INTER-AMERICAN TROPICAL TUNA COMMISSION

WORKSHOP OF AN ELECTRONIC MONITORING SYSTEM (EMS) IN THE EPO: FINANCIAL CONSIDERATIONS

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FINANCIAL CONSIDERATIONS OF AN EMS IN THE EPO

CONTENTS

1. INTRODUCTION AND BACKGROUND

The Inter-American Tropical Tuna Commission has acknowledged and endorsed that electronic monitoring (EM) is a promising tool for monitoring, addressing data gaps, and improving data collection for both purse-seine and longline vessels that do not carry onboard observers, as well as for observed vessel as an instrument to complement observer's data-collection (Resolution C-19-08; Document SAC-07-07f.i ; Gilman et al., 2019). Accordingly, per request of the Scientific Advisory Committee (SAC) during its 10th meeting in 2019, and pursuant to paragraphs 9 and 10 of Resolution C-19-08, the IATTC staff prepared for consideration by the Commission the document SAC-11-10 "*An electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean: objectives and standards*". This document, which received positive feedback from several global experts on the matter, was presented at the SAC 11th meeting in 2020. However, because the meeting was held by videoconference and with time constraints, it was not possible for Members to provide in depth comments and suggestions. Thus, it was proposed that a workshop be held in 2021 to further discuss some of the elements described in SAC-11-10, as well the presentation of a workplan for the implementation of an EM system (EMS) in the eastern Pacific Ocean (EPO), which was provided in EMS-01-02-Rev. The Commission endorsed this concept during its 96th meeting (extraordinary) and agreed that the *1st Workshop on Implementation of an Electronic Monitoring System (EMS)* should be held in April 2021, before the SAC 12th meeting.

Also prepared for the 1st Workshop, the document EMS-01-01 recommended a number of actions for endorsement by the Commission. Among these was a workplan formulated by IATTC staff (EMS-01-02-Rev), which proposed a series of workshops to consider and analyze the EMS components and subcomponents in a hierarchical and chronological order. To provide structure for these workshops and other activities related to the EMS implementation process, the staff also recommended the adoption of Terms of Reference (ToR) for the EM workshops and a set of working definitions. The associated TORs and a set of definitions were adopted through the Resolutions C-21-02 and C-21-03, respectively, during the

98th Meeting of the IATTC. The workplan was also adopted with a minor modification to show flexibility on a potential starting date for the EMS in the EPO (EMS-01-02-Rev). Subsequently, since December 2021, and in accordance with the approved workplan, the IATTC staff has organized three additional workshops covering in a hierarchical manner the EPO-EMS components and subcomponents (2nd workshop: on Institutional Structure, Goals and Scope of the EMS, December 2021; 3rd workshop: on management Considerations, April 2022; 4th workshop: on technical standards and data collection priorities, December 2022). All of these EMS workshops, along with the respective documents presented at each workshop and the discussion summaries for each one, are available at the IATTC website.

This document was prepared for the 5th workshop of the series planned under the adopted EMS workplan (EMS-02-02 Rev), focusing on the final EM Management subcomponent - the financial considerations (Figure 1). The IATTC staff presents, within a series of outlined text boxes, a number of preliminary recommendations on topics to be considered by the workshop. The preliminary nature of these recommendations deserves special emphasis. One of the primary purposes of this series of workshops on EMS is to facilitate discussions and generate ideas that will inform the formulations of future IATTC staff recommendations on EMS, recommendations from CPCs, and recommendation from other IATTC bodies like the SAC or the newly established *ad hoc* working group on EM (EMWG) (Resolution C-22-07). That is, these preliminary recommendations are intended to serve as starting points for stimulating discussion, and they are not intended to preempt or limit meaningful discussion or alternate approaches.

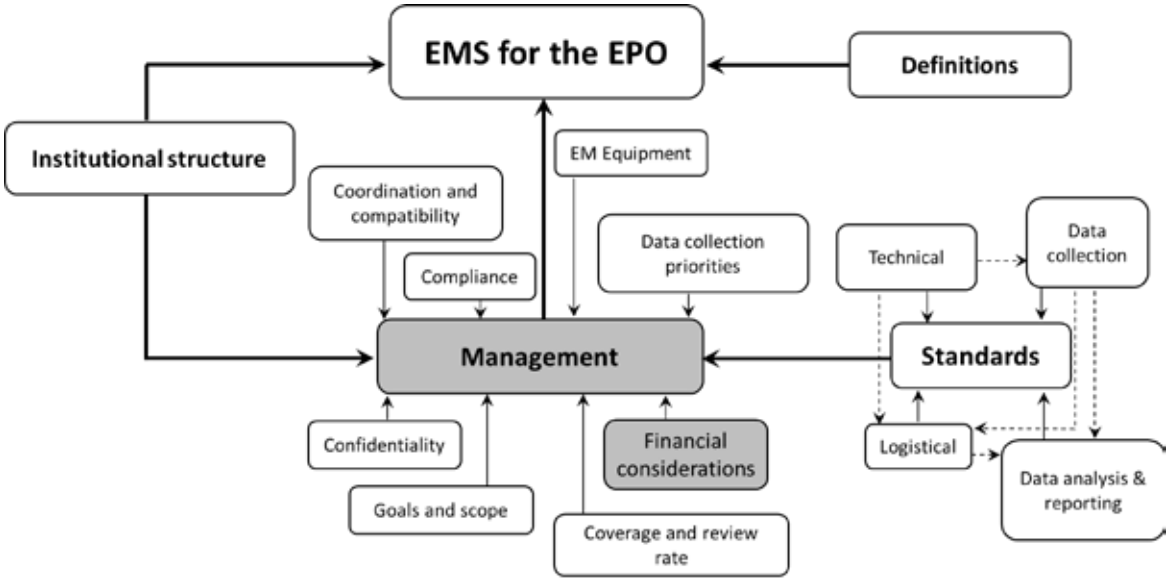

FIGURE 1. Structure of the EMS for the tuna fisheries in the EPO, emphasizing (in gray) the financial considerations (a subcomponent of management considerations) discussed in this document.

2. FINANCIAL CONSIDERATIONS OF AN EMS IN THE EPO

The Commission must carefully consider the financing of an EMS, including whether it would be funded directly through the IATTC budget, or via cost recovery from individual vessels, or through some other mechanism. Before such discussions can take place, the Commission must also determine which aspects of an EMS (e.g. EM programs) would be centralized or coordinated through the IATTC staff, versus those that could be executed and paid for at the national level or through alternative financing mechanisms. Regardless of how an IATTC EMS is implemented, it will almost certainly imply the need for drawing on

additional resources, and thus additional costs to the CPCs. Therefore, it is necessary to consider multiple economic variables related to an IATTC EMS, with a goal of cost efficiency, while also ensuring that the EMS is fit to the purposes identified by the Members, and that the associated costs are shared in an understandable and transparent manner, with a suitable body to review and monitor these financial and administrative aspects.

Throughout the remainder of this document, the IATTC staff presents the financial aspects and schemes that are discussed in the existing literature or followed by ongoing EMS programs to lay out the different options that could be considered for the financial aspects of an EMS in the EPO. The assessment of the economic implications of an EMS will be also addressed taking different factors into account, including the technological advances in EM (e.g. AI, Machine Learning), which are thought to reduce the cost of EM analysis. Regarding these factors, an EMS should be flexible and allow the incorporation of the ever evolving technology to optimize financial and human resources and improve its management outcomes in a system that could change in priorities, with an EPO-EMS following a performance-oriented framework rather than very prescriptive with definitive technical or data analysis specifications (Garren et al. 2021; docs. EMS-04-01 and EMS-04-02). A general description of cost-allocation examples from different EM trials and by ongoing EMS programs will be also presented. Finally, the procedures and organization the Commission should discuss and establish to review and monitor the financial and administrative aspects of the EMS program within a suitable IATTC institutional framework will also be addressed in this document.

a) Assessing the economic implications of an EMS for the tuna fisheries in the EPO

The successful implementation of an EMS for tuna fisheries in the EPO relies heavily on how all stakeholders perceive its value (Fujita et al., 2018), and this value is equated by the benefits of an EMS on one end and the costs to managers and fishers on the other. The economic implications related to the value of the implementation of an EMS are generally addressed with cost-benefit analyses.

Cost-benefits analyses on EM for tuna fisheries are scarce worldwide, and they have only been developed in recent years. Banks et al. (2016), explored the potential economic costs and benefits of EM on fisheries in FFA countries (i.e. Pacific Islands Forum Fisheries Agency - WCPFC's jurisdiction) with emphasis on purse-seine vessels. This study found high level of economic benefits relative to costs. Later on, and mindful that the lessons learned from one fishery may not be fully transferable to others (i.e., purse-seine and longline fishery), and that the economic variables considered as a significant source of value differ between fisheries and RFMOs, Rogers et al. (2021) developed a cost-benefit analysis for the tuna longline fishery in the EPO. This analysis, which will be presented in detail during the 5th EM workshop, estimated the net benefits to be $187,000 USD with a base model output for 20% sampling coverage (5% observer and 15% EM). In contrast, the net benefits for 20% human observer coverage were $ -45,000 USD. The authors also factored in technological developments on EMS, such as advances in machine learning and artificial intelligence, which may reduce the costs associated with EM analysis in the near future. Additionally, these technologies could be directly integrated into the EM record collection and analysis. Furthermore, the application of new data collection technologies, such as the GPS technology of the EM equipment -that georeferences and time stamps every frame of EM records could eventually allow the integration of EM by replacing other existing tools collecting georeferenced data monitoring vessels' movements, such as VMS. This could result in indirect reduction of costs among data collection systems.

The economic variables used by Rogers et al. (2021) were inherent to the longline fishery in the EPO, and the uncertainty in future cost change in EM (i.e., the hard-to-project EM rapidly evolving technology) was estimated with Monte Carlo simulations. The study found that the implementation of an EMS is very likely to produce net economic benefits. However, and as the authors suggested, an EM cost-benefit analysis

for the purse-seine fishery in the EPO is also necessary to characterize its economic value and fully consider the use of EM for all EPO tuna fisheries. Toward this end, the recommendation proposed by the staff as follows:

> Consider the results of the cost-benefit analysis for longline fisheries, as reported in Rogers et al. (2021), and conduct a similar analysis for purse seine fisheries to facilitate a more efficient implementation of an EMS in the EPO.

b) Establishing financing, cost-allocation procedures and responsibilities for EMS and its components

For an EMS be effectively implemented and maintained in the long term, it is essential to identify all the associated costs and establish procedures, mechanisms and responsibilities for financing, including costs-sharing arrangements and other relevant financing aspects . It is worth noting that the shape and form of the procedures and mechanisms established for the elements mentioned above could be directly related to the type of institutional structure of an EMS, which is yet to be decided by the Commission. Some authors propose assigning the costs associated to an EMS to a general structured-model funded program. This cost-reducing intended approach could create strategies for efficient program participation and stakeholders' engagement by allocating costs to a specific program cost, such as EM equipment or EM analysis, rather than to a general program fund (Fujita et al., 2018). Others, emphasize the importance of an RFMO seeking to optimize the costs of its services, ensuring its members receive the maximum value for their investment in fisheries and an equitable sharing of costs among members (Wyatt and Wallis, 2011), and proposed a 'cost recovery' approach. The term 'cost recovery" has been frequently used for EM monitored fisheries recently (Stobberup et al. 2021; Michelin et al., 2020; Fujita et al., 2018; Banks et al., 2016). MRAG (2018) refers to it as "the recovery of expenditure associated with the provision of services to users", these latter, also referred as "beneficiaries". It is based on the conception that the fishers (i.e., users/beneficiaries) profit from the use of a public resource (Michelin et al. 2020), and must therefore be involved in promoting fishery sustainability. This concept originates from "fisheries recovery", which implies rebuilding strategies to recover depleted fishery stocks (Garcia et al. 2003). These rebuilding strategies, taken in a pragmatic sense, may be also approached through other sub-objectives as tools for effective fisheries management, such as discards mitigation, improving selectivity and finding an acceptable handling and destination for the bycatch, which may be achieved, or at least promoted, by the provision and analysis of high-resolution EM data. In this sense, the key to optimization is that fishers, who bear the costs, can influence them by changing their behavior (e.g., increase the value of their catch by improving their fishing practices, monitoring and compliance). For instance, this is likely to occur in globally traded and managed, high-priced, certification-pursued tuna fisheries.

As stated in MRAG, 2018, in the context of cost recovery, all costs involved in the delivery of a service should be considered. These include both the direct costs – i.e., those immediately linked to the delivery of the service (e.g., in the context of EM services, the costs associated with analytical staff to review EM records) – as well as the indirect costs – i.e., those not immediately involved in the delivery of the service but are otherwise necessary for its delivery.

The costs associated with establishing and operating an EMS may vary between national fisheries administrations and can be broadly categorized into one of four types:

1. **Type 1: On vessel costs**. These costs are associated with the installation and operation of EM hardware and supporting systems on board fishing vessels;
2. **Type 2: Program administration and operational costs**. These costs are associated with the administration and operation of the EM program, usually undertaken by national (or regional)

fisheries administrations. These costs typically form the 'core' of the annual EMS budget, and would be a main focus for cost recovery;

3. **Type 3: Policy and regulatory development costs**. These costs are associated with the establishment of relevant regulatory and policy arrangements to support an effective EMS; and
4. **Type 4: Analytical costs.** These costs are associated with the analysis of EM generated information to produce outputs in support of the administration and management of fisheries by national or regional fisheries administrations (e.g., production of reports analyzing annual trends in EM information).

A detailed description of the different elements of each cost type is presented in MRAG, 2018.

Costs are typically categorized as either 'fixed' or 'variable' (MRAG, 2018). Fixed costs are those that are required to be made irrespective of how much the service or facility is used in practice; they are the costs involved in having the system in place (e.g., salaries for program coordination and administrative staff, office overheads, insurance, and IT systems). Variable costs are directly related to how much the service is used. They are costs incurred only when the service is actually delivered. In the context of EM, the key variable cost will be fees paid to contractors or casual staff for each sea-day reviewed. Separating costs into either 'fixed' or 'variable' is important because enables equitable recovery of costs across the fleet and allows the structuring of incentives for voluntary compliance (MRAG, 2018).

For fisheries covered by EM, a cost recovery policy should reflect the real costs associated with the efficient provision of a service (e.g., generating EM records and data), and not be designed as a mechanism to cross-financing inefficient fishing activities or activities not related to EM, or as a mean to generate profit on the use of the fisheries resource (e.g., 'royalties' such as license fees to foreign fishing vessels; Wyatt and Wallis, 2011). For these purposes, alternative specific and transparent procedures are necessary (Wyatt and Wallis, 2011).

Cost recovery is flexible as it may be implemented either by the Government (including multilateral agencies) or non-Government sectors, or as a combination of both. For example, vessel owners may request full cost recovery when they pay for the full cost, or partial cost recovery when a part of the full costs of data provision are paid for by the vessel owners, with the remaining portion covered by the government or another entity (MRAG, 2018, Banks et al. 2016). This flexibility allows for different cost recovery models to be tailored to the specific needs and contexts of different sectors, ensuring that the costs are fairly and efficiently allocated while minimizing the burden on stakeholders.

Cost recovery is also usually guided by a framework with principles that are structured such that they can be easily applied in practice. Details on the guiding principles, their rough order of priority and its framework can be found in MRAG (2018) but range from guidelines for "full recovery as a default" to guidelines for "transparency and accountability" and "simplicity" (MRAG, 2018).

Several FFA members, including Australia and New Zealand, have implemented cost recovery policies with guiding principles set at national level (MRAG, 2018). Additionally, a business case consultancy was developed for Fiji, another FFA member, to design cost recovery scenarios to sustainably use EM as a Monitoring, Control and Surveillance (MCS) and data collection tool (Hurry, 2019). The intention was to provide all the relevant EM information concerning longline fisheries to the Government of Fiji, to inform the decision on the future of EM, and to define a cost recovery policy (Stobberup et al. 2021). A 3-year period EM trial on 50 longline vessels (2015-2018) reached a total amount of $987,000 USD, in which EM equipment and EM analysis equipment amounted to $523,000 USD. These items are considered 'Fixed costs', or the costs incurred in having the system in place (MRAG, 2018). The remaining $463,000 USD included the EM analysis, the staff training, EM equipment maintenance, etc. (Table 1). These expenditures are considered as 'Variable costs' - the costs incurred after the system is in place, or those

applying only when the service is actually delivered or costs directly related to how much the service is used (MRAG, 2018).

As a reference, with the consultation proposal to maintain the EM Fijian program for the next 4 years (Hurry, 2019), the annual fixed costs of maintaining the EM program under this scenario was $325,000 USD (Table 2; Stobberup et al., 2021). The EM equipment is not included in these costs (it was already installed for the EM trial), except for servicing and replacement after useful life is reached. With this scheme, each vessel would pay $6,500 USD per year. However, should vessels only pay for onboard costs of EM equipment maintenance, services, and technical support this would be $3,000 USD per vessel (Stobberup et al., 2021; Hurry, 2019; Table 2). And, in the case that the vessel should also have to pay for the EM analysis, the annual cost per vessel would be $4,365 USD; assuming 20 percent of EM review rate, totalizing $68,000 USD per year for the 50 participant vessels, with a productivity of 528 sea days analyzed per year by each EM analyst, and with an estimated sea-day analysis fee of $64.5 USD (Table 2).

Another example, this one associated to the cost estimations for an ongoing 3-year period (2021-2023) EM trial for 4 longline vessels (3 currently with EM equipment) in the EPO that the IATTC staff is developing (project C.2.b; Table 3) totals $114,820 USD. Fixed costs (EM equipment and EM analysis equipment) sum $61,450 USD. The amount for purchasing equipment for EM analysis included shipment and custom-clearance fees, which represented 52% of this expense. This fee might be lower if accessible markets and custom exoneration fees are in place. The remaining $53,370 USD are variable costs, which include the analysis of EM records, the training of the IATTC staff, vessels' EM equipment maintenance, etc. Since this is a pilot project that aims to better understand a series of aspects for the feasibility of developing an EMS for the longline fishery, the analysis of EM records contemplates a 100% of EM review rate of the fields established in the Annex 4 of document EMS-04-02. Once EM coverage and review rates have been established by the Commission, if different from 100%, the associated costs for the analysis of EM records would be lower (note that EMS-05-02 describes IATTC staff's considerations to develop efficient EM coverage and review rates for the EPO tuna fisheries).

In 2023, a new EM trial for the Costa Rican longline fishery involving 2 medium-sized vessels was estimated to cost $158,370 USD, with $17,473 USD covering fixed costs (Table 4). The trial requires, a 100% EM review rate made by a third-party professional EM review center (Digital Observer Services - DOS), and therefore does not include the EM analysis equipment. Variable costs, including EM analysis, staff training, observer salary, logistics, data collecting forms, EM equipment maintenance, remote assistance services, etc., totaled $140,897 USD. As in the IATTC project C.2.b, the analysis of EM records for this trial also contemplates a 100% of EM review rate, so costs could be lower if the Commission decides to establish lower EM review rates. Point to note, for this EM trial the costs for custom-clearance of the EM equipment nor expenses derived from project managing (e.g. staff traveling) have not been included.

Regarding tuna purse seine fisheries, two notable examples for EM financial considerations are the EM trial for the Ghanaian fleet and the IATTC EM trial for the EPO fleet (project D.2.a). As part of the Ghanaian purse seine fleet trial, a business case for EM was prepared (MRAG, 2017). This business case included an assessment of the costs and benefits of implementing EM. The conclusions were similar to those of the Fijian longline fisheries, with clear benefits that justify a continuation of an EMS beyond the trial period, and proposed cost recovery scenarios (Stobberup et al., 2021; MRAG, 2017). A 3-year period of an EM trial totalized $558,000 USD (Table 5). EM equipment was installed in 17 vessels, and the EM analysis was performed by 5 Ghanaians EM analysts following the standard methodology used by a professional EM service provider (i.e. DOS). They analyzed a sample of 30-50% of the sets made during 14 trips. In-kind co-financing from industry and other sources were not included. Fixed costs (e.g. EM equipment, EM analysis equipment) amounted $289,000 USD whereas variable costs (staff training, remote audits of EM analysis made by a 3rd party (DOS), EM equipment maintenance, Government and industry staff costs, etc.)

covered the remaining $269,000 USD (Table 5). Since the goal for this pilot was for the authorities to take over the EMS program implementation at the end of the trial, various cost recovery options were presented in the business case for EM. One of them was if the vessels would cover all the costs, each vessel would annually pay $10,000 USD. Maintaining the EMS was concluded to be a clear benefits, based on the price differential of maintaining access to the European Union market, and by the fact that improving compliance contributed to a better standing of the fleet with respect to the markets (Stobberup et al., 2021; MRAG, 2017). Other benefits, although difficult to attribute a value, were also identified by MRAG (2017): EMS as a source of verifiable and objective data for compliance and MCS, EMS having a potential to reduce IUU by domestic and foreign vessels, EMS having a potential to demonstrate good practices (both for the Government and for industry), EMS having a potential use for future product certification, and EMS having potential for scientific data collection.

On the other hand, the IATTC EM trial developed for 4 purse seine vessels (project D.2.a; Table 6) totaled $111,699 USD. Fixed costs (EM equipment and equipment for EM analysis) summed $58,850 USD. The amount for fixed costs included shipment and custom-clearance fees, which represented 13% and 31% of these expenses for the EM equipment and the equipment for EM analysis, respectively. These fees could be lower should national or local markets and custom exoneration fees be in place. The remaining $52,849 USD were variable costs, which include the analysis of EM records, the training of the IATTC staff, EM equipment maintenance, etc. The EM analysis contemplated a 100% of EM review rate of the fields established in the Annex 3 of document EMS-04-02. As for longliners, if the Commission establishes EM review rates lower than 100%, the costs for EM analysis would also be lower (see EMS-05-02 for details on considerations to establish efficient EM coverage and review rates).

With all these elements discussed during the present workshop, the IATTC staff's recommendation is as follows:

Establish cost-allocation procedures and financing options for all expenses related to implementing and maintaining an EMS and its components (e.g. EM equipment, installation, technical assistance both at sea and at EM review centers, and EM analysis, including training, hardware and software).

Conduct cost-recovery studies to explore options, and develop guidelines, for the recovery of costs of an EPO-EMS.

c) Committee reviewing and monitoring the EPO-EMS

As mentioned above, the institutional structure of an EMS has yet to be decided by the Commission, and this will have significant implications for the financial aspects discussed. Regardless of the final arrangements established by the Commission, it seems reasonable to assume that the financial and administrative matters of an EMS would need to be monitored and reviewed by a suitable body. To this end, the IATTC staff considers reasonable that the Committee on Administration and Finance (CAF) could be required to undertake this task. The CAF, established in 2012, by the Resolution C-12-02, it is responsible for advising and recommending on all the matters related to the financial administration of the Commission. It meets every year during the IATTC Annual Meeting, and the following items are presented and discussed:

1. The financial activity for the previous fiscal year;
2. An update on the status of the contributions to the operating budget for the current year;
3. The requested budget for next year; and

4. A budget projection for the year following the next one.

Regarding the financial management of the IATTC, its annual budget is funded by contributions from the 21 Members of the Commission. This is agreed by consensus of all Members in accordance with the Article IX.3 of the Antigua Convention. The amount of each Member's contribution to the agreed annual budget is derived from the formula established in the Resolution C-15-05, and based on:

1. 10% of the IATTC budget,
2. 90% is shared among the Members, weighted by Gross National Income (GNI) category (table 7):
    a. 10%, due to an operational component,
    b. 70%, due to the catches by their flag vessels, and
    c. 10%, due to their utilization[1] of tuna from the Convention Area.

Nevertheless, the introduction of any new mechanism of Members' contributions for an EPO-EMS, including the structure of the potential programs and their financing mechanisms, would involve an adopted legal and policy framework to relate with and complement the Commission's institutional financial framework. However, the clear set of financial arrangements already in place by the Commission for similar programs, such as the AIDCP, could help expand these to incorporate EMS financial and administrative aspects into existing IATTC structures and rules, as appropriate. It is then for the Commission to discuss and establish the most appropriate procedures and organism that would review and monitor the financial and administrative aspects of the EMS within the preferred institutional framework (e.g., all financial and administrative aspects being reviewed and monitored by the CAF). Towards this end, the recommendation proposed by the staff is as follows:

The Committee on Administration and Finance (CAF) should review and monitor the financial and administrative aspects of the EMS, and subsequently submit relevant recommendations to the Commission.

[1] To determine a Member's utilization, 50% of the tuna loins included in the calculation shall be attributed to the Member that exported the loins and 50% to the Member that imported them (see Resolution C-15-05).

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4. TABLES

Table 1. Summary of key data on costs during the Fijian EM trial on 50 longline vessels (Modified from Stobberup et al. (2021) and Hurry (2019)).

Cost type	Cost items	Value ($ USD)
Fixed	EM equipment	464,200 (9,284 per vessel)
	Onshore EM analysis equipment (12 units)	59,075
	Total fixed costs	**523,275**
Variable	Two training sessions	11,440
	Maintenance, service costs, and satellite up-time (3 yr)	183,940
	Remote data review services (EM analysis audit by 3rd party)	45,000
	Government staff costs (3 yr)	207,900
	Industry costs (3 yr)	15,000
	Total variable costs	**463,280**
Total costs		**986,555**

Table 2. Summary of annual operational costs for implementing a Fijian LL EMS program on 50 longline vessels (Modified from Stobberup et al. (2021) and Hurry (2019)).

Cost type	Budget items	Cost ($ USD)
Fixed	Staff salaries	38,112
	EM equipment maintenance, services, tech support (onboard)	150,000
	Equipment maintenance, services, tech support (onshore)	95,000
	Regional cooperation and development	14,000
	Office and other costs	28,000
	Total fixed costs	**325,112**
Variable	EM analysis (EM analyst fees)	68,169
Total costs		**393,281**

Table 3. Summary of costs estimated for the IATTC EM trial on 4 longline vessels (Project C.2.b).

Cost type	Cost items	Value ($ USD)
Fixed	EM equipment (3 units; 4 cameras each vessel)	45,850
	EM analysis equipment (2 units)	15,600
	Total fixed costs	**61,450**
Variable	Two 3-day virtual training sessions	1,725
	Maintenance, service costs, and satellite up-time (~1.5 yr)	12,060
	EM analysis (~ 500 sea days of EM analysis by 3rd party. The other 500 days will be EM analyzed by IATTC staff = $0.0 USD)	36,585
	Shipping of hard drives with EM records	3,000
	Total variable costs	**53,370**
Total costs		**114,820**

Table 4 Summary of projected costs estimated for the IATTC EM trial on 2 longline vessels in Costa Rica (year 2023).

Cost type	Cost items	Value ($ USD)
Fixed	EM equipment (2 units; 3 cameras each vessel)	17,472.92
	EM analysis equipment	0
	Total fixed costs	**17,472.92**
Variable	Annual salary, training, logistics, transportation of two observers	70,000
	Keypunch and observers' materials (data collecting forms)	10,000
	Maintenance, service costs, and satellite up-time (1 yr)	3,924
	EM analysis (~ 600 (100%) sea days of EM analysis by 3rd party)	55,956
	Shipping of hard drives with EM records to EM review center	1,017.33
	Total variable costs	**140,897.33**
Total costs		**158,370.25**

Table 5. Summary of costs during the Ghanaian EM trial on 17 purse seine vessels (Modified from Stobberup et al. (2021) and MRAG (2017)).

Cost type	Cost items	Value ($ USD)
Fixed	EM equipment	262,650 (14,450 per vessel)
	EM analysis equipment (6 units)	26,000
	Total fixed costs	**288,650**
Variable	Two training sessions	5,060
	Maintenance, service costs, and satellite up-time (3 yr)	138,850
	Remote data review services (EM analysis audit by 3rd party)	14,400
	Government staff costs (3 yr)	57,000
	Industry staff costs (3 yr)	54,000
	Total variable costs	**269,310**
Total costs		**557,960**

Table 6. Summary of costs estimated for the IATTC EM trial on 4 purse seine vessels (Project D.2.a).

Cost type	Cost items	Value ($ USD)
Fixed	EM equipment (3 units; 8, 6 and 4 cameras each vessel)	54,087
	EM analysis equipment (1 unit)	4,763
	Total fixed costs	**58,850**
Variable	6 days of presential training	6,500
	Maintenance, service costs, and satellite up-time (1.5 yr)	14,880
	Remote data review services (~ 666 sea days of EM analysis by 3rd party. The remaining sea days were EM analyzed by IATTC staff = $0.0 USD)	30,969
	Shipping of hard drives with EM records	500
	Total variable costs	**52,849**
Total costs		**111,699**

Table 7. GNI categories used for allocating contributions

GNI Category	GNI range (US$)
0.5	< 1,499
1	1,500 - 4,499
2	4,500 - 6,499
3	6,500 - 10,999
4	11,000 - 15,999
5	16,000 -20,999
5.5	≥ 21,000