Data for EM Cost-Benefit Analysis

This paper is part of a series that summarizes discussions from the 2022 Global Electronic Monitoring Symposium[1], which convened more than 50 EM experts, both in person and virtually, for a three-day workshop. The symposium focused both on the use of electronic monitoring programs to increase oversight and transparency in international fisheries management and on existing barriers to the uptake of EM. Although this series of papers does not represent an exhaustive discussion of the issues, it includes the key points that symposium participants raised.

Introduction

Worth US$40 billion a year at the final point of sale,[2] tuna species require effective management and monitoring to ensure sustainability. One way to strengthen monitoring oversight is to employ tools that allow cost-effective collection of data. Electronic monitoring—using technology to collect and analyze data on a fleet's catch, fishing efforts and discards—is a potential tool for parts of the global tuna industry where traditional monitoring programs cannot be used: for example, on longline vessels where human observers are not easily placed. However, as with any new fishery tool, there are concerns about cost.

To support the consideration and development of electronic monitoring (EM) programs and help address economic concerns, policymakers and industry leaders are increasingly requesting cost-benefit analyses (CBAs). Three recent reports attempt to answer this call: a study by researchers from Sea Change Economics, the University of California, San Diego, and the National Oceanic and Atmospheric Administration that examined the costs and benefits of implementing EM on eastern Pacific longline vessels; and two studies by Poseidon Fisheries Research that estimated the costs and benefits of an EM program for the Western and Central Pacific purse seine fisheries associated with the Pacific Islands Forum Fisheries Agency.[3] Each report found that wide adoption of EM would provide a positive net

[1] GEMS Steering Committee members – Andrew Clayton, Claire van der Geest, Esther Wozniak, Eugene Pangelinan, Gerald Leape, Mark Zimring, Papa Kebe, Robert Gillett, Ruth Hoban

[2] McKinney, Raiana, James Gibbon, Esther Wozniak, and Grantly Galland. "Netting Billions 2020: A Global Valuation of Tuna." Washington, D.C.: The Pew Charitable Trusts, October 2020. https://www.pewtrusts.org/en/research-and-analysis/reports/2020/10/netting-billions-2020-aglobal-tuna-valuation.

[3] The Pacific Island Forum Fisheries Agency's 17 members are Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.

benefit to the fisheries due to factors such as increased scientific data, reduced mortality of bycatch species, increased market premiums for tuna and better compliance with fishing rules and regulations.

The two regional reports can form a model for future research, but new studies that look at different areas, gears or fleets will require specific information from the relevant fisheries. A standardized form would be helpful to ensure that these reports could be comparable.

Background

Assessing the full range of benefits resulting from EM implementation is difficult, as many potential benefit categories—such as the protection of non-market marine species or a reduction in illegal fishing—are not currently tracked or readily quantified in some fisheries.

Another major hurdle for electronic monitoring cost-benefit research is the limited access to the detailed costs of existing EM programs, each of which records costs differently; when made available to the public, these costs are typically summarized instead of itemized, with valuation methods often poor or absent. Yet CBA models developed for regional adaptation will require detailed information to increase accuracy. Providing detailed cost information, such as costs per camera or wages per observer/review analysts per day, will facilitate using that information in future cost-benefit analyses. Estimating the management costs associated with the implementation of an EM program is particularly challenging, and careful attention should be paid to estimating all costs, including staff time, management and costs of operating data review facilities, that are incurred in the implementation of the EM program.

Advantages of standardized data collection and detailed benefit information

An important first step to comparing costs and benefits is to create a standardized format for recording disaggregated EM cost-benefit information. Standardizing the data collected on EM costs and providing it in sufficient detail will enable cost-benefit and related economic studies to be efficient and comparable. The standardized detailed data can also be used during EM program audits to determine scalability and the feasibility of expansion to additional gear types or fisheries—and to improve programs over time by assessing milestones that include efficient gains to vessel operators.

Each potential benefit should be included in a CBA when possible; even when the true value of each of these benefits cannot be fully quantified, every attempt should be made to find proxies or other useful estimations that get closer to the true value.

Next steps

Current electronic monitoring CBA studies have focused on specific regional fisheries, but the model developed as part of the eastern and Western Pacific Ocean CBA can be easily translated or adapted to other studies of regional and domestic EM pilots or programs. The template below (derived from the eastern Pacific CBA) details the data fields that could be used as the first step of a CBA. Although there may be other benefits and costs specific to other regions—and not all categories will be relevant to every fishery—the fields detailed in the template are a good foundation from which to build.

This template is intended to aid planning for the collection of data categories necessary to fully conduct a cost-benefit analysis of introducing and implementing an electronic monitoring (EM) program within a tuna management area. Only cost and benefit components affected by the presence of EM should be included, rather than *all* operating costs or benefits.

Note: In some instances, "purse seine" or "longline"-specific information is recommended for collection, as these are the two dominant gear types in most tuna fisheries. The same data should be collected for other gear of vessel types, if deemed impactful enough to include in the cost-benefit analyses as well.

Category	Component	Unit	Explanation / Use
Fishery Information			
	Total annual catch of management area	metric tons (mt)/year	Total amount of catch in the management area, per year
	Purse seine – number of vessels in fishery	#/year	Number of purse seine vessels operating in the management area; used to calculate needed number of onboard observers & video reviewers
	Sets per year – Purse seine	#/year	Number of sets purse seine vessels conduct per year; used to calculate onboard observer & video review times

	Longline – number of vessels in fishery	#/year	Number of longline vessels operating in the management area; used to calculate needed number of onboard observers & video reviewers
	Sets per year - Longline	#/year	Number of sets longline vessels conduct per year; used to calculate onboard observer & video review times
	Total observers in management area per year	#/year	Total number of observers employed in the management area per year; used to calculate baseline observer coverage
	Cost of observer program	$/year	Total cost of existing observer program per year; used to compare total changes in program costs
	Required catch data review rate	%	Required rate of review for EM catch data
	Required compliance data review rate	%	Required rate of review for EM compliance data
	Requirement for vessels to carry EM equipment	%	Percentage of vessels in fishery required to carry EM equipment
Observer Costs & Benefits			
	Video reviewer wages	Per view/per day/per hour	Cost per EM video footage reviewer (observer)
	Video reviewer – sets reviewed per day	#/day	Number of sets that can be reviewed per day; includes either human reviewers, ML/A.I., or a combination thereof
	Video reviewers - # employed	#/year	Number of video reviewers; will be based on the review rate and required level of review
	Video reviewer - # of days worked per year	#/year	Number of days per year each video reviewer is available to work; used to calculate total number of reviewers needed per desired level of review

	Review Centers – operational days	days/year	Number of days review center operates per year; could be as high as 24 hours per day, 7 days per week
	Onboard observer wages	Per day or per hour	Cost per onboard observer
	Onboard observer - sets per day	#/day	Number of sets an onboard observer can observe per day
	Onboard observer - average days at sea per year	#/year	Number of days per year each observer is available to work; used to calculate total number of onboard observers needed per desired level of observation
	Onboard observers - # employed	#/year	Total number of observers employed per year
	Onboard training	$/year	Cost per observer for training
	Onboard observer - supplies & equipment	$/year	Cost of required equipment and supplies for onboard observers
	Onboard observer – travel	$/year	Cost of travel per onboard observer
	Onboard observer - insurance & benefits	$/year	Cost of insurance per onboard observer
	Administrative staff – observer program	$/year	Cost of administrative staff required for observer program; may require identifying administrative roles and the full time equivalent allocated to each officer, and their respective salaries; will need to scale with number of employed observers; example roles may include Compliance Manager, EM Director, Technical Support, IT Manager, Review Debriefer, Data Analyst
	Administrative staff - EM program	$/year	Cost of administrative staff required for EM program; may require identifying administrative roles and the full time equivalent allocated to each officer, and their respective salaries; will need to scale with number of employed observers; example roles

			may include Compliance Manager, EM Director, Technical Support, IT Manager, Review Debriefer, Data Analyst
	Technical staff – observer program	$/year	Cost of technical staff required for observer program; may require calculating a minimum amount, plus additional amount that scales with number of employed observers
	Technical staff – EM program	$/year	Cost of technical staff required for EM program; may require calculating a minimum amount, plus additional amount that scales with number of employed video reviewers
	EM software training	$/year	Cost to train technical staff and video reviewers to use EM-related software; may be flat training cost, or may need to scale with size of the program; physical and modular training options should both be included, and separately quantified
	Debriefing / Review of results	%	Percentage of observer results required to be reviewed/debriefed after each trip
	Number of Debriefers	#	Number of Debriefers required per size of observer program; will be a function of percentage of observer results required to be reviewed
	Cost of a Debriefer	$/review	Cost of employing each Debriefer; cost is typically calculated on a per-review basis
	Observer safety	#/year	Number of observer deaths or major accidents occurring while at sea per year
	Observer deaths & accidents per year - % reduction resulting from EM	%/year	Estimated percentage of observer-related deaths or accidents reduced by the presence of onboard EM equipment; for example, known observation by cameras may reduce threats or violence directed at observers
	Value of a statistical life	$/person	Estimate of the value society places on reducing the risk of premature death, expressed in terms of saving a statistical life year; most appropriately measured by estimating how much society is willing to pay to reduce the risk of death

Other Management Costs & Benefits			
	Workstation costs	$/year	Cost of computer hardware needed by management specifically attributable to running the EM program; also includes desk, other support equipment
	EM review software license	$/year	Annual cost of EM system software package
	Data review center costs	$/year	Costs associated specifically with the EM review center site – rent, utilities, etc.
	Data storage	$/year	Costs to store/archive EM data after initial collection by management – hard drives, backups, etc.
	Value of new/scientific information	$/year	Estimated value of additional fisheries information able to be collected via the presence of EM; for example, EM freeing up human observers to conduct biological sampling, or the improvement of certainty in stock assessment estimates; may need to be estimated through management willingness to pay
Onboard Costs & Benefits			
	Cameras - cost	$/camera	Cost per camera
	Number of cameras	#/vessel	Number of cameras required for proper coverage per vessel (note: could change based on vessel size/type)
	Sensors - cost	$/sensor	Cost per sensor
	Number of sensors	#/vessel	Number of sensors required per vessel (note: could change based on vessel size/type)
	Camera central units/computer	$/unit	Costs for onboard EM central computer unit, per vessel
	Hard drive	$/hard drive	Cost per hard drive for use in EM system, per vessel

	Installation of hardware	$/year	Costs for installing of EM components, per vessel
	Maintenance/repair of hardware	$/year	Costs for maintenance & repair of EM components, per vessel
	Data transmission	$/year	Hard drive collection and delivery costs
	Data transmission	$/year	Vessel data transmission costs, for example via satellite data
	EM Equipment remote assistance	$/year	Subscription fee or other costs associated with remote assistance for EM equipment, typically by EM equipment provider
	Data analysis	$/year	Costs associated with individual vessel EM data analysis; often in the form of a subscription fee via EM equipment provider
	EM license fee	$/year	Annual license fee for EM software
	Efficiency gains – onboard operations	$/year	Estimated value of any efficiency gains obtained via the presence of EM onboard, per vessel; for example, automatic recording of all data reporting requirements, onboard activity monitoring, etc.
	Learning costs – EM systems	$/year	Estimated value of efficiency losses due to training staff in the use & maintenance of EM systems; likely to decrease with experience over time
	Product value – handling & efficiency gains	$/year	Estimated value of increased grades in landed product through improvement in handling techniques due to EM onboard monitoring and evaluation
Compliance & Bycatch			
	IUU reduction - % reduction resulting from EM	%	Percentage reduction in IUU associated with the presence of onboard EM equipment; for example, preventing use of illegal gear, verifying best handling practices for protected species, detecting illegal transshipments; rates of deterrence may vary per activity
	Amount of IUU in management area	metric tons/year	Estimated amount of IUU-associated catch per year in the relevant management area

	Value of IUU catch in management area	$/year	Estimated value of the total IUU-associated catch per year in the relevant management area
	Amount of catch theft per year	metric tons/year	Estimated amount of catch stolen per year in the relevant management area
	Theft - % reduction resulting from EM	%	Estimated percentage reduction in theft associated with the presence of EM system
	Value of stolen catch in management area	$/year	Estimated value of stolen catch per year in the relevant management area
	EM bycatch reduction per set	%/set	Estimated level of additional bycatch interaction reduction per vessel per set associated with the presence of an onboard EM system; could possibly require different values based on species or gear
	Value of bycatch reduction per set	$/year	Total aggregate estimated value generated by any lowered bycatch mortality or interaction due to presence of EM; see non-market values section below
	Rate of bycatch detection - onboard observers	%/set	Rate of bycatch detection generated by onboard human observers, per set per vessel
	Rate of bycatch detection – EM	%/set	Rate of bycatch detection by onboard EM systems (possibly AI), per set per vessel
Markets			
	Average ex-vessel price per species - sashimi	$/mt	Average market price for sashimi products, per metric ton; will need separate prices for each relevant species
	Average ex-vessel price – canned/other	$/mt	Average market price for canned products or other tuna end products, per metric ton; will need separate prices for each relevant species
	Purse seine catch – annual for management area	mt/year	Total catch attributable to purse seine fishery in the management area
	Longline catch – annual for management area	mt/year	Total catch attributable longline fishery in the management area

	Average annual landings – per species	mt/year	Total catch for each relevant species in the management area
	Price premium for EM – per species	%/mt	Estimated % price premium resulting from use of EM; per end product per species
	Sales based on real-time reporting	$/mt	Estimated price premium resulting from importers using real-time catch data to pre-sell catch
	Discount rate	%	Discount rate used in calculations; a range of discount rates may be used
Non-Market Values			Estimated non-market value generated by any reduced mortality of non-fisheries species. These values will be different per species, may vary based on perceived value per stakeholder/decision maker, and the relevant species to include will be unique to each management area. Below are likely broad categories of species to include.
	Marine Mammals	$/species or $/% mortality reduction	
	Sharks & Rays	$/species or $/% mortality reduction	
	Sea Turtles	$/species or $/% mortality reduction	
	Seabird	$/species or $/% mortality reduction	