Building the business case for EMS in the Ghanaian Tuna Purse Seine Fleet

WWF US

US2324

Final Report

August 2017

Submitted by

MRAG

MRAG Ltd is an independent fisheries and aquatic resource consulting company dedicated to the sustainable use of natural resources through sound, integrated management practices and policies.

Established in 1986, MRAG has successfully completed projects in more than 60 countries. Our in-house experts have a wide variety of technical expertise and practical experience across all aspects of aquatic resource management, policy and planning, allowing us to take a multi-disciplinary approach to every project. Our capability to service an extensive array of resource management needs is further extended through our network of associations with internationally acclaimed experts in academic institutions and private organisations worldwide.

MRAG Ltd

18 Queen Street
London
W1J 5PN
United Kingdom

T: +44 (0) 20 7255 7755
F: +44 (0) 20 7499 5388
W: www.mrag.co.uk
E: enquiry@mrag.co.uk

Project code:	US2324
Version:	Final Rev 2 v1
Prepared by:	PN; CH; SH, TF
Approved by:	CM

Table of Contents

Table of Contents i
List of Tables iii
List of Figures v
Acronyms vii
Executive Summary ix
1 Introduction 1
1.1 Background and context of the project 1
1.2 Description of an EMS and the Satlink Seatube System in use 2
1.3 Relationships and Linkages within the EMS 3
1.4 Description of the stakeholders involved 4
2 Methodology 5
2.1 (A) What is the basic infrastructure necessary to support EMS as an MCS and data collection tool for the Ghanaian purse seine fleet? 7
2.2 (B) What are the human resource requirements necessary to support EM technologies in Ghana? 8
2.3 (C & D) What are the costs and benefits of implementing EMS in the Ghanaian purse seine fleet (one time and recurrent) or continuing to rely on existing technologies and data collection systems? 9
2.4 (E) What legislative, regulatory or policy changes, if any, are required to allow the full implementation of EM technologies in the Ghanaian purse seine fleet and use of EM as an MCS tool? 10
2.5 (F) What cost recovery methodologies could be employed to ensure the long-term sustainability of the purchase, maintenance, and operation of the EM technologies? 10
3 Results 12
3.1 (A) What is the basic infrastructure necessary to support EM 12
3.1.1 Robust & Tamperproof Transmission and Recording Systems 12
3.1.2 On board Equipment 14
3.1.3 On shore Infrastructure 17
3.2 (B) What are the human resource requirements necessary to support EM technologies in Ghana? 18
3.3 (C & D) What are the costs and benefits of implementing EM in the Ghanaian purse seine fleet (one time and recurrent) or continuing to rely on existing technologies and data collection systems? 19
3.3.1 Assumptions from field consultations 19
3.3.2 Results 24
3.4 (E) What legislative, regulatory or policy changes, if any, are required to allow the full implementation of EM technologies in the Ghanaian purse seine fleet and use of EM as an MCS tool? 26
3.5 (F) What cost recovery methodologies could be employed to ensure the long-term sustainability of the purchase, maintenance, and operation of the EM technologies? 34
3.6 Payment models 34

3.6.1 Upfront risk taken by industry 35
3.6.2 Initial costs borne by government authority 35
3.7 Fixed and variable components 36
3.8 Fee collection agency 36
3.9 Conditions of entry linked to payment 36
3.10 Legal Considerations for Cost Recovery 36
4 Conclusions and Recommendations 38
4.1 Level of Efficiency 38
4.2 Level of Integration between Monitoring Programmes 38
4.3 Remote Data Review by DOS 39
4.4 Strengthening Competence 39
4.5 Cost Benefit Conclusions and Limitations 39
4.6 Legal Aspects 40
5 References 41
Annex 1 Survey Forms for Questions A & B 42
Annex 2 EMS Reporting Templates 49
Annex 3 Relevant Ghanaian Legislation & ICCAT Recommendations 57
Annex 4 Cost-benefit model in detail 60
Annex 5 DOS Service and Fees 62

List of Tables

Table 1 MOFAD Areas of reporting Obligations 6

Table 2 Strategic areas to be examined 7

Table 3 System Health Reports and their Frequency 12

Table 4 Summary of key input data used in the analysis framework. 19

Table 5 Thai Customs Tuna Import Price Data 23

Table 6 East-Atlantic ex-vessel price/MT 24

Table 7 ICCAT Catch Data for Ghanaian-flagged purse seine vessels in metric tonnes 24

Table 8 Overall investment analysis net present values in US$ according to the different stakeholders. 25

Table 9 Total programme costs (US$) over a five-year period (per vessel costs assume n = 17) 35

List of Figures

Figure 1 Operating Diagram of the Satlink SeaTube EMS (Modified from Satlink) 2
Figure 2 Class diagram of the SeaTube EMS in use in Ghana..... 3
Figure 3 Class diagram of stakeholder relationships 4
Figure 4 General schematic of camera configuration for a large purse seiner (DOS 2015) . 14
Figure 5: Position of the forward viewing camera. 14
Figure 6: View from the forward facing camera. 14
Figure 7: Position of the portside viewing camera. 15
Figure 8: View from the portside facing camera. 15
Figure 9: Position of the working deck viewing camera. 15
Figure 10: View from the working deck viewing camera. 15
Figure 11: Position of the aft facing conveyor belt camera. 15
Figure 12: View from the aft facing conveyor belt camera. 15
Figure 13: Position of the midships aft facing conveyor belt camera. 16
Figure 14: View from the midships aft facing conveyor belt camera. 16
Figure 15: Position of the midships aft viewing conveyor belt camera. 16
Figure 16: View from the forward viewing conveyor belt camera. 16
Figure 17: SeaTube Viewer Camera Configuration (DOS 2015) 16
EMS Figure 18 Organogram of EMS team within the FC..... 18
Figure 19 FAO Price Index..... 23

Acronyms

ABNJ	Areas Beyond National Jurisdiction
CBA	Cost Benefit Analysis
CCTV	closed circuit television
DOS	Digital Observer Services
EMS	Electronic Monitoring System
GEF	Global Environment Facility
FAO	Food and Agriculture Organization of the United Nations
FC	Fisheries Commission
HDD	High Definition Disks
ICCAT	International Commission for the Conservation of Atlantic Tunas
ISSF	International Seafood Sustainability Foundation
MCS	Monitoring Control and Surveillance
MOFAD	Ministry for Fisheries and Aquaculture Development
NPV	Net Present Value
PFC	Pioneer Food Company
RFMO	Regional Fisheries Management Organisation
WWF	World Wide Fund for Nature

Executive Summary

Background

In recent years, Electronic Monitoring Systems have become increasing utilized to expand the capability of flag States to monitor the activities of vessels under their jurisdiction. EMS provides a way to obtain independently verifiable information on compliance of fishing vessels, as well as providing an additional source of information on the catch by species and even by sizes. In verifying compliance, EMS provide the advantage of verifying compliance without the need of placing an observer on board of the vessel.

The Government of Ghana, the Food and Agriculture Organization of the United Nations (FAO), World Wide Fund for Nature (WWF), and the International Seafood Sustainability Foundation (ISSF) have formed a partnership under the Common Oceans Areas Beyond National Jurisdiction (ABNJ) Tuna Project funded by the Global Environment Facility (GEF) and implemented by FAO to pilot Electronic Monitoring System (EMS) technologies in Ghana. The EMS deployed in Ghana is described in greater detail in Section 1.2.

Objectives of this study

To support building a business case for EMS in the Ghanaian fleet, including options for financing a permanent implementation of the system, the following questions were posed as a guide to the study;

A	What is the basic infrastructure necessary to support electronic monitoring EM technologies as an MCS and data collection tool for the Ghanaian purse seine fleet?
B	What are the human resource requirements necessary to support EM technologies in Ghana?
C & D	What are the costs and benefits of implementing EM in the Ghanaian purse seine fleet (one time and recurrent) or continuing to rely on existing technologies and data collection systems?
E	What legislative, regulatory or policy changes, if any, are required to allow the full implementation of EM technologies in the Ghanaian purse seine fleet and use of EM as an MCS tool?
F	What cost recovery methodologies could be employed to ensure the long-term sustainability of the purchase, maintenance, and operation of the EM technologies?

This document addresses each of these questions in detail. Other related aspects have also been examined, such as: a) recognising the current priorities of Ministry of Fisheries and Aquaculture Development (MOFAD) in relation to MCS; b) data collection and reporting obligations to ICCAT; c) the current status of the at-sea observer programme and land-based observer programme.

On **infrastructure (A),** the EMS currently used in Ghana is the Satlink Seatube system (described in detail in Section 1.2) In order for the EMS to be fully functional and potentially used for enforcement purposes it must fulfil a number of requirements. It was found that the EMS in use fulfils all necessary infrastructure requirements (Sections 3.1.2 and 3.1.3).

Regarding the **human resource question (B**), the land observer team currently based in Tema, was also found to have sufficient facilities and staffing levels to implement the EMS effectively (Section 3.2). There is sufficient flexibility built in to resourcing of the team to accommodate changes in demand throughout the year. There is also a good rate of staff retention which is important for strengthening capacity with the team. There are further measures that could be taken to strengthen capacity within the team and prevent future issues. These are described in greater detail in Sections 4.1 and 4.4

The **cost-benefit analysis (CBA) (C and D)** was designed around the question of, "what are the costs and benefits arising from installing EMS as opposed to not?" This analysis has been treated as an economic analysis to the overall pilot project enabling the results to inform the future viability of the programme without donor support. The CBA followed standard methodologies (Section 2.3).

Under the conditions in Ghana, improving the compliance has contributed to a better standing of the fleet with respect to the markets, with clear benefits such as the contribution to the lifting of the EU yellow card and thus access to European markets. Therefore, it is not surprising that the CBA indicated that, installing and operating the EMS equipment is a viable and sustainable investment (Section 3.3.2). There was also found to be a strong view that the presence of the EMS would generally promote the sustainability of Ghanaian tuna fisheries to markets. Other more general, and less easily quantified benefits are also expected as a result of the continuation of the EMS, such as;

- source of verifiable and objective data for compliance and MCS
- potential to reduce IUU by domestic and foreign vessels
- potential to demonstrate good practices (both for the Government and for industry)
- potential use for future product certification
- collection of a certain amount of scientific data.

To **achieve total cost-recovery (F),** all costs attributable to delivery of services by the Government agency should be calculated and recovered under an equitable 'user pays' arrangement with industry. This includes not only the direct costs – such as installation costs, travel, video footage analysis – but also indirect costs such as funding land observers and coordinators, debriefing, data entry, office accommodations, communications and administrative equipment. Therefore, it will be important to isolate the additional costs specific to this service from the general costs of the agency's mandated standard operations. The analysis in section 3.3 provides the level of detail required based on the consultation evidence collected.

Two payment models are proposed; i) upfront cost borne by industry, and ii) initial costs borne by government. Under i) it could be designed that a condition of entry to the fishery is to have EMS installed which is compatible with the Ghanaian system. In this case, all onboard installation costs would be incurred by industry and national authorities would only need to recover the incremental service delivery costs. Under ii) the system is paid for upfront by government agencies, but later cost recovered. This may be viewed as more equitable by industry and allows for relatively constant payments associated with licence fees. When a vessel chooses to enter the fishery, the relevant national authority will provide the vessel with the necessary systems and services. Whilst not all the initial cost will be recovered immediately, the subsequent years of access to the fishery net this out. Some risk will be borne by the government if there is high turnover of vessels in the fleet.

Further details of these payment models are presented in Section 3.6.

Fisheries offenses in Ghana are prosecuted under criminal law for which there are stringent rules on presentation of evidence. In considering **the legal aspects of implementing the EMS as an enforcement tool (E)** it was found that considerable adaption would be required

to legislation and institutional arrangements in order to use EMS as an enforcement tool (Section 3.4).

Full details of the analyses undertaken are described in Section 3

Conclusions and Recommendations

From the analyses conducted the following conclusions and recommendations were derived (see a full presentation in Section 4).

Level of Efficiency

The current level of efficiency of some aspects of the implementation of the EMS could be improved. This is explored in further detail in Sections 4.1 and 4.4.

Level of Integration between Monitoring Programmes

There is currently no integration between the at sea observer programme and the land observers reviewing the footage. There is scope for comparisons between these programmes given that both have 100% coverage of the fleet. Should the EMS implementation be continued in the future then some functions of the at sea observer programme could be covered by the EMS and the at sea programme could solely concentrate on scientific functions.

Remote Data Review by DOS

A schedule for remote data review was due to be conducted during the pilot programme however this was not fully implemented. It is recommended that this process be fulfilled in the near future in order to provide independent quality control on the outputs of the EMS. (Section 4.3).

Strengthening Competence

The level of competence and efficiency of the land observer team reviewing the footage could be improved by embedding a trainer from DOS. The storage and chain of custody of EMS footage needs to be more secure. Continuity within the land-based team is needed so as to maximise the benefits of training and experience gained over time (Section 4.4).

Legal Aspects

In order to allow the full implementation of EM technologies in the Ghanaian purse seine fleet as an MCS tool it will be necessary to amend the existing Fisheries Regulations.

However because fisheries offenses in Ghana are prosecuted under criminal law, it is suggested that a suitable amendment should be made to the Fisheries Act to allow EMS data to constitute sufficient evidence of an offense.

The use of EM technologies also raises important data protection issues. New legislation for EMS would need to be carefully aligned with the data protection legislation.

1 Introduction

1.1 Background and context of the project

The Government of Ghana, the Food and Agriculture Organization of the United Nations (FAO), World Wide Fund for Nature (WWF), and the International Seafood Sustainability Foundation (ISSF) have formed a partnership under the Common Oceans Areas Beyond National Jurisdiction (ABNJ) Tuna Project funded by the Global Environment Facility (GEF) and implemented by FAO to pilot EMS technologies to strengthen the transparency and sustainability of the Ghanaian tuna fleet and ensure compliance with national and regional regulations. In addition to combatting illegal unreported and unregulated fishing (IUU), where greater transparency is required relating to the activities of fishing vessels at sea, there are national and international requirements such as those under ICCAT, inter alia: to provide a certain proportion of observer coverage on national fleets (5% minimum for ICCAT as required by Recommendation 16-14) and 100% coverage for vessels operating during the fish aggregating devices (FAD) closure area as required by Recommendation 16-01. Observers and ICCAT member countries are required to provide details of sets made on FADs and free schools; to report on bycatch species and the live release of certain species such as turtles; and to provide mandatory statistical reports. EMS can help with all of these as well as monitoring other operations of a vessel such as bunkering or transhipment.

Some of the mandatory reports are based on logbooks and catch certificates, whilst others that require verification at sea in order to provide the desired transparency of activities conducted there require direct and independent observations. Typically, this has involved placing observers on vessels at sea, however there are financial and practical difficulties in providing 100% observer coverage. Although it does not presently apply to the Ghanaian fleet but could do so in future, vessels that move between EEZs under licence agreements may be required to take on board national observers from either the flag state, the coastal state, or both, with the associated problems and costs of changing or picking up observers. EMS provides a more cost-effective way of providing full observer coverage where it is required and also, if the technology and system is regionally accepted, will allow vessels to move freely between jurisdictions whilst maintaining a permanent and checkable record of activities that are linked to position and time. ISSF allows for either human observers or EMS in order for a purse seiner to adhere to its standards.

EMS therefore has great potential to strengthen transparency and sustainability to meet national and international requirements for monitoring, control and surveillance (MCS) as well as reporting. This is because EMS provides objective and independently verifiable data. EMS data can be reviewed/analysed several times by different people if needed and raw data remains accessible. The purpose of this project is to present a business case for EMS in the Ghanaian tuna purse seine fleet that goes beyond the current pilot project. This business case is intended to inform the Ghanaian Government of the capital and recurrent costs of equipment and operations as well as required legislative changes and institutional arrangements necessary to utilise the EMS as an enforcement tool.

There are currently 17 Ghanaian International Commission for the Conservation of Atlantic Tunas (ICCAT) registered tuna purse seiners of which 14 are currently active with 13 of these currently on the ISSF ProActive Vessel Register. The 14 vessels have previously participated in the pilot project for EMS under the Common Oceans ABNJ Tuna Project. They operate mainly in the Gulf of Guinea and since 2000 catches have varied between 50,000 tonnes and 94,000 tonnes for Ghana with the purse seine fleet share varying between 18,000 tonnes and 67,000 tonnes over the same period.

Of course, EMS can do certain things very well (e.g. record and time stamp the date/position of setting or hauling a net) whilst there are other things that they do less well (e.g. accurately

record species composition of catches) and some they currently cannot do (e.g. gather otoliths, sex a fish). It should be noted that in the context of this project, the EMS is intended to be used as an enforcement rather than a scientific tool. For an EMS to be effectively utilised, the hardware must be correctly positioned and maintained, and ISSF have produced guidelines on this (Restrepo et al (2014). Beyond the hardware is the human interface including land based 'observers' and the policies and legislation supporting the system.

1.2 Description of an EMS and the Satlink Seatube System in use

MRAG Ltd understand an EMS to be the full system, that is the electronic monitoring (EM) technologies and other hardware, the human interface and the systems put in place to analyse and report the outputs of electronic monitoring i.e. it includes the hardware on board the vessels, shore based facilities, human resources, the analysis of the data, generating and storing outputs and reporting to regulatory bodies.

For this project, the request for proposals set out a series of questions to be addressed (see section 2) that require evaluation throughout the full scope of the EMS in Ghana from the infrastructure, the human resources through to the legislative and policy dimension to support it. A cost benefit analysis is also required of an EMS vs existing technologies and data collection systems and a set of potential cost recovery scenarios must be developed. The outputs of this project, whilst specific to Ghana, will have wider generic relevance and can act as a model for similar systems elsewhere.

The EMS employed in Ghana has been developed by Satlink and Digital Observer Service (DOS), with Satlink developing and providing hardware, software etc., whilst DOS provide analytical services, technical inputs on fisheries aspects of the EMS, developing the camera placement plan on board and training services. In the context of Ghana, DOS do not provide full analytical services but do conduct the daily health checks on the EMS (Section 3.1.1) and have also provided training services. Quality control analysis or remote data review was scheduled to be undertaken but has not yet been initiated (Section 4.3).

Figure 1 shows an operational schematic of the Satlink SeaTube system. This schematic also shows some of the basic infrastructure necessary to support EM.

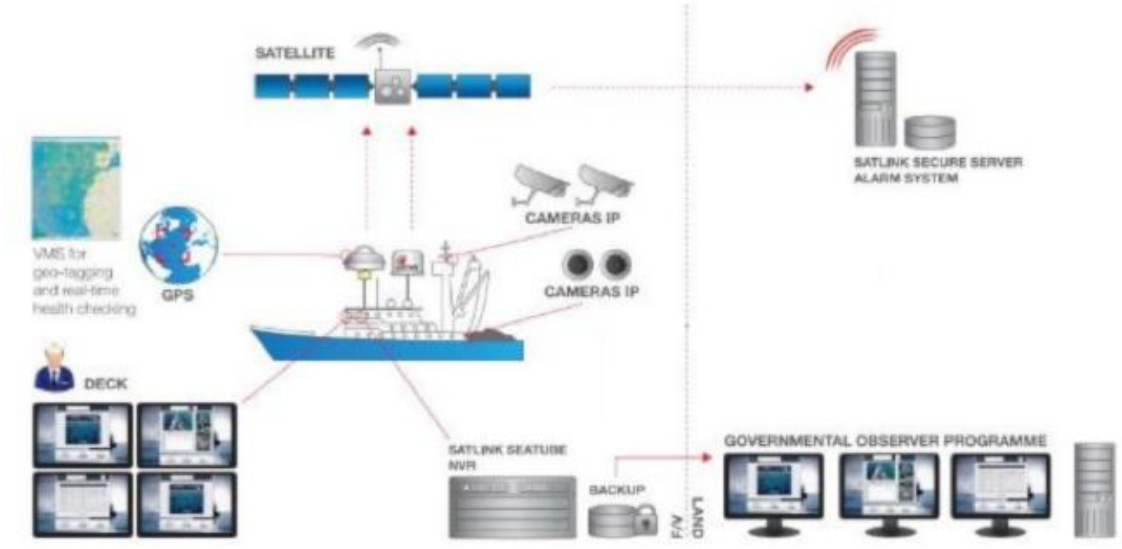


Figure 1 Operating Diagram of the Satlink SeaTube EMS (Modified from Satlink)

The Satlink Seatube EMS is described in further detail in section 3.1.

1.3 Relationships and Linkages within the EMS

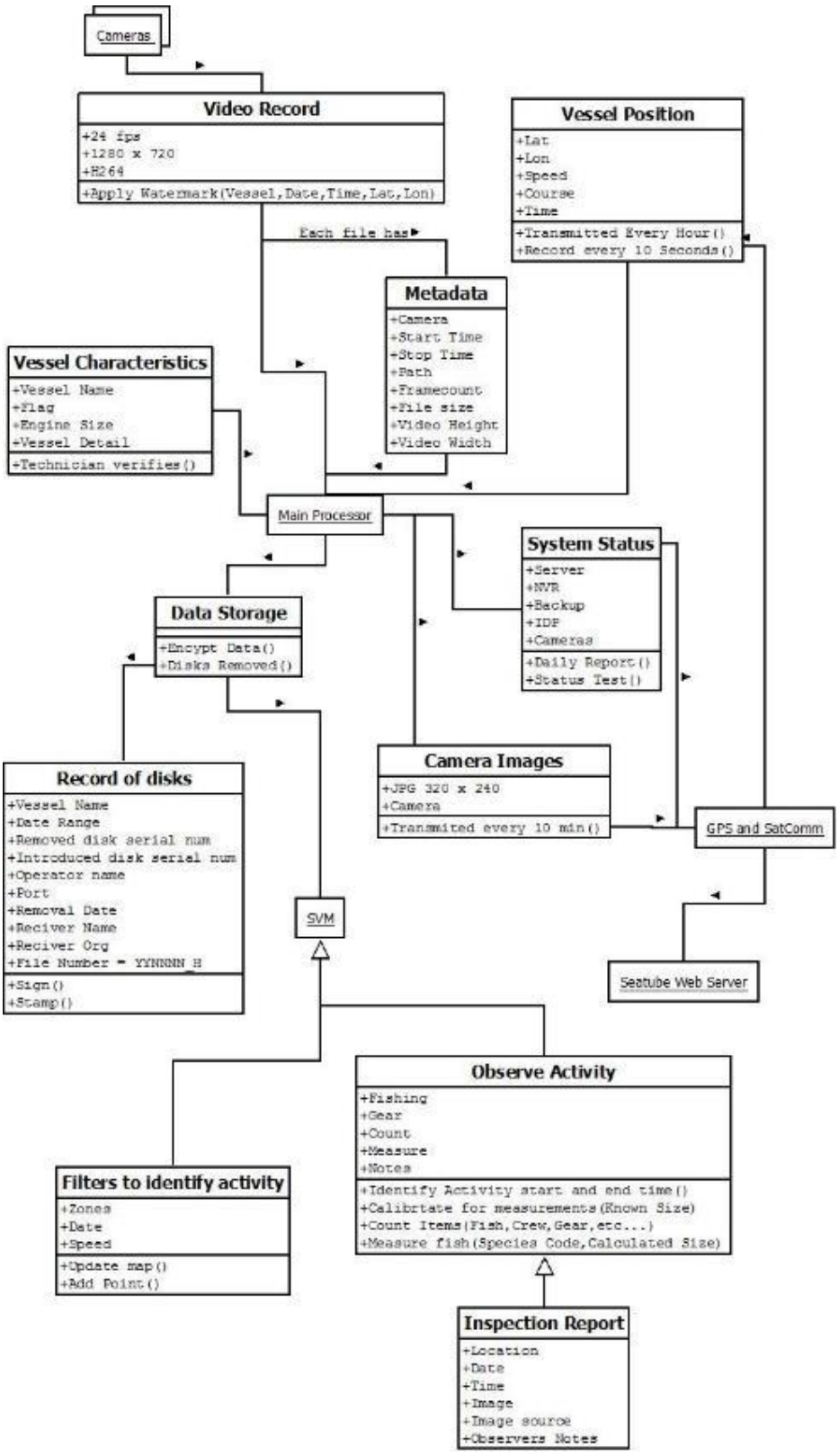


Figure 2 Class diagram of the SeaTube EMS in use in Ghana

The class diagram of the SeaTube EMS (Figure 2), shows the different parts of the system, their attributes and operations, and how the parts of the system relate to each other. For example the vessel position is part of the 'system'. Its 'attributes' are latitude, and longitude, speed, course and time of measurements. The 'operations' of vessel position are that they are transmitted every hour, and updated every 10 seconds. The vessel position has relationships with two 'objects' (objects are physical parts of the system and denoted by being underlined in the model) within the system, that is the GPS and satellite communications, that provide the position information and transmit it, and the main processor of the Sea Tubes equipment that will use the information such as in the watermarks applied to the video files.

1.4 Description of the stakeholders involved

A class diagram of the relationships within the system is shown in Figure 3 below. There are two main types of stakeholder in the system: the regulators, the vessels. It is the regulators who define the external requirements of the system through compliance requirements. The EMS provider can be considered as contractor rather than a stakeholder within the Ghanaian system. Other adaptations of these roles are possible, e.g. reviewers could be contractors from the EMS provider or another private entity.

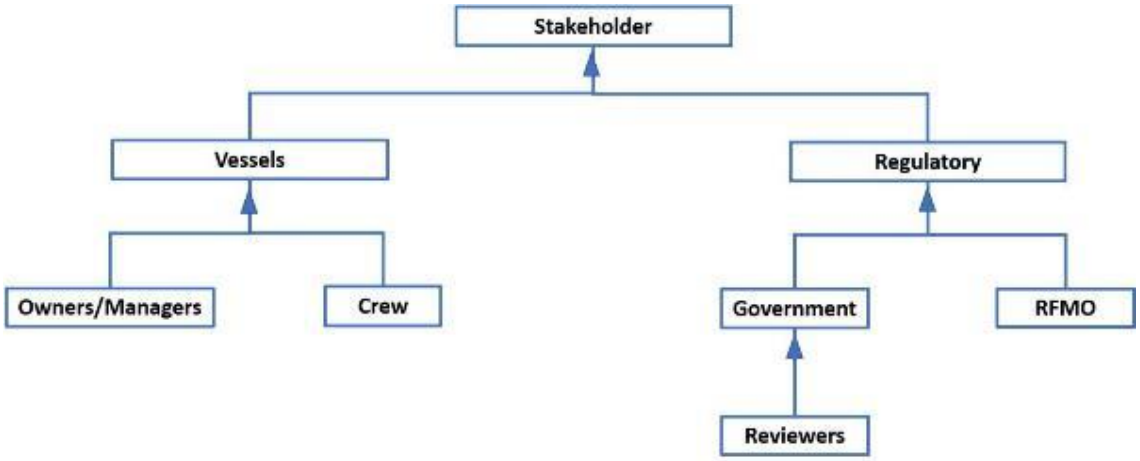


Figure 3 Class diagram of stakeholder relationships

The key stakeholders in Ghana, Government and Industry have formalised this relationship through the introduction of a Memorandum of Understanding (MoU), see Section 3.4 for further information on the MoU.

2 Methodology

Depending on the requirements of Ministry of Fisheries and Aquaculture Development (MOFAD), MRAG will assess the various costs and benefits associated with an EMS in being able to monitor the fishery adequately, and any disadvantages that may exist.

To support building the business case for EMS in the Ghanaian fleet, other aspects need to be examined in addition to the specific tasks A – F set out in the request for proposals (see also below) in order to support these tasks. These include a) recognising the current priorities of MOFAD in relation to MCS, including the prosecution of infractions identified using the EMS; b) data collection and reporting obligations; c) evaluating the current status of the at sea observer programme and EMS.

Observer programmes have different objectives, ranging from purely monitoring compliance with national and regional regulations (and to a lesser extent voluntary measures such as the ISSF PVR requirements), monitoring fishing activity and associated effort, taking biological and biometric sampling, to a combination of all. Furthermore, temporal and spatial restrictions on activities, such as FAD closures also place additional temporary demands on what an observer programme is required to provide. Therefore, observer programmes are tailored to meet the desired requirements.

Currently ICCAT requirements of an observer programme include monitoring the area/time closure relating to the use of FADs, and scientific data collection (Rec. 16-01). Other monitoring requirements onboard purse seine vessels typically include monitoring fishing activity, catch and effort.

The tables below present the various objectives, which, depending on the priorities of Ghana, may or may not need to be monitored. It is also recognised in several cases that these objectives may be adequately achieved with in-port sampling, while MRAG's own experience in the design and testing of EMS indicates that in some cases, EMS may have advantages over a human observer, and in others, disadvantages.

In addition, the strategic long term MCS and enforcement goals of MOFAD regarding EMS and its integration with other control methods will be examined as they will impact on the cost benefit analysis of implementing EMS in the long term. These aspects are further detailed in the following tables.

Table 1 outlines the areas that have reporting obligations, either from a vessel to MOFAD or else from MOFAD to ICCAT. MOFAD's level of priorities in relation to these areas needs to be identified in order to support tasks A & B.

Table 1 MOFAD Areas of reporting Obligations

Data Priorities	Considerations
Fishing activity and effort	Need to monitor number sets, including null catches, and the timing and location.
Total catch	How the total weight of the catch is obtained
Catch composition	How the species composition, considering the main species and size ranges is established.
Bycatch estimation	Estimate bycatch, in particular, other tuna species, large teleosts and elasmobranchs, mahi mahi, small teleosts.
Discards	Large and small fish discards to be considered. Not including live returns.
PET species	Catch and fate of PETs species
FAD related activity	Important to note any FAD related activity, including visits, deployments, maintenance, change of satellite buoy, fishing events. Particularly relevant when considering any restrictions on FAD related activity. Furthermore, FAD construction now required to follow 16-01.
Best practice guidelines	How are PET species handled? Construction of FADs. Are these as per best practice guidelines?
Biometrics	Estimating length and weight
Biological data	Taking biological samples, hard parts, soft tissues, and searching for, and recovering tags.
Traceability	Verification of catch (FAD free, and the traceability from point of capture to storage in the wells, and eventually to discharge)
Transhipments	At sea transhipments are prohibited, including brailing to other vessels.

In addition to the reporting aspects described, the effectiveness and cost of the at sea observer programme needed to be evaluated against the requirements of MOFAD observer programme. How effectively and efficiently the at sea observer programme can deliver these results, either in conjunction with concurrent programmes, i.e., port sampling and electronic monitoring, or in isolation.

Table 2 Strategic areas to be examined

Initial question	Follow on questions
What is the level of integration between land observers, sea observers, port sampling?	Is information shared, allowing effective utilisation of the advantages of each programme. Is double handling and recording of data avoided.
Is there further development planned/identified for further integration across programmes?	Identification of the priorities of each programme.
Has there been significant analysis on comparison of data between land and sea observers?	If conducted, has there been significant findings?
Has there been significant analysis on comparison of data between observers and in port sampling and/or vessel logbooks?	If conducted, has there been significant findings?
What is the level of integration between government programmes and industry in implementing?	Are there any FIPs? Involvement with ISSF PVR?
What is the mechanism for facilitating this on an operational basis?	Assumed it is the MoU, any further updates since this was issued in 2015?
Have periodic meetings been implemented as per the MoU?	Determine frequency, costs to stakeholders, any ongoing tasks as result of these meetings?

2.1 (A) What is the basic infrastructure necessary to support EMS as an MCS and data collection tool for the Ghanaian purse seine fleet?

The Fisheries Commission (FC) is the branch of MOFAD that is responsible for executing the control of fisheries and implementing the EMS currently in place. The existing arrangements that have been put in place in the FC in order to support the pilot EMS were reviewed and their utility considered along with what requirements are necessary to provide a cost effective and efficient infrastructure to support EMS in Ghana beyond the pilot supported by the Common Oceans ABNJ Tuna Project.

Aspects that were evaluated included:

- On board hardware
- Shore based facilities
- IT system requirements
- Communications systems
- Data management systems including, encryption, transmission and storage
- Analysis of the data and reporting
- Materials to allow staff to fully implement the EMS
- Insurance and security etc.

It is also important to determine and differentiate between what are going to be one off initial costs and ongoing operational costs. Initially it will also be important to determine the existing level of infrastructure available to support the EMS in its inception, and that required on an ongoing basis.

This question was addressed through a combination of a desk study as well as the site visit to MOFAD in Ghana. Information from this task fed into C and F. The desk study included analysis of technical information from the EMS provider and MOFAD, key informant

questionnaires and on-site interviews in Ghana. Questionnaires were developed for this purpose and are included in Annex 1 .

This question was addressed working under the assumption that the overall number of vessels involved will remain broadly similar.

2.2 (B) What are the human resource requirements necessary to support EM technologies in Ghana?

Aspects that were required to be evaluated included:

- Optimum number of staff and their roles
- Management procedures to allow staff to fully implement the EMS, including evaluation of quality control procedures
- The potential to use electronic data analysis tools for certain tasks, the respective quality of outputs of human and electronic observer-data analysts, and to understand the priorities of MoFAD in terms of cost effectiveness vs providing land based observer employment opportunities
- The level of competency and training of the staff
- Staff retention rates and the frequency of training
- Staffing costs
- Recruitment procedures and level of experience at recruitment
- Footage review time of staff
- One off and ongoing recruitment requirements

In order to fully evaluate this question, data needed to be collected and analysed relating to the expected number of fishing trips conducted in a year, the time taken to analyse each trip along with reporting and submission requirements. The performance of existing land based observers under the pilot EMS scheme was assessed and points where efficiencies can be made were to be determined through this.

This question was addressed through a combination of a desk study as well as the site visit to the MoFAD in Ghana. The desk study included analysis of technical information from the EMS provider and MoFAD, key informant questionnaires and on site interviews in Ghana. Questionnaires were developed for this purpose and are included in Annex 1 . Information from this task fed in to tasks C, D and F.

2.3 (C & D) What are the costs and benefits of implementing EMS in the Ghanaian purse seine fleet (one time and recurrent) or continuing to rely on existing technologies and data collection systems?

Aspects evaluated included (one off and ongoing):

- EM capital expenditure and installation costs;
- Annual satellite up time or recording device maintenance costs;
- Overall system maintenance
- Land based observers;
- Current technology fixed and variable costs; and
- A collection of benefits that industry and non-industry stakeholders expect.

For the purposes of describing our proposed methodology for addressing these questions, points C and D have been combined because very similar approaches were adopted for both, as follows.

C.1 – Data collection:

The team's economist developed surveys which were populated during the in-country field trip. This survey was designed to collect the data required to construct a quantitative cost-benefit model. To complete this, upfront capital expenditures costs needed to be identified. The ongoing variable costs and annual expected benefits were also identified.

Surveys were conducted with representatives from industry and relevant government departments. An initial list of suggested stakeholders was presented to WWF US and the team took advice on suggested additions to the list.

C.2 – Cost benefit analysis methodology

Following the information collected from the above task, a cost benefit analysis (CBA) was conducted and a net present value (NPV) established. Annual costs and benefits were built into a quantitative model.

This CBA primarily followed standard NPV methodologies. In a typical project, an investment is made upfront and an NPV of this investment is quantified. In this case, the cost of the EMS equipment supporting infrastructure was the investment and all subsequent operations listed above were considered the project's variable costs and benefits. To estimate the net present value, it is important to understand that as time passes, costs and benefits progressively become less and less valuable. These costs and benefits are discounted by a chosen rate to take into consideration future risks and the value of investing money now to make additional money in the future.

Estimating the NPV of a project can be calculated through the following formula:

$$NPV = \left(\sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+r)^t}\right) - C_{t=0}$$

where B is the benefits at time t (annually in this analysis), C is the costs, and r is the discount rate (where $0 < r < 1$) and this is all with respect to any investment costs (the processing facility) made upfront for the project ($C_{t=0}$).

For this analysis we considered the most appropriate discount rate was industry's reasonably expected rate of return (or Internal Rate of Return [IRR]). In economic and financial analysis, there is a standard method for estimating an industry's IRR which can be seen in Reid and Campbell (n.d.)[1] and is described as:

$Z = (RF + \beta M - CPI)$ if analysis is in real terms or;

$Z = (RF + \beta M)$ if analysis is in nominal terms

where RF is the risk free rate of return (set by the Government's bond rate), M is the market premium adjusted by β which is a constant measure of relative risk for an investment of this type, and CPI offsets nominal market rates to real term rates.

2.4 (E) What legislative, regulatory or policy changes, if any, are required to allow the full implementation of EM technologies in the Ghanaian purse seine fleet and use of EM as an MCS tool?

The analysis in the section was conducted in two separate parts: (1) determining what changes may be necessary to positively enable the implementation of EM technologies as an MCS tool; and (2) determining changes may be necessary to address potential legal constraints or other impacts on the use of such technologies.

The areas of legislation concerned were fisheries related, data protection and privacy.

The relevant legislation was identified and reviewed as well as international obligations. Interview questionnaires for the relevant personnel were prepared and were used during the site visit at the end of March (Annex 1 . The list of legislation to be reviewed is contained in Annex 3 .

Unfortunately, it was not possible to meet with the Executive Secretary of the Data Protection Commission (DPC) and a phone interview could not be scheduled despite multiple attempts. Further difficulties were encountered with getting the questionnaire regarding fisheries legislation completed. During the site visit there was nobody available with the suitable expertise to discuss this with. The questionnaire was circulated to the FC and a suggested contact of a legal expert in Ghana, however by the time of writing neither party had responded.

2.5 (F) What cost recovery methodologies could be employed to ensure the long-term sustainability of the purchase, maintenance, and operation of the EM technologies?

Aspects evaluated included:

- Existing governance structures;
- Existing and potential rents obtained to the Ghanaian Purse seine fishery;
- Details of the full costs to be recovered (information from previous Tasks, one off and ongoing);
- Identifying costs which could be fixed or variable;
- The impact of different options on the fleet; and
- Possible mediums for cost-recovery payments.

[1] Reid, C. & Campbell, H. F. N.D. Bioeconomic Analysis of the Queensland Beam Trawl Fishery. Brisbane, QLD, Australia: University of Queensland.

Our experience suggests that a number of key factors are required for a successful cost-recovery system. Most notably, a good governance structure with sufficient political will is critical. Without this, the system essentially relies on voluntary payments. The recommended cost-recovery model depends on the payment mediums available. For example, do licence payments already exist, or will new payment systems be required?

Past examples of our cost-recovery systems have been built based on fixed and variable costs. Examples of fixed costs might be the IT administrator of the EM data because this will be roughly the same regardless of the number of vessels participating. Variable costs might be the up-time required for satellites per vessel and could depend on the number of days fishing per year.

The CBA described above provides a breakdown of potential costs and benefits by stakeholders. This provides some concept of who are the “winners” and “losers” under a policy with respect to designing cost-recovery quantities.

One aspect we considered was the fleet’s economic performance and alternative fishery participation options. For example, the regional nature of the fishery, and the suggestion that this policy will only be implemented to the Ghanaian fleet, has the potential to drive fishery participants to other flag states. This is because the costs of implementing such a system may not be offset by the potential benefits. Other drivers in play, such as onshore investments in Ghana, were identified during the in-country field work. Importantly, we considered both the overall policy, and the overall benefit to industry.

Recommendations on possible cost-recovery amounts and methods have been made based on findings from surveys (Annex 1) and analysis (Section 3.5).

3 Results

3.1 (A) What is the basic infrastructure necessary to support EM

The EMS currently used in Ghana is the Satlink Seatube system previously described in Section 1.2. In overarching terms, the system comprises an array of high definition video cameras capturing fishing operations above and below deck, Seatube records its position independently but can also be linked to a Vessel Monitoring System (VMS) to record positional data, though this is not the case in Ghana. All data is stored on encrypted hard discs which are subsequently analysed using the Satlink View Manager (SVM) at the FC offices.

In order for the EMS to be fully functional and potentially used for enforcement purposes it must fulfil a number of requirements including having tamperproof systems and sufficient hardware (i.e. cameras and High Definition Hard Disc (HDD) storage space).

3.1.1 Robust & Tamperproof Transmission and Recording Systems

Transmission of Position

Currently SeaTube records positions every ten seconds. The reporting frequency is configurable rather than fixed and can easily be adjusted to record as often as every minute.

System Health Monitoring

Monitoring of the health of the system can be divided into two components in the SeaTube system; system health checks and camera health checks.

System health reports are automatically sent on a daily basis via Satcom transmission detailing daily videos created, memory consumed and backup memory remaining. There are also a number of other health checks that are sent automatically if a problem is detected (Table 3).

Table 3 System Health Reports and their Frequency

Health Check	Frequency of Verification
Camera X on & accessible	hourly
VMS unit operational & accessible	hourly
Stationary NVR on & accessible	hourly
Removable NVR (Backup) on & accessible	hourly
Last GPS position recorded less than 3 minutes old	hourly
Disc space remaining, notices at 75% & 95%	hourly
Daily report (no. videos recorded, disc space remaining)	24 hours
Camera X has not recorded for more than 670 seconds	2 min

The health check system also acts to tamperproof the system's equipment by continually monitoring and providing alarms when parts of the system are interfered with. Alarms are registered and recorded at DOS/Satlink facilities as part of the health checks. The system has

to be switched off in order to change the hard discs and once it is switched on the daily report is automatically sent immediately. This allows cross checking against the last previous recordings on the changed hard discs.

The Seatube system uses a number of features to ensure that it is tamperproof. The system is connected to a separate VMS unit that provides position, date, time course and speed of the vessel. These data along with camera number and vessel identification are simultaneously recorded and encrypted and embedded in to the video prior to being sent to the hard disc. The Seatube system can also be connected to the VMS of the vessel.

The encryption method used is AES-256. This is a symmetric encryption method which means that the same encryption key is required to encrypt and decrypt a piece of data. When a hard disk is replaced in the system a random password is generated and is sent through the VMS approved unit to a remote secure server for DOS to consult. Using this procedure hard discs can only be decrypted once they have been returned to any DOS certified centre after completion of the fishing trip.

Cameras are protected from manipulation by being housed in securely fastened weatherproof dome housings. This combined with the health checks performed ensures the integrity of the system.

3.1.2 On board Equipment

Seatube on board a vessel consists of a system of six cameras depending on the size of the vessel.

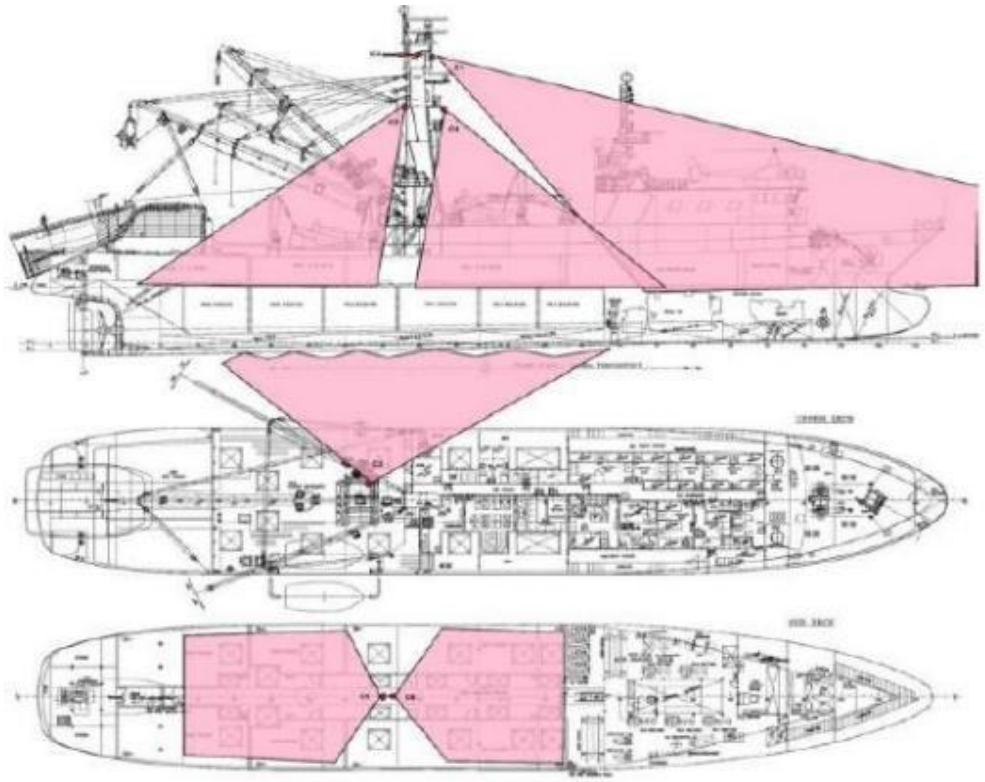


Figure 4 General schematic of camera configuration for a large purse seiner (DOS 2015)

The following section describes in depth the camera configuration and available views from SeaTube on a 95 metre purse seiner. For this vessel Seatube comprised of six P3334-VE cameras in total. Three of these were above deck, with one facing forward to cover FAD related operations (Figure 5 and Figure 6), one viewing the portside of the vessel to primarily identify the fishing set type as well as aid in assessing FAD related activity (Figure 7 and Figure 8), and one viewing the working deck to primarily estimate total catch and large bycatch (Figure 9 and Figure 10).

Figure 5: Position of the forward viewing camera.

Figure 6: View from the forward facing camera.

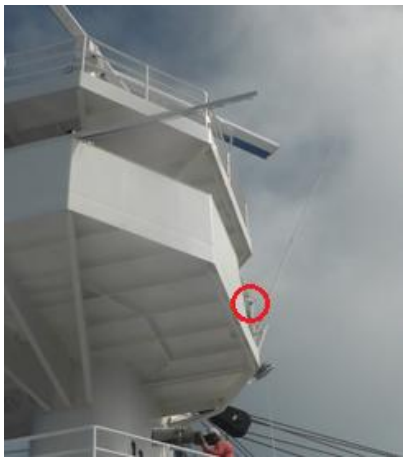


Figure 7: Position of the portside viewing camera.

Figure 8: View from the portside facing camera.

Figure 9: Position of the working deck viewing camera.

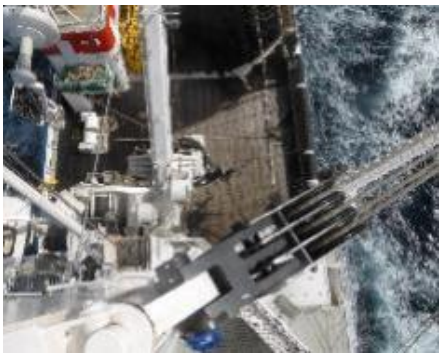


Figure 10: View from the working deck viewing camera.

The remaining three were below deck covering different sections of the conveyor belt to primarily estimate catch composition (species and size range) and small bycatch (Figure 11, Figure 12, Figure 14, Figure 15 and Figure 16).

Figure 11: Position of the aft facing conveyor belt camera.

Figure 12: View from the aft facing conveyor belt camera.

Figure 13: Position of the midships aft facing conveyor belt camera.

Figure 14: View from the midships aft facing conveyor belt camera.

Figure 15: Position of the midships aft viewing conveyor belt camera.

Figure 16: View from the forward viewing conveyor belt camera.

The view available to the land observer for this particular configuration via SeaTube is shown in Figure 17.

Figure 17: SeaTube Viewer Camera Configuration (DOS 2015)

Images from the cameras were recorded on a Synology RS814+ (IP: 10.0.0.8) HDD and periodically backed up on a Synology RS814 (IP: 10.0.0.9) HDD. Health status reports were transmitted approximately every two minutes along with an additional daily report. This system also allowed DOS to assess the working status of the cameras and advise the vessel of any maintenance required.

The HDDs are removed in port in either Tema or Takoradi by a Satlink technician based in Tema and subsequently delivered to the FC by the Satlink technician. The cost of this service is included in the cost benefit analysis (Section 3.3).

3.1.3 On shore Infrastructure

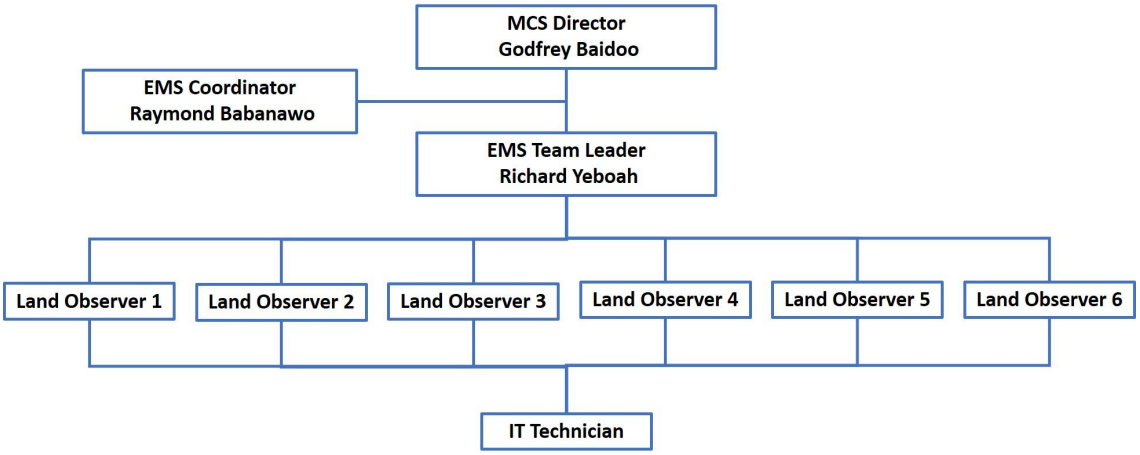
On shore infrastructure required are air-conditioned offices and sufficient IT equipment such as computers and monitors for the land observers.

The pilot project has provided the FC with six desk top computers for video review. The computers are equipped with SVM and have a Synology HDD server available which is necessary for decryption of the HDDs. There should also be secure storage for HDDs awaiting analysis or awaiting formatting following analysis. HDDs are currently stored within the land observer's office in an unlocked filing cabinet (Section 4.4).

The land observer team is currently based in the FC building in Tema, where there is sufficient suitable space and IT equipment available for the current staffing level of the land observer team conducting video review. Further details on the staffing level available to the team are available in Section 3.2

3.2 (B) What are the human resource requirements necessary to support EM technologies in Ghana?

The EMS currently monitors 100% of the Ghanaian fleet, 14 vessels. From the inception of the EMS until March of 2017 94 trips with an average of 31.7 sea days duration have been fully analysed by the FC EMS team. This covers a total of 3012 sea days of footage reviewed by a total of 10 different reviewers with an average review ratio of three sea days to one review day overall. The MCS Director, Mr Godfrey Baidoo-Tsibu has overall responsibility for the EMS within the FC with Dr. Raymond Babanawo and Alexander Adu-Antwi acting as the EMS coordinators. The EMS review team are led by a team leader, Mr Richard Yeboah, and supported by an IT technician.



EMS Figure 18 Organogram of EMS team within the FC

Some land observers are assigned to the EMS team on a part time basis of 50 percent, this staffing level can be changed by the Team Leader as demands change. Demand drops off as a result of the FAD moratorium when many vessels cease fishing. These staff are still employed by the FC when engaged in activities other than the EMS. Though a total of 10 land observers have been involved since the inception of the pilot programme the normal number at one time is six.

Though it was stated that the policy of the FC was to have review time of no more than 3:1 (sea days/review day), the data indicated that the review time recorded was 3:1. See Section 4.1 for recommendations related to the review time and level of staff efficiency.

The staff retention rate is high and recruitment is rare, when it does occur the minimum standards required for land observers are a primary degree related to fisheries, biology or relevant degree, and IT skills are a mandatory requirement. In house training on port sampling and fish identification (ID) together with ID materials are provided. At sea experience is not a pre-requisite though some of the land observer pool do also have at sea experience within the observer programme.

Currently there are no in trip monitoring requirements of FC staff for the EMS. This monitoring, which predominately consists of systems health checks, is performed by Satlink. The HDDs are delivered to the FC by a Satlink technician based in Tema who removes the HDDs from the vessels and subsequently delivers them to the FC office in Tema.

Given the current number of vessels and the level of activity of the fleet the current level of staffing is adequate for the number of trips that are required to be reviewed, particularly given

that the EMS already has access to part time staff to increase capacity as required during busy periods. See Section 4.1 for further recommendations.

The costs of current FC staffing are outlined in greater detail and factored in to further analysis in Section 0.

Completed survey questionnaires from the MCS Director and the EMS Team Leander are shown in Annex 1 . Further survey questions that arose after the site visit that remained unanswered are also shown in Annex 1 .

3.3 (C & D) What are the costs and benefits of implementing EM in the Ghanaian purse seine fleet (one time and recurrent) or continuing to rely on existing technologies and data collection systems?

This analysis is designed around the question of, "what are the costs and benefits arising from installing EMS as opposed to not?" This analysis has been viewed as an economic analysis to the overall pilot project. That is, it considers the costs and benefits of all aspects to the project including donor supplies, not those just currently being borne by industry or the national authority. This then allows the results to inform analysis on the future viability of the programme without donor support. This CBA primarily followed standard NPV methodologies (Section 2.3).

3.3.1 Assumptions from field consultations

As highlighted in section 2.3, much of this analysis has been informed by the field consultations held with industry and national agencies in Ghana. It has been supported by literature, published databases, and industry experience. The following sections indicate the critical assumptions used in this analysis, and the data used in the analysis framework in order to compute costs and benefits are summarised in Table 4. It also highlights the key stakeholder for which the key input will impact.

Table 4 Summary of key input data used in the analysis framework.

Item	Value[2]	Stakeholder	Source
Vessels in fleet	17	Industry	FAO Pers Comm
Total companies in operation	5	Industry	Stakeholder Pers Comm
Costs			
Fixed			
Total Currently installed (number of)	14	Industry	FAO Pers Comm
EMS Equip install cost	17,000		FAO Purchase Order
Unit cost	*15,000*	Industry	
Freight	*500*	Industry	
Insurance	*100*	Industry	
Replacement hard disks (4 for every 17 installations)	*400*	Industry	

[2] USD unless otherwise stated

Item	Value[2]	Stakeholder	Source
Remote installations (approximately half the fleet)	*1,000*	Industry	
Onshore equip req for 17 vessels	118,670		FAO Purchase Order
Units (number of)	*6*	Govt	
Unit cost	*3,900*	Govt	
Freight	*420*	Govt	
Insurance	*25*	Govt	
Training	*2,100*	Govt	
Once-off contractor	*80,000*	Govt	*Estimate of annual expat salary*
Variable			
Annual Training	2,530	Govt	FAO Purchase Order
Annual Govt staff costs	19,000	Govt	MOFAD Pers Comm
Annual Audit Costs	17,150	Govt	FAO Purchase Order
Annual Industry staff costs	18,000	Industry	MOFAD and Stakeholder Pers Comm
Annual maintenance, service costs, and satellite up-time	70,100	Govt	FAO Purchase Order
Benefits			
Annual catch by GH PS (MT)			ICCAT[3]
SKJ	*38,049*	Industry	
YFT	*7,369*	Industry	
BET	*7,965*	Industry	
Ave Ex-vessel price for EU Market eligible/MT (2016; adjusted for inflation and index as per section 3.3.1.3)[4]			See Section 3.3.1.3
SKJ	*1,380*	Industry	
YFT	*1,780*	Industry	
BET	*1,515*	Industry	
Percentage change in price non-EU	-12%	Industry	Author estimate
Discount Rate	12%	Industry	Reid and Campbell (n.d.)
RF	*2.23%*		
Market Rate	*13.62%*		
Market Prem	*0.7*		

[3] https://www.iccat.int/en/accesingdb.htm

[4] 2016 value adjusted for inflation and index as per section 3.3.1.3

3.3.1.1 **Costs**

Whilst many of the EMS capital and installation costs were originally borne by donors, these have been included in this analysis to understand the total programme cost should it be implemented long term which this business case seeks to put forward the case for. Capital costs include EMS onboard equipment, monitoring computers, freight, replacement hard disks, installation (including at more remote locations), one-off foreign staff secondment for capacity building, and insurance.

Annual monitoring staff costs for industry companies have been estimated based on locally-based staff wages. This is assumed to be a single staff member per operating fishing company. These do not currently appear to be a real cost to industry, but it is envisaged this will be necessary in future. It is assumed that industry will not need to hire any additional foreign-based staff to monitor operations. A small portion of a single crew member's time (currently 3% to be conservative) has been allocated towards EMS onboard monitoring and minor maintenance.

Land based national authority observers and review staff have also been included in the analysis. It is assumed that land-based national authority costs are new costs under the EMS programme. That is, these staff would not exist in the absence of the programme as opposed to having been transferred at the expense of another department. It is possible that future advances in technology could reduce the capacity review needs. Nevertheless, consultation revealed the following current capacity requirements:

- A proportion of a team leader's time with other roles (US$250/mo)
- Two full-time land observers (US$400/person/mo)
- Two part-time land observers with other roles (US$178/person/mo)
- IT technician with other roles (US$178/person/mo).

We assume two different scenarios for service provision by the EM supplier (which includes video analysis, satellite time, HDD chain of custody, etc) which are between US$30,000 – US$70,100 (see Annex 4 and assuming EUR350/vessel/month Regional Control Centre cost based on consultation with DOS). To be conservative the higher cost option was used as shown in Table 4. Service provision levels can vary depending on what is required by industry. For example, the current providers offer basic remote systems support, to simple confirmation of set details (time, location, etc), right through to catch quantities and species composition estimates. The cost of these differing services varies also. Whilst services are currently provided by a third-party, some or all of the aspects may be internalised by the national authority in the longer-term.

It is unclear how internalising operations may impact the actual costs of delivering this service in the future. Furthermore, even if internalised, it is expected that this cost would continue to be fully-recovered from industry. Therefore, it was considered prudent to continue to apply current service provision costs in the analysis for future years.

Some annual training has been included based on past training costs. It is acknowledged that annual training may not be required. However, to remain conservative, a small annual amount has been included.

No assumptions have been made regarding commercial decisions on financing the capital costs. That is, the results shown below have not factored in the additional costs that may be incurred through interest on loans. Notwithstanding this, the discount rate applied has attempted to suitably factor in the opportunity cost of this capital outlay (see details in section 2.3).

3.3.1.2 **Benefits**

The biggest benefit arising from the installation of EMS on the PS fleet (as raised by both industry and national authorities) was its contribution to lifting the EU yellow card. Therefore, the price differential in accessing EU markets versus local or less valuable markets was considered the main benefit.

To understand the impact of this market benefit, it was assumed that vessel effort and catch would remain constant regardless of EU market accessibility. If this assumption of continued catch is false, and the industry was to shut down because there was no other viable market alternative, then the benefit would in fact be the entire value of the catch into the EU market and not just the differential in price to a lower-value market.

The alternative market is currently unclear, so estimated price differential is currently only speculative. To demonstrate one aspect of the analysis, a place holder of 12% difference was applied. This was on the assumption that 12% was a reasonably conservative estimate on price differentiation due to some alternative market assumptions. Firstly, vessels landing directly to locally-based canneries can fetch a higher price for their catch because freight costs will not be required for the product to reach a cannery. In Hamilton et al (2011)[5], reefer freight is estimated at US$250/MT (depending on the distance to market) and ex-TTV employees also confirmed freight at approximately US$200/MT. Secondly, since being sold by Thai Union Group, ex-TTV vessels have not been landing directly into the Pioneer Food Company (PFC) factory. These vessels now export whole fish directly to Iran for processing and sale into East Asian markets. Anecdotal evidence from ex-TTV employees indicate that lower quality requirements by these markets drive lower prices fetched by vessels. Considering the above, it is reasonable to conclude that vessels exporting to Iran will be fetching an ex-vessel price lower than landing directly into PFC by at least the cost of freight to Iran. Assuming the ex-vessel price derived in section 3.3.1.3, US$200/MT freight on skipjack price of US$1380/MT could represent approximately 14% decrease in price fetched. Therefore a 12% price differential seemed conservative once considering higher prices fetched by other species and other annual price fluctuations.

Consultation with industry did not reveal any other major intended benefits. Consultation with industry and MOFAD showed that there were no reports of improved reporting as a result of EMS installation. Improved compliance and reporting could lead to better stock management and analysis has been previously conducted to quantify this benefit (MRAG Asia Pacific, 2016)[6]. Consultation with other stakeholders and desk review of literature suggests other benefits may be conferred by the use of EMS. These qualitative benefits may include:

- improved MCS toolbox and as a result improved compliance

- improved potential for future certification and market access, as outlined above

- improved productivity for some companies (if combined with other tools).

As this analysis focussed on quantitative costs and benefits the above points were not evaluated.

[5] Hamilton, A., A. Lewis, M.A. McCoy, E. Havice and L. Campling, 2011. Market and Industry Dynamics in the Global Tuna Supply Chain. Honiara: Pacific Islands Forum Fisheries Agency. Available at: http://www.ffa.int/node/567

[6] https://www.wcpfc.int/system/files/WCPFC-2016-FADMgmtOptions-IWG02-04%20FAD%20Marking%20and%20Monitoring%20report%20final%20draft%20for%20circulation.pdf

The following sections outline the data used to conduct the economic analysis

3.3.1.3 **Price data**

Prices were taken from East Atlantic estimates in Poseidon (2016)[7]. These figures were estimated for 2012 so analysis was undertaken to adjust prices to 2016. Figure 19 from the FAO illustrates that fish price indices that prices for wild caught have been on an overall declining trend since 2012. This is despite some recovery in 2016.

[8]

Figure 19 FAO Price Index

Because the underlying data from Figure 19 were not available, Thai customs data were used to estimate world price fluctuations from 2012 to 2016. These figures are reported in nominal prices so to align prices with the rest of the analysis, they were adjusted by Thai inflation values. This generated a fish index for each year assuming 2012 = 1. From this analysis, it was estimated that prices in 2016 equated to 0.787 of the prices in 2012 and adjustments to Poseidon (2016) were made (see Table 5 and Table 6).

Table 5 Thai Customs Tuna Import Price Data

	QTY (kgs)[9]	Thai Baht (BHT)	BHT/QTY	Thai CPI[10]	Adj BHT/QTY	Index (2012 = 1)
2016	528,829,487	26,561,431,963	50.22683609	100.19	50.22683609	0.787
2015	478,699,691	19,581,799,432	40.90622952	100	40.82865508	0.6399
2014	520,049,647	24,401,821,005	46.92209897	100.91	47.2592974	0.7407
2013	577,073,053	36,374,756,878	63.03319257	99.03	62.30339416	0.9765
2012	534,572,099	35,262,198,010	65.96340901	96.91	63.80391224	1

[7] http://www.pewtrusts.org/~/media/assets/2016/05/estimate-of-global-sales-values-from-tuna-fisheries--phase-1.pdf

[8] http://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/338601/. Currently the index includes seafood imports to three markets (EU, Japan and USA) and six major species groupings (salmon, whitefish, other fish, crustaceans, small pelagics, and tuna)

[9] http://search.customs.go.th:8090/Customs-Eng/Statistic/StatisticIndex2550.jsp

[10] http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=409&language=ENG

It is worth noting that these estimates for 2016 were ground-truthed with industry members and were found to be accurate. However, skipjack prices landed into Tema factories in 2017 were approximately US$1,800/MT.

Table 6 East-Atlantic ex-vessel price/MT

East Atlantic canning price	ALB	BET	SKJ	YFT
2012 (Poseidon, 2016)	3,531	1,927	1,754	2,262
2016 (Adjusted with author's analysis)	2,780	1,515	1,380	1,780

3.3.1.4 Catch data

Catch data were sourced from the ICCAT catch records and data were filtered by purse seine and Ghanaian flagged vessels (see Table 7 below). It was assumed that this catch was taken by the 11currently active vessels which have had the EMS equipment installed.

Table 7 ICCAT Catch Data for Ghanaian-flagged purse seine vessels in metric tonnes

Species	2010	2011	2012	2013	2014	2015	Ave 5- year
SKJ	37,455	31,759	39,181	33,936	37,868	47,500	38,049
YFT	6,855	4,821	6,357	6,450	8,885	10,332	7,369
BET	7,797	7,491	6,796	8,378	7,901	9,258	7,965
ALB	20	0	0	0	0	0	0
Total	***52,127***	***44,072***	***52,335***	***48,764***	***54,654***	***67,090***	

3.3.2 Results

The annual net benefits (from year 0 – 5) of the programme are outlined at the top of Table 8. These reflect the sum of all the assumed costs and benefits shown each year, as per Table 4, resulting from the installation and operation of the EMS equipment. The NPV is the sum of those net benefits discounted by time. When an investment's NPV is analysed to be equal to or greater zero, it is considered a worthwhile investment. This investment's positive value, shown towards the bottom left of Table 8 (US$32.7 million), suggests the programme is a viable and sustainable investment.

The NPV of US$32.7 million can also be disaggregated to indicate the NPV that would be achieved by each key stakeholder in the analysis based on the split indicated in Table 4. For this analysis these key stakeholders are assumed to be the fishing industry and the government. Industry is assumed to benefit with a US$33.2 million NPV whilst the programme is assumed to come at a cost to the government with a -US$0.56 million NPV. Importantly, under this analysis structure, the high positive return to industry provides a good justification for full programme cost recovery by the government.

Table 8 Overall investment analysis net present values in US$ according to the different stakeholders.

Year	0	1	2	3	4	5
Net Benefits	-403,250	9,169,968	9,169,968	9,169,968	9,169,968	9,169,968
Industry	*-284,580*	*9,293,748*	*9,293,748*	*9,293,748*	*9,293,748*	*9,293,748*
Government	*-118,670*	*-123,780*	*-123,780*	*-123,780*	*-123,780*	*-123,780*

NPV	*32,652,431*
Industry	*33,217,300*
Government	*-564,869*

Given section 3.3.1.2 stated the price differential assumptions were speculative due to lack of clear supporting information, threshold analysis was conducted to determine the point at which EMS would not have been viable. Using this technique, and the assumptions above, it is estimated that the price decrease between the EU and less-valued markets would only need to be 0.29% (<1%) for EMS to be viable to all parties combined (i.e., when the total NPV = 0).

3.4 (E) What legislative, regulatory or policy changes, if any, are required to allow the full implementation of EM technologies in the Ghanaian purse seine fleet and use of EM as an MCS tool?

This question effectively has two separate parts:

(1) What changes may be necessary to positively enable the implementation of EM technologies as an MCS tool?

At present the use of EMS as an MCS tool is not addressed in Ghana's fisheries legislation, the principal elements of which are the Fisheries Act 2002 (as amended in 2014) and the Fisheries Regulations 2010 (as amended in 2015). The current pilot EMS activities are being undertaken on a purely voluntary basis in accordance with the MoU mentioned in section 1.4 above. The parties to the MOU, which is dated 9 December 2015, are the FC and industry partners, namely PANOFI, TTV, AGNES PARK, and D.H. Fisheries, Ltd.

In outline the MoU provides that: (a) the FC will install and maintain the EM equipment which is provided by FAO; (b) the vessel owners/operators and captains will ensure proper care of the equipment to ensure its correct functioning and notify the FC prior to their return to port; (c) the FC will retrieve the hard disk from each vessel and thereafter review its contents in order to prepare a trip report which is to be provided, together with a trip video, to the relevant owners, and to securely store the EMS data for a period of six months after which it is to be erased. All intellectual property rights in the EMS data are vested in the Government of Ghana, which is to be treated as confidential and neither the data nor trip reports are to be released to a third party without the consent of all parties. Periodic meetings to review the trip reports are foreseen and the industry partners may withdraw from the MoU on four weeks' notice in the event of repeated breaches of its terms by the FC resulting in financial loss to the company concerned. The MoU will terminate on 30 September 2018.

If the use of EMS is to become a legal requirement in relevant fisheries, then it will be necessary to provide for this in law as is currently done with regard to VMS. In this respect, Regulation 45(1) of the Fisheries Regulations 2010 (as amended) provides that:

> The owner, operator, charterer or master of a fishing vessel specified in Regulation 44 shall install, maintain and operate a vessel monitoring system approved by the Commission at all times during the currency of the license or authorization and transmit relevant data including catch data to a Fisheries Monitoring Centre.

Regulation 44 in turn provides that Regulations 45 to 49D apply to local industrial and semi-industrial fishing vessels or carrier vessels licensed under the Fisheries Act (irrespective of whether they fish within or beyond Ghana's fishery waters) as well as to foreign vessels licensed to fish within Ghana's fishery waters.

Subsequent paragraphs within Regulation 45, as well as Regulations 46 to 48, contain additional provisions on VMS (including with regard to: the manner in which the VMS is to be operated; reporting obligations in the event that the VMS fails to transmit; the ownership of the VMS data; restrictions on the release and use of such data; and a set of offenses and penalties relating to a failure to comply with provisions of Regulations 45-46 with regard to VMS).

Similar requirements could be imposed with regard to EMS, presumably through a further amendment to the Fisheries Regulations 2010 (which would be done through a specific amending regulation) together with appropriate sanctions for non-compliance. It does not appear that the adoption of such regulations would require an amendment to the Fisheries Act, section 139(1) of which confers broad regulation-making powers upon the Minister on the recommendation of the FC. It follows that if such regulations on EMS are adopted, there will be no need to conclude further MoUs with the industry partners.

Taking into account the experience of the FC and the industry partners with regard to the implementation of the MoU, it would also be appropriate to include provisions in new regulations on EMS on such matters as the purpose or purposes for which the data is to be obtained, the procedure for the recuperation of hard disks, periodic reviews, ownership of the intellectual property in the data and, as discussed in more detail in the second part of this section, the management of such data by the FC.

However simply requiring the use of EMS, or more specifically the installation of EM equipment on fishing vessels and the operation of that equipment at sea, will not serve much purpose in terms of MCS until and unless the information provided by the EMS can be easily and effectively used as evidence in enforcement proceedings in cases of non-compliance.

In this connection it is necessary to consider the general rules of evidence applicable in Ghana, as set out in the Evidence Act of 1975, NRCD 323, and in particular to have regard to the provisions on evidence contained in Part V of the Fisheries Act, which is entitled 'Jurisdiction and Evidence'.

In Ghana, as in many other countries, offenses under the Fisheries Act are essentially criminal offenses and therefore, subject to one exception, punishable under criminal law. In other words, fisheries offenses are prosecuted just like other criminal offense such as theft and assault. This has a number of implications including with regard to the use of evidence. Before turning to those implications, the exception can quickly be mentioned. This is the option, provided in section 116 of the Fisheries Act, for the compounding of offenses. This approach, which will be familiar to anyone who has paid a fixed penalty notice parking or traffic fine, allows for an accused person to admit the offense in return for paying a fixed penalty.

In cases where offenses are not compounded, offences under the Fisheries Act including those that may in the future relate to EMS will be punishable under criminal law. In fact, to be precise, offenses relating to EMS in the future may arise in two main ways. The first category concerns cases involving the incorrect use of EMS (such as tampering with the equipment) or the failure to use EMS when this is required. The second category involves what can be described as general fishing offenses that may be recorded by EM equipment. Obviously in terms of improved MCS detecting the latter type of offense is the main purpose of introducing an EMS.

The fact that offenses are prosecuted under criminal law has important implications in terms of the evidentiary standard applicable. In brief, in all cases involving questions of fact, the party asserting a particular fact has to prove the relevant facts to the court through the presentation of evidence.

In civil cases, such as contract disputes, the court must be satisfied that the facts are proved on the 'balance of probabilities'. In other words the court must be satisfied that it is more likely than not that the facts are as asserted by the person bringing the case. In criminal cases, however, the prosecution must satisfy a higher standard of proof in order to secure a conviction. The prosecution has to prove the facts asserted 'beyond reasonable doubt'.[11] In other words the court must be 'virtually certain' that the facts are as asserted by the prosecution.

It follows that extremely compelling evidence must be available in order to successfully prosecute a criminal offence. Any evidentiary gaps, any suspicion that evidence has been tampered with or inadequately preserved, indeed any chance to argue that evidence should be dis-regarded, will be gratefully seized upon by a defendant's lawyers. The prosecution of fisheries offenses poses particular challenges not least because fishing takes place far out at

[11] Section 13(1) of the Evidence Act 1975.

sea. Direct witness evidence of, say, illegal fishing is unlikely to be available unless that witness was actually on board the vessel at the time. Documentary evidence may be compelling, but it may also be tampered with. It is one thing to believe that an offence has been committed, quite another to be able to prove that offence beyond reasonable doubt.

Technology, of course, can be used to assist in providing the necessary evidence. However it is important to ensure that such evidence is formally admissible in court proceedings and is given the appropriate weight. This is why Part V of the Fisheries Act is entitled 'Jurisdiction and Evidence'. And in fact the majority of the sections contained in Part V are concerned with the issue of evidence rather than jurisdiction.

For example, sections 117 to 119 provides for the issue by fisheries officers of certificates of fact that are admissible as evidence for a range of issues. In outline the facts contained in a certificate are to be accepted by the court as proof unless disproved by the defendant (thereby reversing the burden of proof).

Of more relevance to the issue of EMS, though, is section 120 on 'designated machines'. Section 120 (1) provides that the Minister may, by notice in the Gazette, designate any machine or class of machine as a designated machine or machines.

Section 120(2) goes on to provide that the readings of such machines shall be admissible as evidence of the facts that they aver provided: (a) the readings were made by a competent operator of the machine; and (b) the machine was checked for correct working at a reasonable time before and after the readings it is sought to use as evidence were made and the machine appeared to be working correctly.

Section 120(3) provides that a designated machine that has been so checked and read by a competent operator shall, unless the contrary is proved, be presumed to give accurate readings within the manufacturer's specified limits. Subsequent provisions go on to specify how the readings are to be made (from a printout or visual display) and to require such machines to be able to make the readings wholly or partly by themselves.

The purpose of section 120 is to allow VMS data to be accepted as evidence in court. In outline unless a defendant can prove that the VMS equipment was not functioning correctly then a VMS readout will be accepted by the court as evidence of the vessel's location, course, speed or whatever other parameters can be provided by that system.

In terms of MCS in general, VMS has of course been hugely important. In terms of fisheries prosecutions, however, the role of VMS has often been more limited, particularly as far as actual illegal fishing is concerned. VMS essential proves only the location, course and speed of a fishing vessel. It can be used to prove that a fishing vessel was within a certain area (Ghana's fishing waters for example) at a certain time on a certain date. Moreover the particular 'tracks' of a vessel may be evidence that the vessel was fishing at a certain date and time. An expert could give an opinion that the pattern of movement of a vessel was consistent with, say, the shooting of nets, of trawling and then of hauling the nets.[12] But unless that expert was also a witness to such activity, s/he could not satisfy the necessary evidentiary burden, 'beyond reasonable doubt'. In other words the witness could not say that they were certain that the vessel was fishing and the vessel's master would surely come up with the usual fishermen's stories of cleaning the nets, or un-fouling the propellers etc.

[12] Evidence given by experts in particular technical fields is an exception to the basic rule that opinion evidence is not admissiable.

This is why very often VMS data has been successfully used for the prosecution of other types of offense such as logbook offenses (where there are discrepancies between logbook entries and VMS data).

A key benefit of EMS, coupled with VMS or alone if the EMS has its own GPS system, is that it has the potential to provide evidence of actual illegal fishing at a certain place and time. So the question arises, can EMS data to be produced as evidence in accordance with section 120?

Before answering this question it is also useful to refer to section 121, which is concerned with photographic evidence. Specifically, section 121(1) provides that where a photograph is taken of a fishing or related activity and simultaneously the date and time and position from which the photograph is taken are superimposed on the photograph then it shall be presumed unless the contrary is proved that the photograph was taken on the date, at the time and in the position so appearing.

Section 121 (2) goes on to provide that this presumption only arises if: (a) the camera taking the photograph is connected directly to the instruments that provide the date, time and position concerned; (b) the instruments used are 'judicially recognised', in other words formally recognised by the courts as being usually accurate, or are 'designated machines' (in accordance with section 120) or were checked as soon as possible after the photographs were taken. In addition section 121 (3) provides for the provision of certificate evidence by the officer who took the picture relating to that picture.

Returning to the question as to whether or not sections 120 and 121 are sufficient to provide for EMS images to be admitted as evidence in criminal prosecutions under the Fisheries Act, the short answer is: this is arguable either way.

On the one hand there does not seem to be any reason why EMS equipment (in particular video cameras, associated geo-location device (if any) and related transmission equipment) could not be recognised by the Minister as a 'designated machine'. However section 120(2) is expressed in terms of the 'readings' of such a machine. Common sense that a reading is something that can be read. In other words data provided in letters and numbers. Is a video recording really a reading? This might be arguable.

Similarly, while section 121 is clearly concerned with visual evidence as contained in a photograph, as opposed to 'readings', it does specifically refer to photographs. The usual meaning of a photograph is of an image that does not move. So could a video recording be classified as a photograph? This too may be arguable, particularly in the case of digitally recorded images. At the same time though section 121 does explicitly provide that an instrument capable of taking a photograph may be recognised as a 'designated machine', which may suggest that the concept of a reading under section 120 goes beyond letters and numbers.

In short, the position is arguable both ways. If reliance is placed only on sections 120 and 121, a good defence advocate might seize all possible arguments to have EMS evidence dis-regarded. Given the high burden of proof in criminal cases and given too the fact that the courts are typically very strict in terms of the rules of evidence and that the provisions of Part IV of the Fisheries Act are effectively an important exception to those rules, there is a non-negligible chance that an attempt to use EMS evidence on the basis of sections 120 and 121 alone would not be successful.

The key point to emphasize here is that sections 120 and 121 have the effect of reversing the burden of proof. As already noted, evidence produced by a designated machine in accordance with section 120 is presumed to be accurate unless the contrary is proved. Similarly it is up to the defendant to prove that date and time stamped photographic evidence provided pursuant

to section 121 was not taken on the date, at the time and in the position stamped on that photograph.

The Fisheries Act itself is obviously not the only source of law on the question of the admissibility of EMS data as evidence in criminal proceedings. As already mentioned, the main legal text regarding evidence in court proceedings in general in Ghana is the Evidence Act of 1975, NRCD 323. Given the date of adoption of that instrument it is not surprising that it does not refer to video or closed circuit television (CCTV) evidence. Of more potentially more direct relevance is the Electronic Transactions Act of 2008.

The basic object of the Electronic Transactions Act is to 'provide for and facilitate electronic communications and related transactions in the public interest' (section 1(1)). However section 7(1) provides that the 'admissibility of an electronic record shall not be denied as evidence in legal proceedings except as provided in this Act'.

The term "electronic record" is defined to include 'data generated, sent, received or stored by electronic means *(a)* voice, where voice is used in an automated transaction; and *(b)* a stored record'. □

The wording of section 7 therefore suggests that EMS data, as a record of images and data stored by electronic means, would be admissible in legal proceedings (and the act does not seek to deny its admissibility). This argument can be made on basis of the clear wording of section 7 of the Electronic Transmissions Act itself, even though the main focus of the act is broader than evidentiary issue.

However the act is not conclusive as to the weight to be given to such data. Section 7(2) provides that in assessing the evidential weight of an electronic record the Court must have regard to:

> *(a)* the reliability of the manner in which the electronic record was generated, displayed, stored or communicated, □
> *(b)* the reliability of the manner in which the integrity of the information was maintained, □
> *(c)* the manner in which its originator was identified, and □
> *(d)* any other facts that the Court may consider relevant. □

In other words, if it is not possible to rely on sections 120 and 121 of the Fisheries Act in criminal proceedings relying on EMS data it would still be for the prosecution to prove its case beyond reasonable doubt and for the defense to cast doubt on the strength of that data so as to argue that the burden of proof is not satisfied (by reference to the factors set out in section 7(2)).

In practice it may well be the case that video or CCTV data has been successfully and routinely used in criminal prosecutions in Ghana. Unfortunately in the absence of feedback as outlined in section 2, it has not been possible to verify this. Nevertheless the fact remains that there is a clear difference between the admissibility of evidence as such and the weight to be given that evidence. In the case of, say, a common assault, the prosecution might present CCTV evidence but it is unlikely that they would rely on that evidence alone (at the very least the victim would be called as a witness). In the case of a prosecution for a fisheries offence, though, if EMS data is the only evidence available to the prosecution, there is surely a question mark as to whether that evidence would be accepted by the court as proving the case beyond reasonable doubt. At the very least, in order to facilitate the routine use of EMS data and to mitigate the risk of failed prosecutions, it would be advisable to amend the Fisheries Act so as

to provide that unless the contrary is proved the recording was taken on the date and time identified by the EMS device.[13]

(2) What changes may be necessary to address potential legal constraints or other impacts on the use of such technologies?

The use of EMS also raises important data protection issues. Ghana has data protection legislation in place in the form of the Data Protection Act of 2012 (the 'DPA') and the right to privacy is expressly recognised in article 18 of Ghana's Constitution.

The DPA is a comprehensive text comprising 99 sections on 43 pages. It applies to 'personal data' which is defined to mean 'personal data which consists of information that relates to: (a) the race, colour, ethnic or tribal origin of the data subject; (b) the political opinions of the data subject; (c) the religious beliefs or other beliefs of the data subject; (d) the physical, medical, mental health or mental condition or DNA of the data subject; (e) the sexual orientation of the data subject; (f) the commission or alleged commission of an offence by the individual; or (g) proceedings for an offence committed or alleged to have been committed by the individual, the disposal of such proceedings or the sentence of any court in the proceedings (section 96).

As to the meaning of 'data', this 'means information which is: (a) processed by means of equipment operating automatically in response to instructions given for that purpose; (b) is recorded with the intention that it should be processed by means of such equipment; (c) is recorded as part of a relevant filing system or with the intention that it should form part of a relevant filing system; or (d) does not fall within paragraphs (a), (b) or (c) but forms part of an accessible record (section 96).

While the DPA does not explicitly refer to CCTV or EM technologies it is clear that the data implications of the use of such systems fall within the ambit of the act, which also applies to VMS.

At the outset it is important to emphasize that the DPA does not prevent the introduction of an EMS. What it does do, though, is to set out relatively strict rules and procedures as to how this can be lawfully done.

Key to understanding the approach of the DPA are the 'data protection principles' set out in sections 17 to 26 of the act. These have clear implications for the design and implementation of an EMS.

Section 17 provides that a person who processes data must take account of the following principles:

(a) accountability;
(b) lawfulness of processing;
(c) specification of purpose;
(d) compatibility of further processing with purpose of collection;
(e) quality of information;
(f) openness;
(g) data security safeguards;
(h) data subject participation.

The notion of 'processing' is also defined in section 96 and means 'an operation or activity or set of operations by automatic or other means that concerns data or personal data and the (a)

[13] Of course there are numerous options for Ghana in terms of updating the Fisheries Act to deal with future technological advances, the discussion of which goes beyond the scope of this report.

collection, organisation, adaption or alteration of the information or data, (b) retrieval, consultation, or use of the information or data, (c) disclosure of the information or data by transmission, dissemination or other means available, or (d) alignment, combination blocking, erasure or destruction or information or data;'.

In other words the operation of the EMS must take into account these principles.

Section 18 provides that a person who processes personal data must ensure that the personal data is processed: (a) without infringing the privacy rights of the data subject; (b) in a lawful manner; and (c) in a reasonable manner. It goes on to provide that personal data received from a foreign jurisdiction must be processed in compliance with the data protection legislation of the jurisdiction.

Section 19 of the DPA provides that personal data may only be processed if the purpose for which it is to be processed, is necessary, relevant and not excessive. In the context of the EMS, which will gather a large amount of recorded material, it will be necessary to ensure that cameras cover only the operational parts of fishing vessels and not, for example living quarters or mess areas.

Section 20 is concerned with issues of consent, justification and objection. More specifically, paragraph (1) provides that personal data must not be processed without the prior consent of the data subject unless the purpose for which the personal data is processed is:

(a) necessary for the purpose of a contract to which the data subject is a party;
(b) authorised or required by law;
(c) to protect a legitimate interest of the data subject
(d) necessary for the proper performance of a statutory duty; or
(e) necessary to pursue the legitimate interest of the data controller or a third party to whom the data is supplied

Paragraph (2) provides that a data subject (which is defined in section to mean a person who is the subject of personal data) can object to the processing of his or her personal data unless this is otherwise provided by law. In such a case, the person who processes the personal data must stop doing so.

It follows that as regards the existing EMS pilot projects the consent of crew members is required. This could be an explicit signed document to that effect (in the form or a waiver) or contained in the relevant employment contracts.

In the future though, if EMS is required by law, through an amendment to the Fisheries Regulations, it would seem that individual consent may not be required (although this is an issue still needs to be clarified with the Data Protection Commission, the data regulatory body established under the DPA).

Section 21(1) provides that data must be collected directly from the data subject and not indirectly from another source, although section 21(2) goes on to provide a number of exceptions to that rule. In the context of EMS, where the data will collected directly through the use of video cameras, this does not seem to create a particular issue.

Section 22 states that a data controller who collects personal data must collect the data for a purpose which is specific, explicitly defined and lawful and is related to the functions or activity of the person.

The term 'data controller' is defined to mean a person who either alone, jointly or in common with other persons or as a statutory duty determines the purposes for the manner in which personal data is processed or is to be processed. In the other words the data controller is the

person who is legally responsible for how the data is sued. In the context of an EMS this would be the Fisheries Commission or, more specifically a unit within the Fisheries Commission.

Such an entity would be responsible for ensuring that personal data collected through an EMS for the purpose, say, of improved MCS is only be used for that purpose. Such a purpose, in a regulatory context, would ordinarily be specified in the instrument requiring the collection of such data (such as an amendment to the Fisheries Regulations).

Section 23 provides that a data controller who collects data must take the necessary steps to ensure that the data subject is aware of the purpose for the collection of the data. In other words, under an EMS, the Fisheries Commission as data controller would need to ensure that fishing vessel crews are informed of the fact that they are being filmed. This could be done by requiring the relevant fishing vessels to display a sign on board.

Section 24 is concerned with the retention of records. It provides that with the exception of data retained for historical, statistical or research purposes (which are not purposes for which personal data would be acquired under EMS), a data controller who records personal data must not retain that data for a period longer than is necessary to achieve the purpose for which the data was collected and processed unless this required by law, reasonably necessary for some lawful purpose, required by contract or the data subject consents.

Paragraph (4) provides that a person who uses a record of the personal data of a data subject to make a decision about the data subject must (a) retain the record for a period required or prescribed by law or a code of conduct, or (b) where there is no law or code of conduct that provides for the retention period, retain the record for a period which will afford the data subject an opportunity to request access to the record.

Otherwise a data controller must destroy or delete a record of personal data or de-identify the record at the expiry of the retention period and this must be done in a manner that prevents its reconstruction in an intelligible form. In other words in the context of an EMS it will be necessary for the data controller to develop a policy as to how long EMS data is to be retained and also as to how it is to be destroyed. Presumably if the data provides *prima facie* evidence of wrongdoing it would be retained pending a decision on prosecution.

Section 25 is concerned with the further processing personal data. In outline such further processing must be compatible with the purposes for which the data was originally collected. In the context of an EMS, under which data is collected or MCS purpose, this provision probably has little relevance.

Section 26 on the other hand provides that a data controller who processes personal data must ensure that the data is complete, accurate, up to date and not misleading having regard to the purpose for the collection or processing of the personal data. In other words strict quality control must be built into an EMS.

Moreover pursuant to section 27 every data controller who intends to process personal data must register with the DPC. Section 27(2) provides that such a data controller must also ensure that the data subject is aware of various aspects of the data collection process, although this requirement does not apply in situations where it is necessary *inter alia* for the enforcement of a law which imposes a pecuniary penalty.

Section 28 provides that a data controller must take the necessary steps to secure the integrity of personal data in the possession or control of a person through the adoption of appropriate, reasonable, technical and organisational measures to prevent (a) loss of, damage to, or unauthorised destruction; and (b) unlawful access to or unauthorised processing of personal data.

To this end the data controller must take reasonable measures to:

(a) identify reasonably foreseeable internal and external risks to personal data under that person's possession or control;

(b) establish and maintain appropriate safeguards against the identified risks;

(c) regularly verify that the safeguards are effectively implemented; and

(d) ensure that the safeguards are continually updated in response to new risks or deficiencies.

Additionally a data controller must observe generally accepted information security practices and procedure, and specific industry or professional rules and regulations.

Section 29 is concerned with the duties of a 'data processor' or an authorised person. A 'data processor' is defined in relation to personal data as any person other than an employee or the data processor who processes the data on behalf of the data controller. Such a person must process the data only with the prior knowledge or authorisation of the data controller and treat such data as confidential. Moreover a data process must not disclose the data unless required by law or in the course of discharging a (legal) duty.

In conclusion, while the DPA does not prevent or constrain the use of EMS technologies, it does clearly set out a relatively detailed legal framework as to how data derived from EMS is to be managed. In particular such data can only be used for the specific purpose, or purposes, for which it is collected. Overall, though, the requirements of the DPA with regard to EMS should not be any more onerous than those already applicable to VMS data.

3.5 (F) What cost recovery methodologies could be employed to ensure the long-term sustainability of the purchase, maintenance, and operation of the EM technologies?

There are a range of objectives and justifications behind cost-recovery approaches. For example, where services seem to not derive any obvious market value to the private sector, it could be argued that through positive externalities, provision of such services by the government could generate higher earnings for the private sector. In this case, a Government agency may seek to recover costs on the grounds that the service will actually provide an overall net-benefit to the private sector and therefore, they should pay for it. This particular business case falls into this category, so it is assumed that the programme is to be completely cost-recovered.

To achieve total cost-recovery, all costs attributable to the delivery of services by the Government agency should be calculated and recovered under an equitable 'user pays' arrangement with industry. This includes not only the direct costs – such as installation costs, travel, video footage analysis – but also indirect costs such as funding observer and coordinators, debriefing, data entry, office accommodations, communications and administrative equipment. Therefore, it will be important to isolate the additional costs specific to this service from the general costs of the agency's mandated standard operations.

Section 3.6 provides suggested payment structures for cost recovery. It is then followed by sections with details of possible timing and collection agencies required for payment.

3.6 Payment models

Ultimately, the structure of payments, their intervals, and what payments are made by which party should be decided through consultation between industry and national authorities. Nevertheless, some potential scenarios are presented below; all of which will result in full cost recovery.

To better inform cost recovery options, the results from section 3.3.2 have been restructured to understand an annualised cost per vessel. Assuming the number of active vessels remains at 14[14], the total annual costs over the programme per vessel over five years is shown in Table 9. Details of the different rows and their implications are discussed further in the following sections.

Table 9 Total programme costs (US$) over a five-year period (per vessel costs assume n = 17)

Year	0	1	2	3	4	5
1) Total programme costs	*403,250*	*151,580*	*151,580*	*151,580*	*151,580*	*151,580*
2) Vessel cost	23,721	8,916	8,916	8,916	8,916	8,916
3) Vessel cost for Govt recovery[15]	23,721	7,281	7,281	7,281	7,281	7,281
4) Annualised vessel cost	11,384	11,384	11,384	11,384	11,384	11,384
5) Annualised vessel cost for recovery	10,021	10,021	10,021	10,021	10,021	10,021

NB: these are costs only; no benefits have been included.

3.6.1 Upfront risk taken by industry

It could be designed that a condition of entry to the fishery is to have EMS installed which is compatible with the Ghanaian system. In this case, all onboard installation costs would be incurred by industry and national authorities would only need to recover the incremental service delivery costs. This approach would be similar to a fishery which requires VMS equipment as a condition of entry. The cost schedule for this approach to industry would be combination of option 2) and 3) in Table 9.

Under this approach, it should be recognised that industry will be expected to absorb the majority of the risk. Furthermore, it is unclear if such systems are required in immediately surrounding fisheries. It has been demonstrated in the WCPO fisheries, that systems would generally have a very short-term impact on one nation's compliance if they were the only ones imposing such requirements. It can be inferred that this would also be the case in the Atlantic. Unless there are barriers to leaving, or other incentives, rational companies would simply move to another country which is not imposing that level of monitoring (or associated cost). Therefore, it may be a disincentive to operate in the fishery, if all risk is laid upfront on industry and there are competing fisheries without these requirements.

3.6.2 Initial costs borne by government authority

Having a system which is paid for upfront by government agencies, but later cost recovered, may be viewed as more equitable by industry and allows for relatively constant payments associated with licence fees. Under option 5) in Table 9, the cost of the programme is spread across a system's expected lifetime (5 years of operations and an initial cost of entry). The difference between option 4) and option 5) is the cost already internalised by industry staff.

When a vessel chooses to enter the fishery, the relevant national authority will provide the vessel with the necessary systems and services. Whilst not all the initial cost will be recovered immediately, the subsequent years of access to the fishery net this out.

[14] Minor efficiencies could be gained by increases in vessel numbers, but a large proportion of the costs will increase relative the number of vessels in the programme.

[15] This row acknowledges that some estimated programme costs are already internalised by the private sector.

Some risk will be borne by the government if there is high turnover of vessels in the fleet, this does not seem to be the case in Ghana at present. Though there has recently been a change of operators in Ghana, the vessels themselves have remained the same. However, with government ownership of the systems, conditions could be placed to pay for removal of a system if it was installed and licenses to fish are taken up for less than a defined period.

As discussed above, the benefit to this approach is a relatively constant user-pays system. Whilst taking on some risk by only collecting a portion of the installation cost upfront, there will be reduced administrative burden for the government in trying to track which vessels need to pay which amounts based on their current year in the programme.

3.7 Fixed and variable components

If there is high variability in the number of days spent at sea by different vessels, it may be worth considering an equitable payment system based on fixed and variable components. This can be achieved because there are quite defined fixed and variable costs associated with the programme (e.g, EMS equipment: fixed; sea day video analysis: variable). However, it should be noted that the administrative burden is substantially increased in this scenario, so it should be well-justified before being implemented. Currently this is not the case in Ghana with most vessels operating with a trip length of between 35 and 40 days.

3.8 Fee collection agency

If the system is to be truly cost-recovered, the actual agency through which fees are collected may need to be considered. Depending on the country, different risks on the money being allocated appropriately may exist between fees passing directly through central government revenue or a specific authority (such as the Fisheries Commission). Notwithstanding this, there may also be legislative barriers which force a specific decision on the issue.

Regardless of the collection agency, it appears to be industry's preference that the fee be paid as a single fee at the same time as any fishery access fee. Structuring it as a levy in this sense also makes it clear of changes in any other collection method (such as export or income taxes).

3.9 Conditions of entry linked to payment

As discussed in section 3.4, there is a legislative basis for collecting required fees as a condition of access to a fishery. Effectively and comprehensively applying this condition will be critical to the success of recovering the system's cost. The above sections have provided ample analysis and estimates of the programme costs to be recovered. However, this must be underpinned by effective institutional arrangements and the political will to restrict access to this fishery unless all fees are paid.

3.10 Legal Considerations for Cost Recovery

In terms of the funding of a mandatory EMS simply requiring specified types of Ghanaian fishing vessel not to proceed to sea without an appropriate working EMS device on board (along the lines of Regulation 42 of the Fisheries Regulations with regard to VMS) would clearly impose the costs of the installation and operation of such a device on the vessel owner.

With regard to the FC's own costs of managing the EMS, section 36 of the Fisheries Act provides for the establishment of a Fisheries Fund, which is to be applied, among other matters, to meet the liabilities of the FC in respect of MCS in Ghana's fishery waters (section 38 (b)). The sources of income for the fund include fees for licenses, permits and other authorisation for fishing issued under the Act (section 37 (a)). In the absence of full information

about how such fees are currently calculated, there does not seem to be any legal reason why license fees for vessels subject to EMS could not be increased so as to fully or partially offset the corresponding increased costs of the FC.

4 Conclusions and Recommendations

4.1 Level of Efficiency

The current level of efficiency of some aspects of the implementation of the EMS could be improved. The time recorded as used by the land observers for review of video footage and report generation is one quarter of the sea days of a particular trip on average since the inception of the programme. This compares very well with DOS when also reviewing footage from the same EMS who do not meet this rate despite the difference in the level of experience between the two. This may call in to question the review time given. Currently there does not appear to be a computerised log of active review time, though it should be possible for this type of function to be built in in the future. This would allow an independent record of review time and could have a significant effect on the prevention of misreporting of time review time in the future.

Some sections of industry also expressed doubts regarding the level of accuracy of the data and reports generated by the FC from the EMS. So much so that TTV (Thai Union) had continued to pay separately for DOS to independently review the same footage that is reviewed by the EMS team of the FC following the inception of the pilot project and prior to recently selling the fleet.

4.2 Level of Integration between Monitoring Programmes

The FC operates a number of monitoring programmes of the tuna purse seine fleet;

- Land Observers (EMS)
- At sea Observers
- VMS
- Port Sampling

Currently there is no integration between the EMS and VMS unless there is a particular infraction or anomaly detected by the land observers. This is not such a critical aspect as a large number of robust safe guards exist that prevent interference with the positional reporting of the EMS.

There is no integration between the at sea observer programme and the land observers analysing the footage. There is scope for comparisons between these programmes given that both have 100% coverage of the fleet. It had been indicated in a previous report and during the site visit that these comparative studies were due to have begun some time ago, but to date no progress has been made. Comparisons of estimates of catch by species, particularly bycatch would be the main areas that both programmes would overlap to a required degree. These analyses could also incorporate logbook records and port sampling. This would provide valuable cross referencing even though the programmes have different goals. These studies could also be used to demonstrate the level of accuracy of the different programmes and could be linked to a series of randomly chosen trips to be also analysed by DOS as part of the programme of review audits (Section 4.3).

Another area where complementary work could be done between the at sea observer programme and the EMS is FAD activity. This aspect could be important given the seasonal FAD moratorium in place in the Gulf of Guinea. ICCAT Recommendation 16-01 prohibits the launching, removal from the moratorium area and fishing associated with a man-made or natural FAD. Checking on FADs is permitted during this time.

Should the EMS implementation be continued in the future, then some functions of the at sea observer programme, such as recording the position of the catch, or the overall catch estimate,

could be covered by the EMS and the at sea programme could solely concentrate on scientific functions.

4.3 Remote Data Review by DOS

For the course of pilot project, 16 remote data reviews were scheduled to have been conducted by DOS in order to cross check and verify the observations made by the Ghanaian land observer team. However, footage enabling review of only two trips was sent to DOS (once in 2015 & once in 2016). It is recommended that this process be fulfilled in the near future in order to provide independent quality control on the outputs of the EMS. It is understood that this would require the signing of a non-disclosure agreement with DOS which has not been completed yet. The pilot project could have been implemented in a stronger fashion had this aspect that was budgeted for had been carried out.

4.4 Strengthening Competence

The level of competence and efficiency of the land observer team reviewing the footage could be improved by embedding a trainer from DOS with the team for a period of one to two weeks depending on willingness and an allowable budget. This would serve a dual purpose of strengthening review and improving computer skills of the team as well as addressing the issues of absenteeism and supervision, albeit in the short term.

As described in Section 3.1.3, the storage and chain of custody of HDDs containing analysed and unanalysed footage is not currently secure. Given that on occasions during the site visit it was possible to enter these unmanned offices without meeting anybody on route, the security of the storage of the HDDs needs to be strengthened.

4.5 Cost Benefit Conclusions and Limitations

The CBA results are based on the assumption following consultation in Ghana that the primary benefit recognised by installing EMS is the lifting of the EU yellow card, avoiding an EU red card, and thus continued access to European markets. Where fisheries are not currently subject to EU yellow cards (or red cards), this analysis, and its outcomes, may not apply. This is not to suggest these are the only benefits that can be experienced through installing EMS (see MRAG, 2016)[16], more so that this was the overwhelming benefit raised during consultation. There are other considerable other quantitative benefits that can be for installing EMS such as the control of collaborative fishing and deterrence of illegal transhipments.

The presence of cameras on board can lead to improvements in monitoring crew safety and evidence collection. This benefit exists from a number of perspectives. For example, constant video monitoring can act as a deterrent to abusive behaviour towards crew. Alternatively, this video evidence has supported vessel operators where there was suspicion of foul play which was later proven not to be the case.

Numerous sources have indicated that monitoring operations through EMS are also expected to increase voluntary compliance (e.g., MPI NZ, 2016)[17]. However, quantifying this benefit can be difficult given the lack of a clear counterfactual. Nevertheless, one approach can be

[16]Opt cite

[17]https://www.mpi.govt.nz/dmsdocument/14668-the-future-of-our-fisheries-volume-iii-integrated-electronic-monitoring-and-reporting-system

found in MRAG Asia Pacific (2016)[18] where the benefits of increased compliance are measured by the impact it can have on stock status.

The increased monitoring, and thus management of the fishery, can also enhance the possibility of the fishery becoming certified under numerous sustainable fisheries certifications. This can lead to market access and, under the right circumstances, price premium benefits. A method to quantify this market access and price premium benefit was constructed in MRAG Asia Pacific (2015)[19].

4.6 Legal Aspects

In order to allow the full implementation of EM technologies in the Ghanaian purse seine fleet as an MCS tool it will be necessary to amend the existing Fisheries Regulations through the adoption of a separate set of amending regulations. These would need to provide for the mandatory installation and operation of EMS equipment on specified vessel types (e.g. purse seiners) as well as such matters as the procedure for the recuperation of hard disks, periodic reviews, ownership of the intellectual property in the data and the management of such data by the FC.

However because fisheries offenses in Ghana are prosecuted under criminal law, given the particular requirement of the rules of evidence relating to criminal offenses, if data from EMS equipment will be substantially the only evidence available to the prosecution it is suggested that a suitable amendment should be made to the Fisheries Act concerning the admissibility of EMS images along with relevant data showing the time and place of recording and to effectively reverse the burden of proof with regard to challenges to the accuracy of such data.

The use of EM technologies also raises important data protection issues. The existing data protection legislation does not prevent the full introduction of EM technologies in the fisheries sector but rather clearly sets out how such data is to be managed and used. In other words new legislation for EMS and the implementation of that legislation will need to be carefully aligned with the data protection legislation.

[18] https://www.wcpfc.int/system/files/WCPFC-2016-FADMgmtOptions-IWG02-04%20FAD%20Marking%20and%20Monitoring%20report%20final%20draft%20for%20circulation.pdf

[19] MRAG Asia Pacific (2015) Economic analysis of MSC fishery certification: Scoping study of the variables. A report to the Marine Stewardship Council. MRAG Asia Pacific, Brisbane, Australia.

5 References

Banks, R., Muldoon, G. and Fernandez, V. (2016). “Analysis of the cost and benefits of electronic tracking, monitoring and reporting systems applied in FFA countries and identification of the required legislative, regulatory and policy supporting requirements”. WWF – Poseidon Aquatic Resources Management Ltd.

Monteagudo, J.P., Legorburu, G., Justel-Rubio, Q. & Restrepo, V. (2014). Preliminary study about the suitability of an electronic monitoring system to record scientific and other information from the tropical tuna purse seine fishery. IOTC-2014-WPEB10-INF19

Republic of Ghana. (2015). Memorandum of Understanding for Implementation of Electronic Monitoring System (EMS) on board Tuna Purse Seine Vessels in Ghana.

Restrepo, V., Ariz, J., Ruiz, J., Justel-Rubio, A., Chavance, P. (2014) Updated Guidance on Electronic Monitoring systems for Tropical Tuna Purse Seine Fisheries, ISSF Technical Report 2014-08. https://iss-foundation.org/knowledge-tools/technical-and-meeting-reports/download-info/issf-technical-report-2014-08-updated-guidance-on-electronic-monitoring-systems-for-tropical-tuna-purse-seine-fisheries/

Ruiz, J., Batty, A., Chavance, P., McElderry, H., Restrepo, V., Sharples, P., Santos, J., Urtizberea, A. (2015). Electronic monitoring trials on in the tropical tuna purse-seine fishery. ICES J. Mar. Sci. (2014) doi: 10.1093/icesjms/fsu224

Recommendation by ICCAT on a multi-annual Conservation and Management Programme for Tropical Tunas16-01, 2016. http://iccat.int/Documents/Recs/compendiopdf-e/2016-01-e.pdf

Schedule of Prices, Digital Observer Services, 2017,

MRAG 2015. DOS Electronic Monitoring System Assessment against ISSF Requirements Phase 1 Report.

MRAG 2015. DOS Electronic Monitoring System Assessment against ISSF Requirements Phase 3 Report.

MRAG 2015. DOS Electronic Monitoring System Assessment against ISSF Requirements Phase 4 Report.

Annex 1 Survey Forms for Questions A & B

MCS Management Personnel Questions: MCS Director Godfrey Baidoo (questionnaire completed remotely)		
EMS	**Considerations**	**Answers provided**
Final report template	Can I have a copy? Is there any other relevant documents? Is there further development planned on this aspect of documentation?	
Fleet Summary report template		
EMS Control sheet template		
Data Backup and Restoration: Has there been any issues with data management to date? Has there been any cases where data was lost/corrupted and restoration required?	If data restoration did occur, please describe the process. Was it successful?	No. We have not had any issues with data management to date. The issue about how to keep data on the HDD longer in case the need to make reference to it later. It will be appreciated if the EMS data could be stored on a dedicated server.
Are you happy with the quality of outputs of the EMS team?		Yes, we are happy with the outputs of the EMS team. We have timely and quality responses from the project management, SATLINK and DOS.
Do you think you currently have enough skilled staff for the EMS?	Including reviewers & IT support	The current staff strength is okay. As time goes on the staff have improved their capacity in the analysis of EMS data in terms of output and quality.
Do you think the EMS is being supported sufficiently by the current agreement with Satlink?	Including all technical aspects, and the technician based in Ghana	Satlink's support to the EMS is appreciated. The locally based Satlink staff is effective in dealing with the technical issues.

MCS Management Personnel Questions: MCS Director Godfrey Baidoo (questionnaire completed remotely)		
EMS	**Considerations**	**Answers provided**
Has the EMS already been used for enforcement purposes?	If so, what has been the outcome?	The EMS reports are being shared with the operators and issues of non-compliance with national and international legislations are brought to their attention for corrective actions to be put in place. The operators and their crew have shown improvement in minimizing incidents of non-compliance.
If not, how soon do you see this occuring in the future?	After completion of the pilot?	Ghana is reviewing the Fisheries legislation to accommodate EMS and will be used for enforcement when it comes into force.

Interviewee: Land Observer Team Leader – Mr Richard Yeboah		
Land Observers	**Considerations**	**On site answers**
Staffing & Training		
Recruitment criteria and land observer required skill sets	What are the minimum entry requirements? Experience at sea on purse seine vessels is a must. How is species ID tested.	1st degree related to fisheries, biology or relevant degree, IT skills are a must. ID materials are provided, port sampling & in house training on ID provided.
Training - initial	Cost to be determined. Who conducts this?	Training conducted offsite, at a total cost 10,00USD for a week course for 10, this figure includes accommodation & subsistence. The cost of the trainer provided by DOS was covered by the ABNJ project.
Training - ongoing	Determine ongoing training plan	None scheduled, likely to occur when there is a major update to the SatLink system.
Retention rate	Also to consider temporary workers	N/A, very settled team, recruitment happens very occasionally.
Staffing rate relative to volume of footage	Reporting deadlines and protocols	Review time is to be no more than 1/3 of sea days with reporting deadlines linked to this.
Recruitment procedures	Is there any expansion planned?	Not at the moment.

Staff management	This is related to demand and growth. How are spikes in activity managed? Are there established limits of working hours?	Some staff are assigned to the EMS team on a part time basis, this ratio can be changed by the Team Leader when there is increased demand. Monthly salaries as follows; • Team Leader 250 USD (has other role apart from EMS) • Full time land observer (n=2) 400 USD • Part time land observer (n=2) 178 USD (has other role apart from EMS) • IT technician (n=1) 178 USD (has other role apart from EMS) Demand does drop off as a result of the FAD moratorium where many vessels cease fishing.
Staff insurance	What is the cost per annum?	N/A
Technical Procedures		
Video review policy/protocols	Is it possible to get a copy of any written protocols?	not at the moment, to be developed
Quality assurance and sign off procedure		Responsibility is Richard Yeboah's to cross check and sign off
Data handling procedures		not at the moment, to be developed
Review time per trip	Reporting deadlines and protocols	1/3 of sea days allowed for review and report generation.
Video Analysis (Fishing Operations)		
Fishing set determination	Determine MOFAD's level of priorities for this list. Is the size measurement tool performing satisfactorily?	yes
Fishing set type determination		yes

FAD deployment determination	What other biological sampling requirements/goals are there for MOFAD? How is this complemented with other programmes, i.e., scientific observers, in port sampling and monitoring.	yes
Other FAD activity determination		yes
Estimation of total catch		yes
Catch composition		yes
Size composition		opportunistic
Large bycatch monitoring		yes
Small bycatch monitoring		yes
Discard of target species and bycatch		yes
Handling of PET species		yes, specific video capture will be taken.
Well storage and catch traceability		yes, for all sets
Fishing Effort		Yes, sea days and fishing days are logged in the report.
Monitoring		
What in trip monitoring requirements are there?		None, they are provided with HDD by Stalink technician based in Tema.
What system health checks fall under the remit of the land observers?		None, this is currently conducted by Satlink under their contract with FAO.
Are VMS checks incorporated in any process by the team?		Only when a potential infraction or anomaly is detected by the land observers.
Reporting		
How are reports extracted?	Does this require manual inputting or are data extracted from the table	Manually, notes taken during review, totalled manually in xl and then the final report is produced.
Are reports corroborated against secondary tests (i.e., position), and if so how?		Only when a potential infraction or anomaly is detected by the land observers.
Facilities		

Office facilities		No data provided.
IT equipment		Most equipment provided by ABNJ project.
Insurance		No data provided.
Maintenance & Running Costs (IT & Office equipment)		No data provided.
Other		
Are there any currently known deficiences of the programme?		Camera resolution and field of view could be improved.
Level of integration with at sea observers		None

Further questions sent to the Fisheries Commission that were not answered		
Land Observers	**Considerations**	**On site answers**
Facilities		
Office facilities	only those dedicated to the EMS	
IT equipment	project & IT tech	
Insurance	only those dedicated to the EMS	
Maintenance & Running Costs (IT & Office equipment)	IT tech, electricity bill for the year	

EMS	**Considerations**	**On site answers**
EMS Control sheet template		

General	**Considerations**	**On site answers**
How would you like to see EMS funded beyond the pilot?		
Do you see cost recovery happening through the licence fee?		
Are you happy with the quality of outputs of the EMS team?		
What is the level of export taxes?		
What is the company tax rate in Ghana?		
What are the main export markets for Ghanaian tuna?		

Annex 2 EMS Reporting Templates

Title of the Trip

EMS REVIEW – TRIP REPORT

Vessel name:	
Trip number:	
Reviewer:	

I. TRIP INFORMATION

Departure	Date	
	Port	
Arrival	Date	
	Port	

Map of the trip

II. REVIEW INFORMATION

HDD1	Serial number	
	Date loaded	
	Date retrieved	
HHD2	Serial number	
	Date loaded	
	Date retrieved	
HHD3	Serial number	
	Date loaded	
	Date retrieved	
HHD4	Serial number	
	Date loaded	
	Date retrieved	

Review	Starting date	
	End date	
	Land-based Observer	

III. EFFORT

a) Fishing days

Fishing days	
Non-fishing days	
Total days trip	

Comments:
If non fishing days, explain the reason (breakdown, bad weather, etc.)

Non-fishing days included the day of departure, night drift, deployment of FADs and day of arrival.

b) Fishing sets

	Free School	**FAD**	**Total**
Positive Sets			
Null Sets			

TOTAL			

c) FADs

Nb. of FADs deployed		
Nb. Of FADs retrieved		
Nb. Of FADs visited		
Nb. Of FADs catch		
Nb. Of FADs transferred		

IV. ESTIMATED CATCH

a) Target species

	FS	**COLLABORATION**	**FAD**	**TOTAL**
SKJ				
YFT				
BET				
FRI				
TOTAL				

b) Bycatch

Total bycatch species, retained or discarded)

	FS		**FAD**		**TOTAL**	
	Qtity	Unit (weight or number)	Qtity	Unit (number)	Qtity	Unit (number)
RUB						
RRU						
TRI						
DOL						
WAH						
BIL						
TTX						
FAL						
BUM						
GBA						

MOX			
TOTAL			

c) Discards

d) *Quantities of target and bycatch species discarded*

There were no discards of tuna during trip

V. Compliance with national and regional requirements

	Yes	No	Comments
ICCAT Rec. 04-10			
Full utilisation of sharks caught (excepting head, guts and skins)			
ICCAT Rec. 09-07			
Bigeye thresher caught			
Release of all bigeye thresher sharks caught unharmed			
Release of all other thresher sharks caught unharmed			
ICCAT Rec. 10-06 (*if Ghana is not reporting T1 data for shortfin mako)*			
Shortfin mako sharks (*Isurus oxyrinchus)* caught			
Release of all shortfin mako (*Isurus oxyrinchus)* caught unharmed			
ICCAT Rec. 10-07			
Oceanic whitetip sharks (*Carcharhinus longimanus*) caught			
Release of all oceanic whitetip (*Carcharhinus longimanus)* sharks caught unharmed			
ICCAT Rec. 10-08			
Hammerhead sharks *(Sphyrnidae)* caught			
Release of all harmmerhead sharks (*Sphyrnidae)* caught			
ICCAT Rec. 10-09			
Encirclement of marine turtles			
Release of marine turtles unharmed			
ICCAT Rec.10-10			
Observer on board during the trip			

ICCAT Rec. 11-08			
Silky sharks (*Carcharhinus falciformis*) caught			
Release of all silky sharks (*Carcharhinus falciformis*) caught unharmed			
ICCAT Rec. 12-06			
Transhipment at sea			
ICCAT Rec. 14-01			
Activities in area/time closure			
- Launch of floating object in area/time closure			
- Fishing around object, including vessel in area/time closure			
- Fishing around logs, in area/time closure			
- Towing objects from inside to outside the area-time closure			
- Observer on-board when engaged in fishing activities during the time/area closure			
Use of non-entangling FADs			
Fisheries ACT 625 (Amend.) ACT 2014 & Fisheries Regulations 2010 (L.I.1968)			
Fishing without licence, authorisation, permit			
Fishing in a closed area			
Use prohibited or non-compliant fishing gear			
Taken on board, transhipped or landed undersized fish			
Polluted fishing waters			
Dumped fish into the sea			
Endangered species caught			

COMMENTS

ANNEX

	Summary trip report for EMS project				
TRIP IDENTIFICATION		Vessel Name	Panofi Master		
		Trip number			
	DEPARTURE	Date			
		Port			
	ARRIVAL	Date			
		Port			
IDENT. HDD	EXTRACTING HDD	Date			
		By			
		Serial Number			
DATA ANALYSIS		Starting Date			
		End date			
		By who			

ESTIMATION TOTAL CATCH	FAD	YFT		FREE SCHOOL	
		SKJ			
		BET			
		Other			
		Other			
	COLLABORATION	YFT			
		SKJ			
		BET			
		Other			
TOTAL BY-CATCH		spp1(RUB)		Spp6 (DOL)	
		spp2(RRU)		Spp7(BIL)	
		Spp3(TRI)		Spp8(MOX)	
		Spp4(WAH)		Spp9(GBA)	
		Spp5 (FAL)		Spp1(BUM)	
DISCARD AT SEA		spp1			
		spp2			
		spp3			
FAD	NB. FAD VISITED				
	NB. FAD DEPLOYED				
	TRANSHIPMENT NOTED				
	CARRIER VESSEL OBSERVED				

Annex 3 Relevant Ghanaian Legislation & ICCAT Recommendations

Fisheries Compliances Issues	ICCAT	Ghana
	Recommendation	Law
Fishing License	15-1 (25) TRO	88A(1l) (FA 880, 2014) 88A(1m) (FA 880, 2014) 2(1) (FR L.I. 1968, 2010) 4(1) (FR L.I. 1968, 2010) 24 (FR L.I. 1968, 2010)
Vessel Monitoring System (VMS)	14-09 GEN	88A (1a) (FA 880, 2014) 42(FR L.I. 1968, 2010) 43 (FR L.I. 1968, 2010)
Data Transmission	14-09 GEN	45 (FR L.I. 1968, 2010) 46 (FR L.I. 1968, 2010) 47 (FR L.I. 1968, 2010) 48 (FR L.I. 1968, 2010)
Observer on board / Inspector	15-1 (37) TRO 15-1 (38) TRO	35 (FR L.I. 1968, 2010) 37 (FR L.I. 1968, 2010)
FADs	15-1 (13) TRO 15-1 (14) TRO 15-1 (16) TRO 15-1 (20) TRO 15-1 (21) TRO 15-1 (22) TRO 15-1 (23) TRO 15-1 (24) TRO	21 (FR L.I. 1968, 2010)
Mesh		12(2) (FR L.I. 1968, 2010)
By catch		31 (FR L.I. 1968, 2010)

Fisheries Compliances Issues			ICCAT	Ghana
			Recommendation	Law
Discard (Dumping at sea)				32(1a) (FR L.I. 1968, 2010)
	Non-commercial size	Juvenile		88A(1j) (FA 880, 2014) 14 (FR L.I. 1968, 2010) - TABLA 1 (FR L.I. 1968, 2010) 32(1a) (FR L.I. 1968, 2010)
	Bycatch species			32(1a) (FR L.I. 1968, 2010)
	Endangered species		10-09 11-08 11-10 12-05 13-10 13-11 14-06	16(2) (FR L.I. 1968, 2010) 17 (FR L.I. 1968, 2010)
	Other species			32(1a) (FR L.I. 1968, 2010)
Landed				31 (FR L.I. 1968, 2010)
	Non-commercial size	Juvenile		88A(1j) (FA 880, 2014) 14 (FR L.I. 1968, 2010) - TABLA 1 (FR L.I. 1968, 2010)
	Bycatch species			31 (FR L.I. 1968, 2010)
Fish size	Commercial size			14 (FR L.I. 1968, 2010) - TABLA 1 (FR L.I. 1968, 2010)
Transhipment			12-06 GEN	88A(1j) (FA 880, 2014) 33 (FR L.I. 1968, 2010)
Fishing Logbooks			15-1 (33) TRO	50 (FR L.I. 1968, 2010)
IUU				88A (1) (FA 880, 2014)
	records and reports catch data			88A (1b) (FA 880, 2014)
	Fishing in closed area or season		15-1 (13) TRO 15-1 (14) TRO	88A(1c, e) (FA 880, 2014)
	Falsified fishing vessel documents			88A(1d) (FA 880, 2014)

Fisheries Compliances Issues	ICCAT	Ghana
	Recommendation	Law
Prohibited fishing gear and method		88A(1f) (FA 880, 2014) 11(1c) (FR L.I. 1968, 2010)
Fishing vessel with falsified identification		88A(1g) (FA 880, 2014)
Concealment, tampering to an investigation		88A(1h) (FA 880, 2014)
obstruction to inspection a fishing vessel		88A(1i) (FA 880, 2014)
Unregulated Transhipment		88A(1k) (FA 880, 2014)
Fishing activity with an IUU fishing vessel		88A(1n) (FA 880, 2014)
Company conducting business with IUU fish and products		88A(1o) (FA 880, 2014)

Annex 4 Cost-benefit model in detail

Item	0	1	2	3	4	5
Scenario						
Catch						
SKJ		38,049	38,049	38,049	38,049	38,049
YFT		7,369	7,369	7,369	7,369	7,369
BET		7,965	7,965	7,965	7,965	7,965
Price (EU Eligible)						
SKJ		1,380	1,380	1,380	1,380	1,380
YFT		1,780	1,780	1,780	1,780	1,780
BET		1,515	1,515	1,515	1,515	1,515
Price (EU Ineligible)						
SKJ		1,214	1,214	1,214	1,214	1,214
YFT		1,566	1,566	1,566	1,566	1,566
BET		1,333	1,333	1,333	1,333	1,333
Revenue Benefit						
SKJ		6,299,793	6,299,793	6,299,793	6,299,793	6,299,793
YFT		1,573,782	1,573,782	1,573,782	1,573,782	1,573,782
BET		1,447,972	1,447,972	1,447,972	1,447,972	1,447,972
Costs						
EMS onboard	-237,998					
EMS onshore	-118,670					
Onshore monitoring cost						
Annual Training		-2,530	-2,530	-2,530	-2,530	-2,530
Annual Staff E-monitoring costs		-19,000	-19,000	-19,000	-19,000	-19,000
Annual performance audits		-17,150	-17,150	-17,150	-17,150	-17,150
Maintenance costs		-70,100	-70,100	-70,100	-70,100	-70,100

Industry monitoring costs		-18,000	-18,000	-18,000	-18,000	-18,000
Total Costs	*-356,668*	*-126,780*	*-126,780*	*-126,780*	*-126,780*	*-126,780*
Benefits						
Catch revenue benefit		9,321,547	9,321,547	9,321,547	9,321,547	9,321,547
Total Benefits	*0*	*9,321,547*	*9,321,547*	*9,321,547*	*9,321,547*	*9,321,547*
Net Benefits	-356,668	9,194,767	9,194,767	9,194,767	9,194,767	9,194,767
Industry	*-237,998*	*9,303,547*	*9,303,547*	*9,303,547*	*9,303,547*	*9,303,547*
Government	*-118,670*	*-108,780*	*-108,780*	*-108,780*	*-108,780*	*-108,780*
Check	0	0	0	0	0	0

NPV	*32,788,411*
Industry	*33,299,209*
Government	*-510,798*

Annex 5 DOS Service and Fees

DIGITAL OBSERVER SERVICES

Services and Fees 2017

Service	Description	Price
Mainteinance	→ Software updates. → Remote control of the correct functioning of the system	150 €/vessel/month
Regional Control Center	→ Maintenance Service → 5 days Training per year in: EMS concept, HDD managing, SVM software, report issuing, ... → Remote assistance to observers → 1 remote audit per year	350€/vessel/month (Price per one single vessel)
Electronic Observer Service	→ Manteinance Service. → Every trip analyzed by experts. → Report issuing. → 1 year HDD custody.	€/vessel/month (See Analysis types)
Fishing day analysis	→ Analysis of selected days → Report issuing.	€/fishing day (See Analysis types)

DOS
DIGITAL OBSERVER SERVICES

Related services and products 2017

Service	Description	Price
Training service	→ SeaTube Concept, HDD management, SVM reviewing software, Report issuing	600 €/day
Auditing service	→ Post trainig follow up sessions → Performance auditing	450 €/day
Customized certificates	→ Any other certificate based on the review not expresed in prior services. → 3 Cathegories: * Fishing effort and FADs * Bycatch, species and fates * Catches, sizes and wells	65 €/ud
Substitution Kit	→ Waterproof suitcase containing HDDs, instructions and forms. → 6 HDDs 4TB Kit ..... → 4 HDDs 4TB Kit.....	1250 €/ud 800 €/ud
Extra Hard Disk	→ 4TB extra hard disk	175 €/ud

DOS
DIGITAL OBSERVER SERVICES

Purse Seine: analysis types and prices 2017

			FADs		BYCATCH			TUNA 1			TUNA 2	TUNA 3		SCIENCE
Monthly Fee (€)	Price (€) per Analyzed Sea Day	ANALYSIS TYPE	Set n°, (date, time, pos) & Set Type	FAD activ. (date, time, pos) & activity Type	FAD components & description	Bycatch SSI; n° (date, time, pos) & Fate	Bycatch SSI + Bony fishes	Bycatch BP; Fate, Liberation methods and injuries	Tuna tons per set	Discards; Set n° & discarded species composition	Transhipment; (date, time, pos) & species composition.	Tuna species; specific composition per set	Tuna in wells; tons per species & wells	Tuna Categories lenght & weight	Length sampling >100 indiv per set
300	10	SETs CERTIFICATE	X												
450	15	FAD activity	X	X											
510	18	FAD activity & components	X	X	X										
510	18	Bycatch Description 1	X			X									
600	20	Bycatch Description 2	X			X	X								
750	22	Tuna Catches 1	X						X	X	X				
810	25	Tuna Catches 2	X						X	X	X	X			
900	28	Tuna CAtches 3	X						X	X	X	X	X	X	
810	35	Tuna Catches & Bycatch	X			X	X		X	X	X	X			
900	42	DOS Full Observer Service :	X	X		X	X		X	X	X	X			
1050	45	DOS Full Observer Service :	X	X		X	X		X	X	X	X	X		
1200	50	DOS Full Observer Service :	X	X		X	X		X	X	X	X	X	X	
900	32	Best Practices basic	X	X	X	X	X	X							
1050	35	Best Pract. + Tuna Catches	X	X	X	X	X	X	X	X	X				
1200	55	DOS Full Observer + BP 1	X	X	X	X	X	X	X	X	X	X			
1500	60	DOS Full Observer + BP 2	X	X	X	X	X	X	X	X	X	X	X	X	
1950	85	Scientific data observer	X	X	X	X	X	X	X	X	X	X	X	X	X

Set n° & type: usefull for FAD free, Dolphin safe, ... does not include tuna catch information
FAD Module: n° activ. FAD; (date, time, pos) & types of activity, Visit, deploy, collect....
FAD Components & description
Bycatch Module: SSI: Species Special Interest
Bony fishes
Bycatch BP: Best Practices
Tuna Module: Total tons, Discards & Transhipments
Species composition distinction = Atún 2
destiny wells and length measures = Atún 3
Science Module: Includes, samplings per set, measuring, sightings, encounters, pollution, ...

DOS
DIGITAL OBSERVER SERVICES