowfin tuna	129	145
Total Estimated Bigeye tuna	80	87
Total Estimated Albacore tuna	70	52

Table 2. Example comparison of individual fish catch (Yi Mann 3 – set #9)

ON-BOARD OBSERVER DATA									E-M Video Analysis					
Date	Time	Hook No.	Species	Condition	Condition (let go)	Fate	Sex	Species	Hook No.	Species	Condition	Condition (let go)	Fate	Sex
26/03/2014	1643	9	YFT	A1	NULL	RGT	M	YELLOWFIN	13	YFT	A1	U	RGT	U
26/03/2014	1649	21	YFT	A1	NULL	RGT	F	YELLOWFIN	24	YFT	A1	U	RGT	U
26/03/2014	1653	6	YFT	A1	NULL	RGT	M	YELLOWFIN						
26/03/2014	1722	5	YFT	A2	NULL	RGT	M	YELLOWFIN	21	YFT	A1	U	RGT	U
26/03/2014	1723	6	YFT	A1	NULL	RGT	F	YELLOWFIN						
26/03/2014	1724	8	YFT	A1	NULL	RGT	M	YELLOWFIN	5	YFT	A1	U	RGT	U
26/03/2014	1730	3	YFT	A2	NULL	RGT	M	YELLOWFIN						
26/03/2014	1731	5	YFT	A2	NULL	RGT	F	YELLOWFIN						
26/03/2014	1734	20	YFT	A2	NULL	RGT	M	YELLOWFIN						
26/03/2014	1742	23	ALX	D	D	DSO	U	LONGSNOUTED LANCETFISH						
26/03/2014	1757	10	ALB	D	NULL	RWW	U	ALBACORE						
26/03/2014	1806	21	YFT	A1	NULL	RGT	M	YELLOWFIN	21	YFT	A1	U	RGT	U
26/03/2014	1821	2	PLS	A1	A3	DUS	F	PELAGIC STING-RAY	1	PLS	A1	D	DUS	F
26/03/2014	1824	21	ALB	D	NULL	RWW	U	ALBACORE	24	ALB	D	U	RWW	U
26/03/2014	1833	**OBSERVERS BREAK FROM MONITORING**							5	YFT	A2	U	RGT	U
26/03/2014	1841								10	YFT	D	U	RGT	U
26/03/2014	1844								15	YFT	A2	U	RGT	U
26/03/2014	1845								26	PLS	A2	D	DSO	F
26/03/2014	1852	5	YFT	D	NULL	RGT	M	YELLOWFIN	8	YFT	D	U	RGT	U
26/03/2014	1853	8	ALB	D	D	DSO	U	ALBACORE	10	ALB	A3	D	DSO	U
26/03/2014	1949	10	BET	A2	NULL	RGT	M	BIGEYE	8	BET	A1	U	RGT	U
26/03/2014	1950	11	BET	A2	NULL	RGT	F	BIGEYE						
26/03/2014	1954	2	YFT	A1	NULL	RGT	M	YELLOWFIN	2	YFT	A1	U	RGT	U
26/03/2014	2001	9	ALB	D	NULL	RWW	U	ALBACORE	4	YFT	D	U	RGT	U
26/03/2014	2028	1	BAB	A1	NULL	RWW	U	BLACKFIN BARRACUDA	4	GBA	A1	U	RWW	U
26/03/2014	2110	15	BET	A2	NULL	RGT	M	BIGEYE	16	BET	A2	U	RGT	U
26/03/2014	2120	4	BUM	D	NULL	RHG	F	BLUE MARLIN	8	BUM	D	U	RHG	U
26/03/2014	2133	2	PLS	A1	A3	DSO	U	PELAGIC STING-RAY	4	PLS	A1	D	DSO	F
26/03/2014	2145	16	BET	A1	NULL	RGT	M	BIGEYE	17	BET	A1	U	RGT	U
26/03/2014	2146	17	BET	A1	NULL	RGT	F	BIGEYE						

ON-BOARD OBSERVER DATA									E-M Video Analysis					
Date	Time	Hook No.	Species	Condition	Condition (let go)	Fate	Sex	Species	Hook No.	Species	Condition	Condition (let go)	Fate	Sex
26/03/2014	2151	15	BET	A1	NULL	RGT	M	BIGEYE	20	BET	A1	U	RGT	U
26/03/2014	2200	21	ALX	D	D	DSO	U	LONGSNOUTED LANCETFISH						
26/03/2014	2209	16	BET	A1	NULL	RGT	F	BIGEYE	16	BET	A1	U	RGT	U
26/03/2014	2247	1	BET	A2	NULL	RSD	F	BIGEYE	15	BET	A1	U	RGT	U
26/03/2014	2308	9	ALB	D	NULL	RWW	U	ALBACORE	7	ALB	D	U	RWW	U
26/03/2014	2337	7	BET	D	NULL	RGT	M	BIGEYE	23	BET	D	U	RGT	U
26/03/2014	2341	17	ALX	D	D	DSO	U	LONGSNOUTED LANCETFISH	14	ALX	A2	D	DSO	U
26/03/2014	2355	16	BET	D	NULL	RGT	M	BIGEYE	16	BET	D	U	RGT	U
27/03/2014	0005	22	PLS	A1	A3	DUS	F	PELAGIC STING-RAY	20	PLS	A1	D	DUS	F
27/03/2014	0010	8	BET	D	NULL	RGT	F	BIGEYE	17	BET	D	U	RGT	U
27/03/2014	0013	18	ALB	D	NULL	RWW	U	ALBACORE	8	ALB	D	U	RWW	U
27/03/2014	0016	18	ALB	D	NULL	RWW	U	ALBACORE	25	ALB	D	U	RWW	U
27/03/2014	0018	3	YFT	A1	NULL	RGT	F	YELLOWFIN	2	YFT	A1	U	RGT	U
27/03/2014	0052	10	ALX	D	D	DSO	U	LONGSNOUTED LANCETFISH	10	ALX	A3	D	DSO	U
27/03/2014	0054	16	LAG	D	NULL	RSD	M	OPAH / MOONFISH	13	LAG	D	U	RPT	F
27/03/2014	0057	21	PLS	A1	A2	DSO	U	PELAGIC STING-RAY	22	PLS	A1	A3	DCF	F
27/03/2014	0116	6	ALB	D	NULL	RWW	U	ALBACORE	25	ALB	D	U	RWW	U
27/03/2014	0117	7	ALB	D	NULL	RWW	U	ALBACORE						
27/03/2014	0131	2	WAH	D	NULL	RHG	M	WAHOO	11	WAH	D	U	RPT	U
27/03/2014	0145	2	YFT	A2	NULL	RGT	M	YELLOWFIN	2	YFT	A1	U	RGT	U
27/03/2014	0146	4	EBS	A2	A3	DSO	U	BRILLIANT POMFRET						
27/03/2014	0149	11	GES	D	D	DSO	U	SNAKE MACKEREL						
27/03/2014	0150	12	LAG	D	NULL	RSD	F	OPAH / MOONFISH	13	LAG	D	U	RPT	F
27/03/2014	0151	15	YFT	D	NULL	RGT	M	YELLOWFIN						
27/03/2014	0210	26	WAH	D	NULL	RHG	F	WAHOO	26	WAH	D	U	RPT	U
27/03/2014	0223	19	YFT	D	NULL	RGT	M	YELLOWFIN	12	YFT	D	U	RGT	U
27/03/2014	0224	20	YFT	D	NULL	RGT	F	YELLOWFIN	14	YFT	D	U	RGT	U
27/03/2014	0227	24	BET	A2	NULL	RGT	M	BIGEYE	16	BET	A2	U	RGT	U
27/03/2014	0307	12	ALX	D	D	DUS	U	LONGSNOUTED LANCETFISH	7	ALX	A1	A3	DUS	U

ON-BOARD OBSERVER DATA									E-M Video Analysis					
Date	Time	Hook No.	Species	Condition	Condition (let go)	Fate	Sex	Species	Hook No.	Species	Condition	Condition (let go)	Fate	Sex
27/03/2014	0309	17	ALB	D	NULL	RWW	U	ALBACORE	10	ALB	D	U	RWW	U
27/03/2014	0318	20	YFT	D	NULL	RGT	M	YELLOWFIN						
27/03/2014	0327	19	PLS	A1	A3	DUS	F	PELAGIC STING-RAY	18	PLS	A1	D	DUS	F
27/03/2014	0348	9	ALX	D	D	DSO	U	LONGSNOUTED LANCETFISH						

Table 3(a). Breakdown of catch by species according to the ON-BOARD OBSERVER
(13 sets of the Yi Man 3 trip only)

On-board Observer							
Species	N	RETAINED		DISCARDED		ESCAPED	
		No.	%	No.	%	No.	%
PELAGIC STING-RAY	132	0	0%	132	100%	0	0%
YELLOWFIN	123	113	92%	8	7%	2	2%
BIGEYE	76	74	97%	2	3%	0	0%
LONGSNOUTED LANCETFISH	69	0	0%	69	100%	0	0%
ALBACORE	67	66	99%	1	1%	0	0%
GREAT BARRACUDA	18	18	100%	0	0%	0	0%
SAILFISH (INDO-PACIFIC)	17	17	100%	0	0%	0	0%
OPAH / MOONFISH	13	13	100%	0	0%	0	0%
ESCOLAR	12	10	83%	2	17%	0	0%
WAHOO	8	8	100%	0	0%	0	0%
SILKY SHARK	7	0	0%	7	100%	0	0%
SNAKE MACKEREL	7	0	0%	7	100%	0	0%
STRIPED MARLIN	6	6	100%	0	0%	0	0%
MAHI MAHI / DOLPHINFISH / DORADO	5	4	80%	1	20%	0	0%
BLUE MARLIN	4	4	100%	0	0%	0	0%
POMFRETS AND OCEAN BREAMS	3	0	0%	3	100%	0	0%
BLACKFIN BARRACUDA	3	3	100%	0	0%	0	0%
BRILLIANT POMFRET	3	0	0%	3	100%	0	0%
SICKLE POMFRET	3	1	33%	2	67%	0	0%
SKIPJACK	2	2	100%	0	0%	0	0%
SHORT FINNED MAKO SHARK	2	1	50%	1	50%	0	0%
BRONZE WHALER SHARK	2	0	0%	2	100%	0	0%
BIGEYE THRESHER SHARK	2	0	0%	2	100%	0	0%
SNAKE MACKERELS AND ESCOLARS	1	0	0%	1	100%	0	0%
BLACK GEMFISH	1	0	0%	1	100%	0	0%
OILFISH	1	0	0%	1	100%	0	0%
BARRACOUTA (SNOEK)	1	0	0%	1	100%	0	0%
SWORDFISH	1	1	100%	0	0%	0	0%
SOAPFISH	1	0	0%	1	100%	0	0%
PELAGIC THRESHER SHARK	1	0	0%	1	100%	0	0%
GIANT MANTA	1	0	0%	1	100%	0	0%
UNSPECIFIED	1	0	0%	1	100%	0	0%
	593	341	58%	250	42%	2	0%

Table 3(b). Breakdown of catch by species according to the E-Monitoring Video analysis
(13 sets of the Yi Man 3 trip only)

E-Monitoring Video Analysis -- "Dry" Observer							
Species	N	RETAINED		DISCARDED		ESCAPED	
		No.	%	No.	%	No.	%
PELAGIC STING-RAY	130	0	0%	130	100%	0	0%
YELLOWFIN	141	130	92%	10	7%	1	1%
BIGEYE	84	84	100%	0	0%	0	0%
LONGSNOUTED LANCETFISH	59	0	0%	59	100%	0	0%
ALBACORE	50	50	100%	0	0%	0	0%
GREAT BARRACUDA	22	21	95%	0	0%	1	5%
SILKY SHARK	18	0	0%	18	100%	0	0%
OPAH (MOONFISH)	18	18	100%	0	0%	0	0%
SAILFISH (INDO-PACIFIC)	14	14	100%	0	0%	0	0%
ESCOLAR	13	9	69%	2	15%	2	15%
SNAKE MACKEREL	10	0	0%	10	100%	0	0%
BLUE MARLIN	7	7	100%	0	0%	0	0%
WAHOO	5	4	80%	1	20%	0	0%
SHORTSNOUTED LANCETFISH	4	0	0%	4	100%	0	0%
BLACK MARLIN	4	4	100%	0	0%	0	0%
MAHI MAHI / DOLPHINFISH / DORADO	4	4	100%	0	0%	0	0%
SKIPJACK	4	4	100%	0	0%	0	0%
RAY'S BREAM / ATLANTIC POMFRET	3	0	0%	3	100%	0	0%
SICKLE POMFRET	3	1	33%	2	67%	0	0%
UNSPECIFIED	3	0	0%	2	67%	1	33%
SNAKE MACKERELS AND ESCOLARS	2	0	0%	2	100%	0	0%
ROUDI ESCOLAR	2	0	0%	2	100%	0	0%
MOBULA (A.K.A. DEVIL RAY)	2	0	0%	2	100%	0	0%
BIGEYE THRESHER	1	0	0%	1	100%	0	0%
BRILLIANT POMFRET	1	0	0%	1	100%	0	0%
PELAGIC THRESHER	1	0	0%	1	100%	0	0%
SWORDFISH	1	1	100%	0	0%	0	0%
BLACK MACKEREL	1	0	0%	1	100%	0	0%
	607	351	58%	251	41%	5	1%

FIGURES

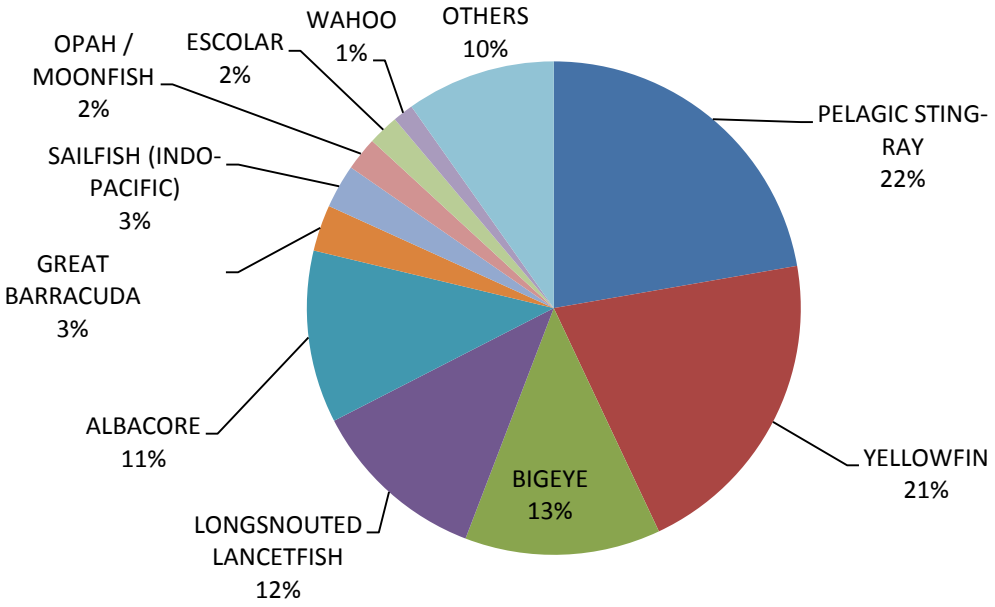

Figure 1(a). Breakdown of catch for the main species according to the ON-BOARD OBSERVER
(13 sets of the Yi Man 3 trip only)

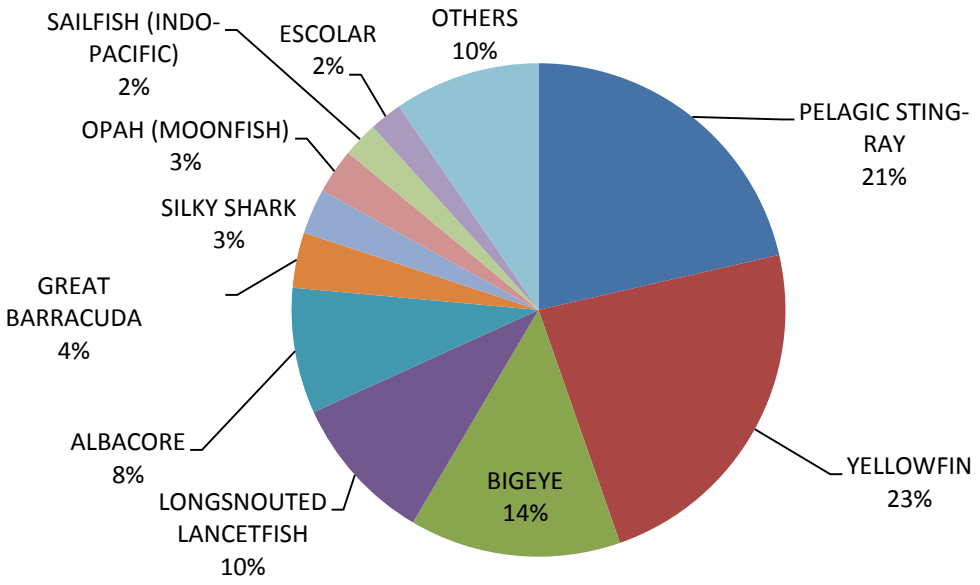

Figure 1(b). Breakdown of catch for the main species according to the E-Monitoring Video analysis
(13 sets of the Yi Man 3 trip only)

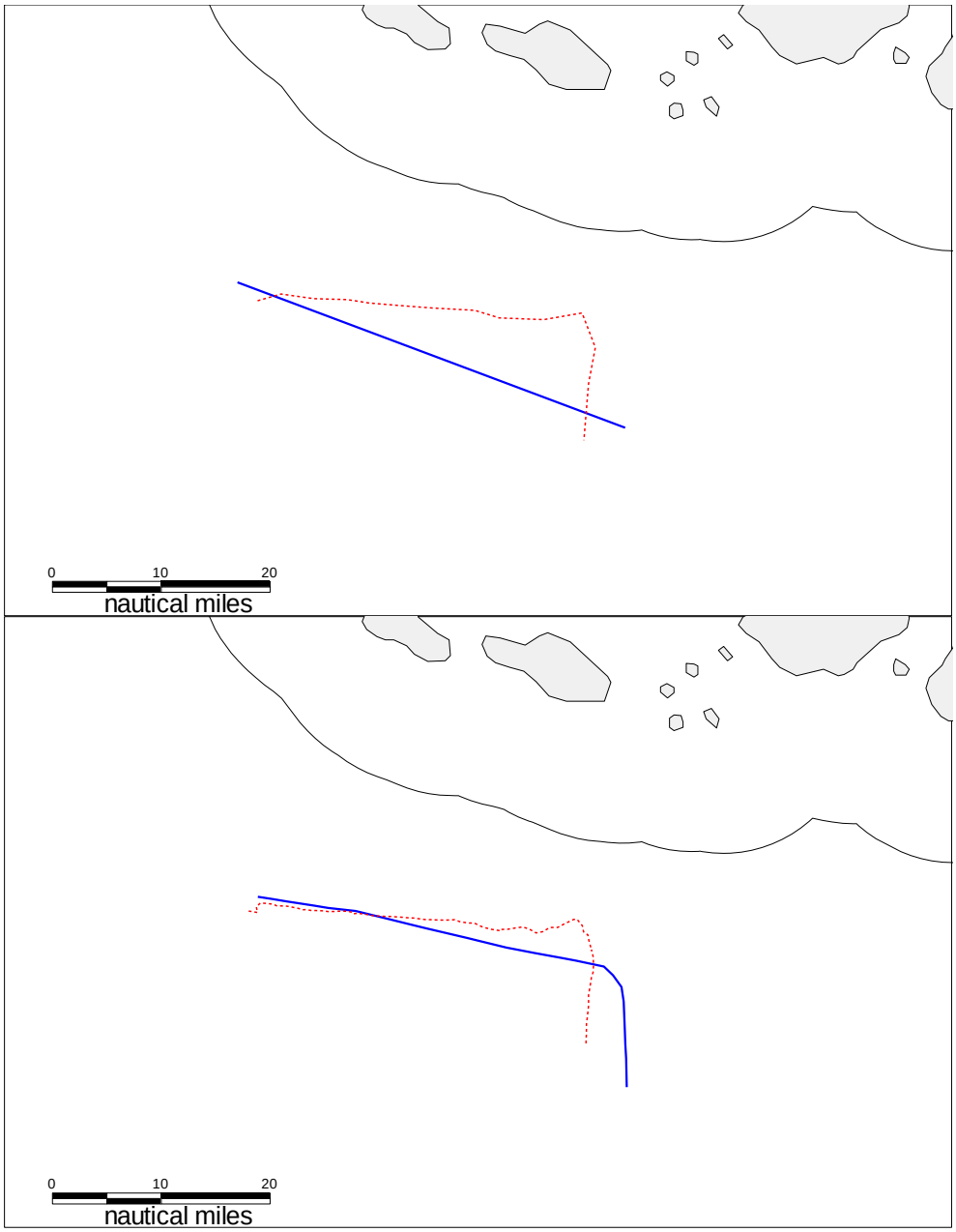

Figure 2. Map showing an example of the set/haul tracks – the on-board observer data (top) compared to the SATLINK system data (bottom)

Track for SETTING – BLUE

Track for HAULING – Dashed RED

ILLUSTRATIONS

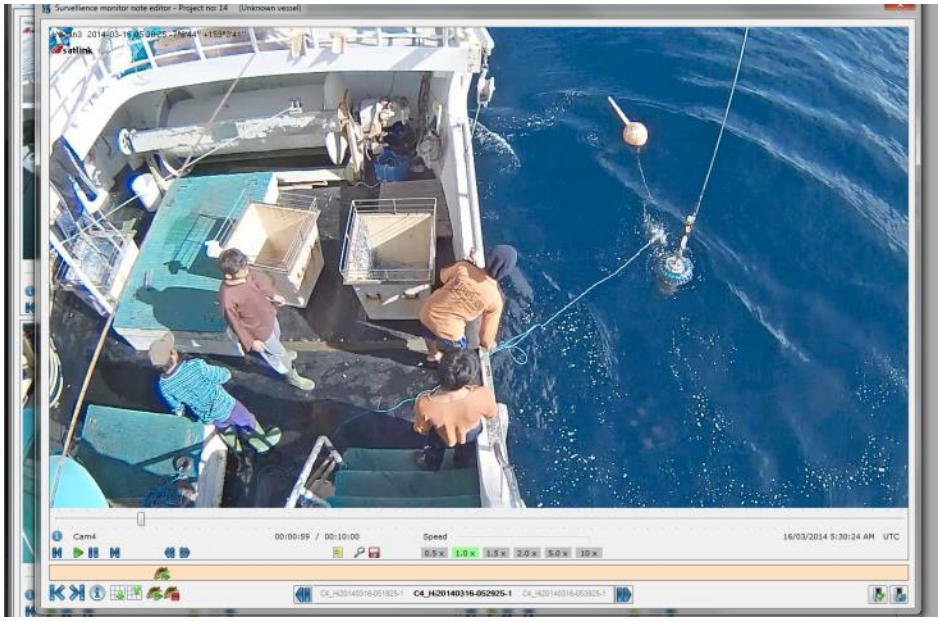

Illustration 1: Screen shot from the View Manager. This is the moment when the crew of the Yi Man 3 retrieve the first radio buoys attached to the longline. This marks the start of the hauling. The pink timeline bar at the bottom of the screen includes note functions to allows the 'dry observer' to record data for each new event.

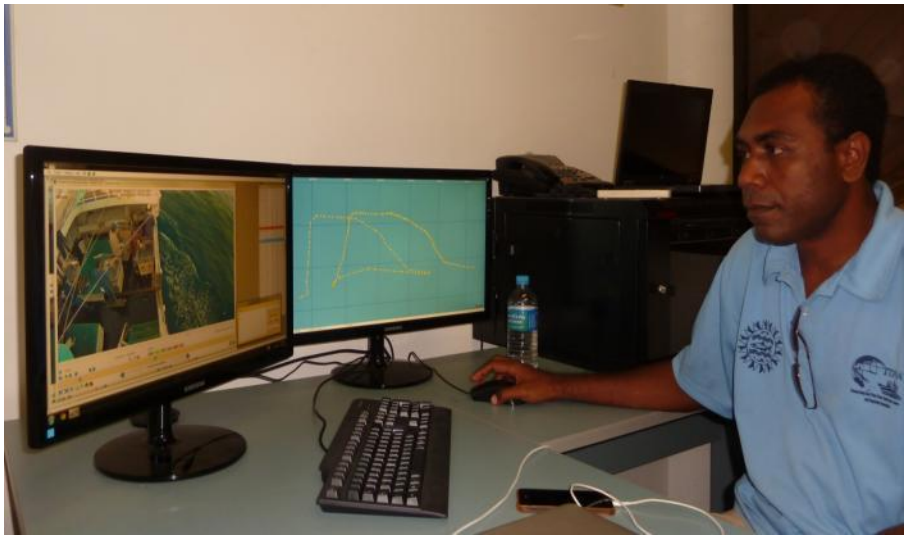

Illustration 2: MFMR 'dry observer' Harold Vilia analysing the E-Monitoring data. The screen at right is used to display the vessel's track for the setting and hauling period while the screen at left displays the camera footage. The central unit housing the computer and the hard drive racks is at the far right.

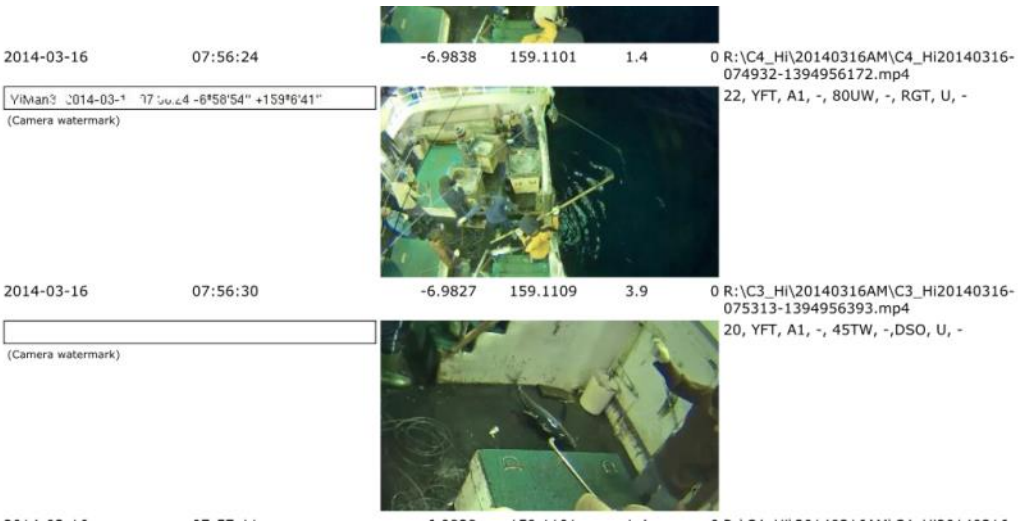

Illustration 3: Example of the report produced by the VM after a set has been analysed. The GMT date and date and position for each event is displayed at left, a thumbnail picture can also be included in the report (it can also be removed), and finally at right the coded data regarding the species.