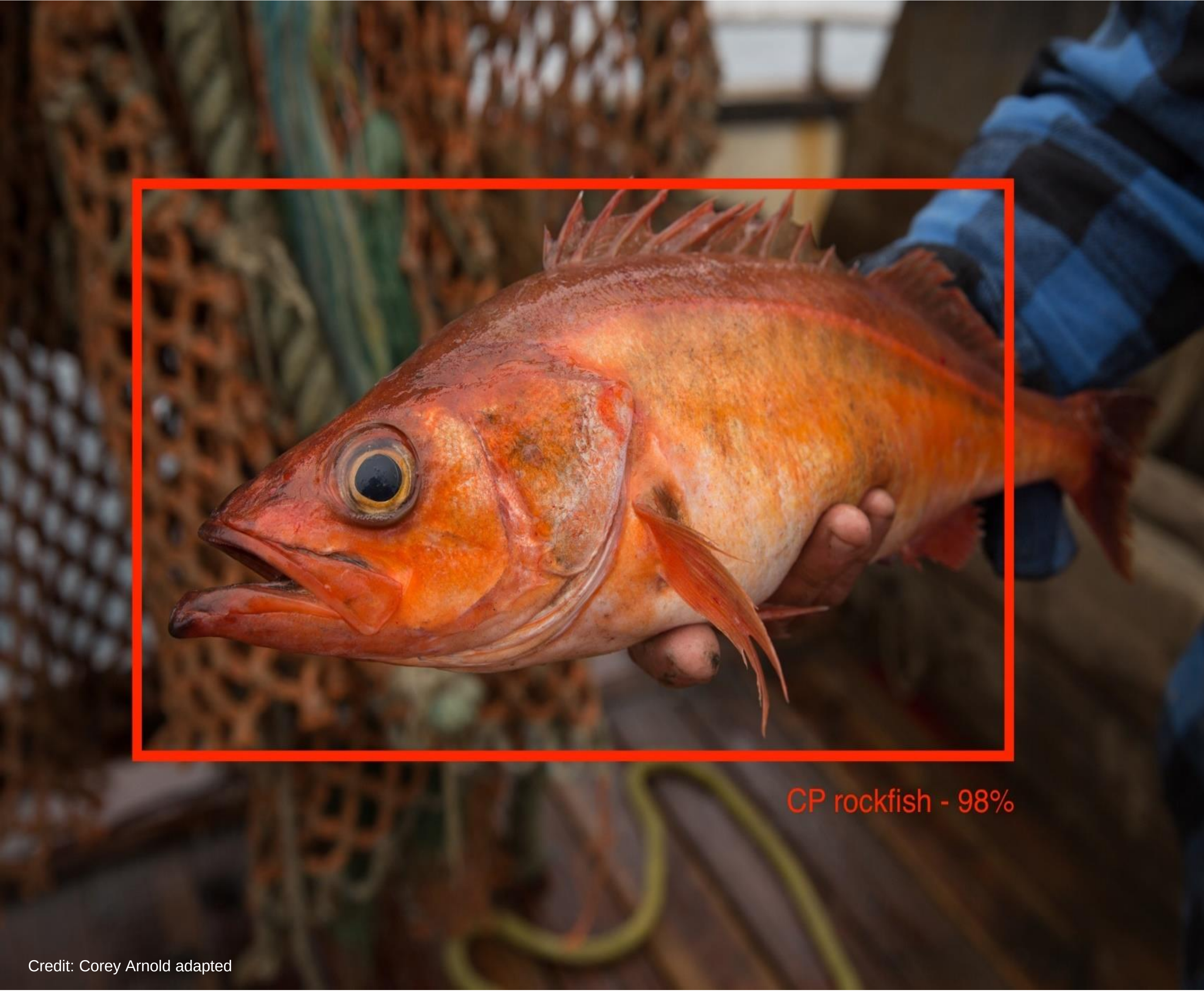

Credit: Corey Arnold adapted

ENHANCING FEDERAL COST SAVINGS: ELECTRONIC MONITORING AND REPORTING IN U.S. FISHERIES

Environmental Defense Fund

Enhancing Federal Cost Savings: Electronic Monitoring and Reporting in U.S. Fisheries

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How to cite this report: Colson Leaning, D., McGonigal, H., Seeley, M., Jud, S., 2024. Enhancing Federal Cost Savings: Electronic Monitoring and Reporting in U.S. Fisheries. Environmental Defense Fund, New York, New York.

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ACKNOWLEDGEMENTS

Environmental Defense Fund (EDF) would like to thank the Walton Family Foundation for generously supporting this work. In addition, EDF would like to thank all interviewees and advisors (listed in Appendix III) that contributed their time and expertise to the development of this report. Special thanks to our reviewers and contributors Brett Alger, Lesley Hawn, Catie Bruger, Chris McGuire, Christopher Cusack, Sarah Poon and Sara Carney.

EXECUTIVE SUMMARY

A changing climate requires more adaptive fisheries management and better tools for collecting data and making decisions. But better data, more responsive management and increased accountability can be costly. Electronic monitoring (EM), electronic reporting (ER) and modern data management systems are essential tools for meeting this challenge in a cost-effective way. Nevertheless, the potential efficiency gains from these tools depend greatly on how and where they are deployed. This report draws on expert interviews with the National Oceanic and Atmospheric Administration (NOAA), fishery commission staff, fishermen, Council members and technology service providers to identify how making more strategic use of EM and ER can maximize government cost savings and increase management efficiency.

The tables below highlight federal cost savings opportunities through the advancement of EM, ER and the use of associated data. EM recommendations focus on strategic fishery selection, using advanced electronic technologies to address high program costs and ways to improve support for existing programs. ER recommendations focus on improving efficiency in data streams that support both commercial and recreational fisheries, as well as overall data modernization.

Electronic Monitoring	
Maximize savings through strategic fishery selection	• Prioritize use of EM in fisheries where observer coverage rates and monitoring costs are already high or where there is a newly identified monitoring need and the cost of developing an observer program would be high. • Prioritize use of EM in geographically dispersed fisheries where maintaining a network of observers is costly.
Streamline EM program design	• Use an audit model approach that requires the submission of self-reported logbook data alongside 100% EM capture, using the lowest video review rate feasible while still meeting core accountability goals. • Only require short video retention periods. Do not let overly conservative law enforcement concerns drive up data storage timelines and costs. • Optimize EM video data transmission strategies for cost-effective monitoring. Explore options for using AI to recognize the portion of video that needs to be transmitted wirelessly. • Stay laser-focused on program goals and avoid mission creep.
Support AI development	• Invest in AI algorithms to automate video review and further reduce costs. • Standardize vessel monitoring plans and EM camera setups to improve AI performance across different vessels and fisheries. • Collaborate with initiatives like Fishnet.AI to create a global repository of annotated EM imagery.
Consolidate or supplement observer programs with EM	• Consolidate observer and EM programs to reduce administrative burden when data collection efforts are redundant. • Supplement observer programs with EM when aspects of fisheries monitoring like catch accounting can be done more cost efficiently by EM and direct observers to collect data that EM has difficulty collecting.
Align fishermen's cost incentives with federal cost savings	• Establish policy directives for observer programs like those for EM to balance cost responsibilities between NOAA and the fishing industry.

Electronic Reporting	
Improve the efficiency of ER in the commercial sector	• Design less complex and error-prone ER systems to minimize agency staff time required for quality assurance. • Streamline and standardize the development of new ER applications by providing packaged tools to developers. • Reduce redundancy and costs by consolidating the back-end management of regional ER programs. • Highlight efficiency gains from ER in NOAA's reporting to Congress.
Make greater use of ER in the recreational sector	• Ensure that data can inform management by standardizing reporting in the private recreational sector. • Support broader and more effective use of ER in the private sector. • Continue to pursue vessel tracking strategies and technologies in the charter sector.
Make better use of ER data by improving integration with other data streams	• Modernize underlying data streams so that systems are better able to communicate and integrate. • Increase efficiency by creating platforms that pre-integrate data sources for stock assessors, in-season managers and marine spatial planners.
Provide greater funding and leadership for data modernization	• Increase staffing and funding to allow for needed engagement in multi-year planning and problem solving. This includes hiring and retaining staff with institutional knowledge, expanding Fisheries Information System program funding, and providing more dedicated funding to key data modernization projects. • Advance a national plan that provides a cohesive vision, steps and timeline to help attract resources and ensure they are directed in a strategic way.

In conclusion, the adoption of EM and ER technologies offers significant potential for enhancing the efficiency and accountability of fisheries management. However, their success hinges on strategic deployment, careful design and ongoing investment in innovation, particularly in AI and data integration. As the demand for adaptive management grows in response to climate change and other challenges, fostering collaboration between agencies, the fishing industry and tech providers will be essential. By aligning cost-saving incentives and modernizing data systems, fisheries management can meet future challenges in a more sustainable and cost-effective manner.

INTRODUCTION

Effective fisheries management is challenging at the best of times. It requires in-depth understanding of fish populations and timely and reliable information from the fisheries that target them. But as the climate changes, species shift and fisheries adapt, this challenge becomes even more pronounced. To ensure the nation's fisheries remain sustainable and profitable, we must capitalize on technological innovation and modernize the data collection systems they depend on. Not only will this benefit fish and fishermen, it will also increase management efficiency and reduce costs for taxpayers. Two of the most promising uses of technology are the use of electronic reporting (ER) which replaces paper logbooks with apps that record catch and discards, and electronic monitoring (EM) which can fulfill many functions normally performed by human observers using onboard cameras.

The ability of these tools to provide valuable data to managers and reduce costs for industry are well documented,[1,2] however, their ability to increase efficiency and reduce taxpayer costs is underexplored. This is largely due to the lack of cost information regarding legacy programs and the variables associated with the potential pace of integrating more modern approaches. While these uncertainties preclude a meaningful agency-wide cost analysis, there are good examples that illustrate how EM and ER are reducing costs and increasing efficiency in specific programs. This report draws from interviews with NOAA and fishery commission staff, fishermen, Council members, and tech providers to identify these examples and discuss how they can be scaled more broadly. The hope is that describing, and where possible quantifying, these cost and efficiency gains will encourage greater investment of the time, resources and leadership needed to expand the use of EM and ER and modernize fisheries data collection and management.

1. ELECTRONIC MONITORING

Federally managed U.S. fisheries are some of the best monitored fisheries in the world. The Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) require the government to collect data on fishing activities to monitor the impact on marine resources, and NOAA's National Observer Program is a key element of this effort. NOAA has been employing observers to collect fisheries data since 1972, but observer costs are becoming increasingly expensive and federal budgets are not always able to keep pace. As a result, NOAA may be compelled to reduce observer coverage rates. This is already taking place in the Hawaiʻi deep-set longline fishery, in which NOAA reduced the target observer coverage rate from 20% in 2023 to 7% in 2025 citing increasing costs.[3] Falling and low observer coverage rates means less transparency into fishing operations, which impacts our scientific understanding of protected species interactions and incidental bycatch.[4] EM represents a cost-efficient solution to help supplement or in some instances replace observer programs to ensure that catch and bycatch data can still be collected under current and future budget constraints. EM also represents an improvement over observer programs in some respects. There is evidence demonstrating fishing behavior changes when observers are present, making extrapolation of observer data to unobserved trips problematic.[5] Additionally, fishermen-reported discard rates have been shown to be biased low compared to observed discard rates.[6] Despite its promise, uptake of EM has been slow. Achieving cost efficiencies is a key lever that can increase the rate of EM adoption.

This section explores the various means by which cost savings can be realized. Subsection 1.1 identifies specific fishery characteristics that indicate when EM may be better suited than observers to achieve cost-efficient monitoring. Subsection 1.2 reviews EM design considerations that improve cost efficiency. Subsection 1.3 explores current and future applications of AI technology in EM to achieve long-term cost savings. Subsection 1.4 reviews opportunities for consolidation of fisheries monitoring programs (e.g., observer and EM programs). Subsection 1.5 discusses cost allocation policies that align fishermen's personal cost incentives with keeping overall programmatic costs low to save taxpayer dollars. This section concludes with a case study on the Hawaiʻi longline fisheries to specifically illustrate how the generalized recommendations discussed in subsections 1.1–1.5 might be applied to a real fishery along with an estimate of potential cost savings.

It is worth noting that these discussions are against the backdrop of the 2023 Supreme Court case, *Loper Bright Enterprises v. Raimondo*, which overturned what is known as the "Chevron doctrine".[7] Under the Chevron doctrine, agencies were afforded significant deference in how they implemented the laws they are charged with carrying out. The case has created some uncertainty regarding NOAA's ability to require industry to pay for observers and EM outside of Limited Access Privilege Programs (LAPP), more commonly referred to as catch shares. While the MSA provides clear authority for NOAA to recover the costs of accountability monitoring in a LAPP[8], lower courts may soon find on remand that the MSA does not provide sufficiently explicit authority for cost recovery in non-LAPP fisheries. While this uncertainty does not change our recommendations below, it is important context, particularly as it relates to how monitoring costs are allocated.

1.1 Maximize EM cost savings through strategic fishery selection

With finite resources and staff time to implement EM programs, NOAA should carefully analyze fishery characteristics prior to implementing an EM program. Existing literature indicates that EM can be more cost efficient than observer programs,[9] but several factors such as scale, geographical dispersion, review rates, data reporting requirements and method of transmitting data influence this outcome. Staying focused on monitoring needs and applying lessons learned from other EM programs will allow fisheries managers to implement EM programs in fisheries where cost savings potential is greatest.

Prioritize implementation of EM when target observer coverage rate is high

EM benefits from economies of scale. The administrative costs associated with developing an EM program — staff time for program design, training staff, legal review, auditing of EM vendors and integrating EM and its data into existing monitoring efforts — are fixed costs. The more vessels that implement EM systems, the more these fixed costs can be brought down on a per vessel basis. Observer coverage rate is also important to consider. EM can be cost efficient compared to an observer program when required human observer coverage is high, as is the case in the West Coast groundfish fishery, which is required to have 100% observer coverage. By contrast, replacing an observer program with a low coverage rate with an EM program is not likely to result in significant cost savings. Fishing effort, defined as the number of days fishing per year, is an additional factor that impacts the scale of the monitoring program. EM costs relative to observer program costs go down as fishing effort increases due to the high fixed costs and lower marginal costs of EM programs.[10] In essence, the greater the size of the monitoring program, the more likely it is that EM represents a more cost-effective solution. While cost savings are a factor, other considerations may influence the decision to implement EM. Low observer coverage often stems from financial limitations rather than scientific or management needs. In such cases, EM may not significantly reduce costs but can greatly enhance scientific outcomes, which should be carefully weighed against potential savings.

Substitute EM for observers in geographically dispersed fisheries

Geographical dispersion, defined as the number of ports and their geographic isolation within a fishery, must also be considered when assessing EM cost efficiency compared to observer programs. The cost of running EM and human observer programs both go up as geographical dispersion increases. For EM programs, the costs of equipment installation, equipment maintenance and data transmission via hard drive retrieval all increase when ports are geographically dispersed. However, the effect of geographical dispersion on cost is even stronger for an observer program because the logistical support needed to deploy observers across multiple ports is more of a challenge compared to EM systems.[11]

1.2 Streamline program design to achieve cost efficiency

This subsection focuses on EM program design, with an eye toward not duplicating the existing literature on the topic[12,13,14] but instead focusing on EM design elements that have the potential to increase cost efficiency.

Optimize EM video review rates for cost-effective monitoring

EM video review rates have a big impact on the overall cost of an EM program. The competing goals of cost efficiency and reducing scientific uncertainty should be carefully considered. Higher review rates contribute to reduced uncertainty in catch and bycatch estimates, but if review rates are set too high, an EM program can become unsustainable from a funding perspective. When review rates are low, increasing the rate can have an outsized beneficial impact on scientific certainty, but returns diminish as review rates keep increasing.[15] While there is no agreed upon review rate, one of the stock assessment scientists we interviewed suggested that a 5% review rate is needed for target species monitoring, a 15% review rate for incidental bycatch species monitoring, and a 30% review rate for monitoring rare encounters with protected species. Some fisheries have explored options for minimizing uncertainty without having to substantially increase review rates. For example, in the West Coast groundfish fishery, the captain's logbook serves as the primary data source and EM data serves to verify the logbook's accuracy. A subset of EM data is reviewed and compared to logbook data for each trip, and the full set of logbook data is deemed accurate if the reviewed data match. With 100% EM capture and low review rates, managers can choose to review additional footage when something unusual appears. This flexibility sets it apart from regular observer coverage. Other creative methods may be possible for achieving high levels of accuracy at a fraction of the cost of human observers. Ultimately, review rates depend on the monitoring needs of the fishery, and setting a rate that is financially sustainable is important.

Limit federal data reporting to essential information to minimize costs

While data storage may not represent a large portion of cost in an EM program, federal policy on data storage can have big implications on total government expenditures when you consider the sum of impacts it has on the many existing EM programs and the likelihood that EM programs will continue to grow in number as fisheries monitoring modernizes. For example, NOAA policy procedure 04-115-04 requires all federally obtained EM data (video, images, sensor and metadata) be stored for a minimum of 5 years.[16] In contrast, NOAA policy procedure 04-115-03 requires all EM data collected by a "third-party" EM service provider be stored for a minimum of 1 year.[17] The greater the storage time, the greater the costs for both cloud and physical storage. As such, during

EM program design, careful consideration should be given to what data is required to be passed on from third-party EM service providers to NOAA. Where possible, data should be sent in tabular form, rather than raw footage, to keep costs low. Data accessibility also plays a role in overall cost of data storage, so the speed at which data needs to be accessed should also be analyzed as a potential cost savings measure.

When determining EM data storage policy, data users' preferences should be weighed against cost efficiency. For example, the NOAA Office of Law Enforcement may prefer to retain data as a federal record or even prefer to retain EM video data indefinitely to ensure access should the need arise. Yet in the case of the Northeast groundfish fishery, during most investigations the Office of Law Enforcement focuses its efforts on the incident reports submitted by the third-party EM provider, and reviewing the supplemental video data is not necessary.[18] Considering law enforcement, scientific and data analytics preferences alone may result in greater data storage costs that could render an EM program financially unsustainable. The Atlantic Highly Migratory Species (HMS) EM program's data storage policy is on one end of the spectrum with 100% of EM data considered a federal record with a resultant 5-year retention period.[19] In contrast, the agency only retains a subset of video data collected through the Northeast groundfish EM program. Of all EM video data recorded, 35%–50% is reviewed by a third-party reviewer, and only a portion of that video data is sent to NOAA for a secondary review and stored. Each fisheries EM video data storage policy should be reassessed periodically to ensure that data storage fees aren't maintained at levels higher than necessary. Furthermore, cost efficiency and frequency of data recall from storage should be analyzed when NOAA reviews its third-party data retention policy in April 2025.

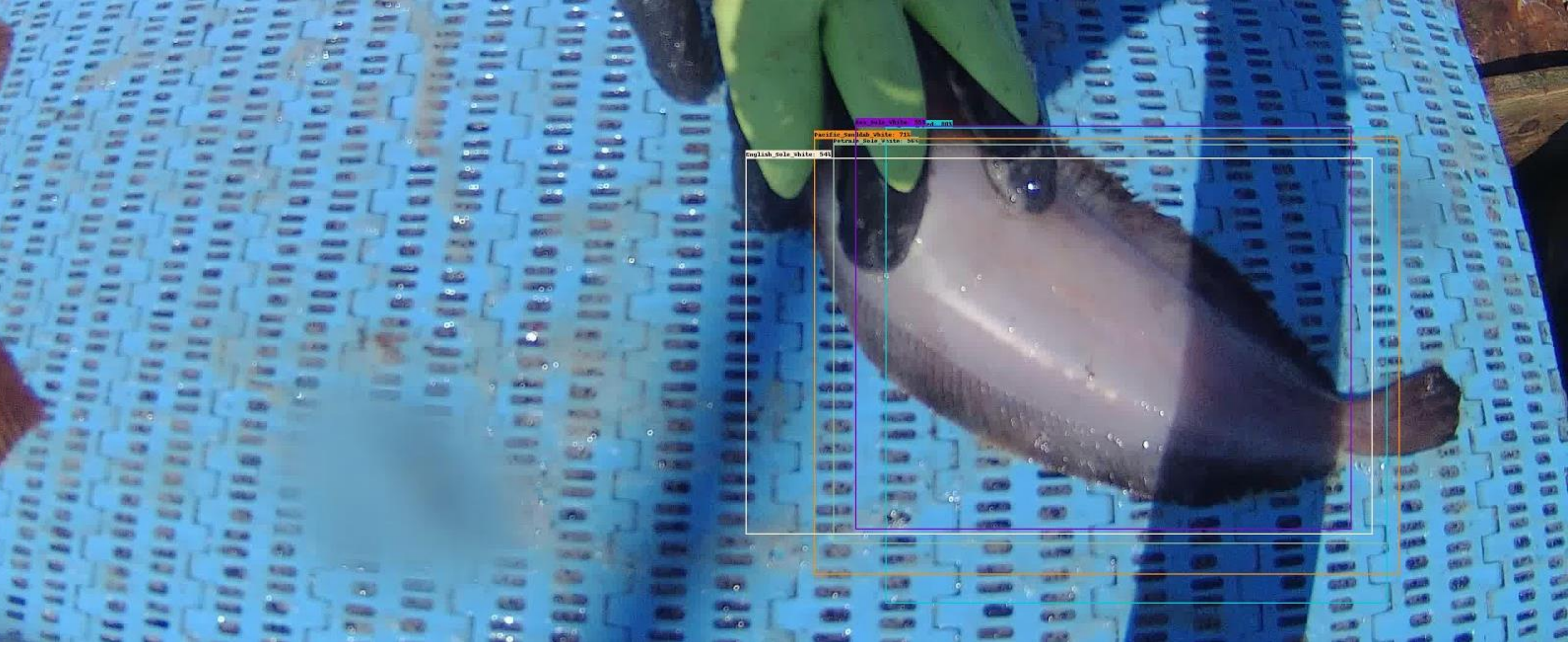
Optimize EM video data transmission plan for cost-effective monitoring

When designing a data transmission plan for an EM program it's important to first consider the pre-existing conditions of a fishery. Geographical dispersion of the fleet, fishing trip length, typical length of stay in port, the number of ports visited, and how and when the data is needed all impact decisions on data transmission method. Wireless transmission of EM data could be cost efficient compared to shipping hard drives in a fishery characterized by many short coastal fishing trips where EM data is needed in near real time for in-season management. In this instance, the need to frequently ship hard drives could be costly. However, in a fishery characterized by vessels that take long fishing trips far out at sea with a short time window for data transmission in port, wireless transmission may not be feasible. This is because data transmission via cellular network and Wi-Fi require proximity to land, and transmitting large files from a lengthy fishing trip could require more time than the duration of a vessel's stay in port.[20] Wireless transmission of EM data via Starlink is a possibility, but the costs are still high relative to the alternative of mailing hard drives. Starlink charges a one-time fee of $2,500 for hardware and a monthly rate of $250 for 50 GB of data or $1,000 for 1 TB of data, and $2 per GB of data over the stated limits. Data collected from EM can reach 40–70 GB per day at sea in some fisheries.[21] At Starlink's current rate of $1–$5 per GB, mailing hard drives represents a much more cost-effective solution in most situations. Despite these costs, EM provider Integrated Monitoring is already bundling Starlink with EM for increased efficiency. This has the secondary benefit of providing internet connectivity to fishermen while out at sea. Technology is advancing toward the potential for AI to be combined with edge computing to analyze the footage onboard and wirelessly transmit only select fishing activities. The next section discusses the cost savings potential of this and other AI efforts in greater detail. In conclusion, during the design phase of an EM plan, policymakers should carefully consider all fishery characteristics prior to setting guidelines on the method of data transmission and retrieval.

1.3 Support AI development in EM for long-term cost savings

Invest in the advancement of AI algorithms

Artificial intelligence is revolutionizing many industries, and the fishing industry is no exception. The incorporation of AI into EM to assist data collection and video review is a burgeoning field of study. AI is capable of detecting and counting fish via EM footage.[22] Other studies have harnessed AI to identify species and generate length estimates of fish.[23,24,25] While still in development, automatic species ID and length estimation may ultimately lead to dramatic cost reductions as it replaces the current high cost of human review. Another study has demonstrated AI's capacity to detect catch events on longline fishing vessels with a 98.8% accuracy rate.[26] In the near-term, significant cost efficiencies can be realized if AI is able to segment out the instances where catches occur; this allows human reviewers to focus their time efficiently. Firstly, transmitting and storing less data represents potential cost savings. Secondly, video reviewers would have less video footage to review by an order of magnitude or more depending on the fishery. While improvements to AI in streamlining video review efficiency represent upfront costs, there are significant cost savings to be gained in the long-term. As such, federal fisheries management should invest in improving AI algorithms for activity recognition, species detection and length estimation.



Standardize camera views and catch handling protocols for greater AI applicability

While the aforementioned developments in AI offer promise of cost savings through greater efficiency, to date most applications of AI technology have been through small-scale pilots. Lack of standardization across EM programs and fishing vessels represents one barrier to scaling. AI algorithms perform best when the field of view for EM cameras is standardized, but vessel layout can vary greatly even within the same fishery. Without standardized catch handling protocols and fields of view, each application of AI algorithms must be custom designed, making the process both costly and time-consuming. To improve AI species identification performance some researchers have tested the use of a fish conveyor belt contained within a housing unit to standardize lighting, background and the distance between the fish and the camera. This has enabled more accurate fish species detection and weight estimation.[27] The more that EM vessel monitoring plans can standardize aspects such as the camera field of view, camera distance from the scene, camera angle, catch handling protocols, etc., the better and more consistent AI performance will be across fishing vessels and fisheries.[28]

Build an open-access repository of annotated EM imagery to catalyze AI advancements

Legal issues around data sharing and concerns about EM video data confidentiality represent another barrier to scaling AI solutions. AI algorithms are only as good as the data that is used to train them. Knowing this, The Nature Conservancy (TNC) has created Fishnet.AI, a dataset of images from on-board monitoring cameras designed to accelerate the development of automated systems for analyzing EM imagery. The images in Fishnet.AI are annotated with metadata and labels that describe the contents of the images. These annotations are crucial for training machine learning models to recognize and classify species and human activities aboard fishing vessels. Fishnet.AI is designed to be an open-access resource, allowing researchers, institutions and developers from around the world to contribute to and utilize the database. NOAA should pioneer an effort of their own or partner with an existing platform like Fishnet.AI to further the goals of creating a publicly accessible repository of EM annotated imagery to improve AI tools for fisheries monitoring. NOAA has already contributed seed funding and data to FathomNet, a very similar project that endeavors to do the same as Fishnet.AI except with a focus on marine underwater imagery.

There are however a few challenges with sharing on-board imagery. Fishermen are likely to have confidentiality concerns about video footage of their vessels' operations, and some EM providers may see sharing video access as giving away potential proprietary advantages. However, clear communication of the goals of this type of project and the likely efficiency gains may persuade some private institutions and fishermen to participate. To ameliorate concerns about data privacy, Fishnet.AI removes any information related to location, vessel name, or unique identifying features like vessel license number and blurs human faces. One possibility for obtaining more annotated data for AI algorithm improvement includes retrofitting NOAA survey vessels with EM systems to build a pipeline of non-confidential imagery suitable for incorporation into a publicly accessible database.[29] NOAA should also analyze the pros and cons of a national versus global database. While FathomNet has had success as a global database, there may be challenges with developing a global database for on-board EM imagery. Whatever the method and scale, building out an open access library of annotated EM video data will lead to improved AI algorithms, ideally resulting in cost savings in the form of automation.

1.4 Consolidate EM and observer programs to reduce administrative burden

Fisheries dependent data collection is a central pillar of fisheries management, but rising costs of data collection put the sustainability of these programs at risk. During the pilot and pre-implementation phases of EM it is logical to keep multiple data collection programs running simultaneously. However, once an EM program is established, efforts should be made to consolidate monitoring programs to reduce redundancy and keep administrative costs low. The Northeast groundfish fishery is a prime example where this recommendation should be implemented.

In 2023, the Northeast groundfish fishery had four observer and EM programs: the Northeast Fisheries Observer Program (NEFOP), At-Sea Monitoring (ASM), audit model EM and Maximized Retention Electronic Monitoring (MREM). The administrative burden of managing these programs and maintaining quality assurance and quality control of all data streams increases with the number of programs. In 2022, 11.7 million taxpayer dollars were spent on the ASM and EM programs alone.[30] By comparison, the gross annual revenue from groundfish trips in 2022 was $65.4 million.[31] Trimming down the number of overlapping and redundant fisheries monitoring programs and focusing efforts on one or two is likely to be more cost efficient. In fact, the MREM program was suspended in 2024 due to low enrollment and the high administrative cost of maintaining the program. Further optimization of data collection may still be necessary. The audit model EM program collects almost identical data streams to ASM, and as such, one could be substituted for the other. By comparison, NEFOP represents a more comprehensive biological specimen collection program, and may not be replaced as easily by EM.[32] However, biological specimens could feasibly be collected via dockside intercepts. Paying staff to intercept vessels when they return would likely be more cost efficient than paying observers to stay aboard a vessel for the entire fishing trip. The MREM program represented an effective way of retaining discards to ensure that biological sampling could occur for both retained target and incidental catch. Staying focused on management needs and the data streams required for effective management can allow for optimization of new and existing monitoring programs to meet fishery, science and user needs cost-effectively.

1.5 Align fishermen's cost incentives with federal cost savings

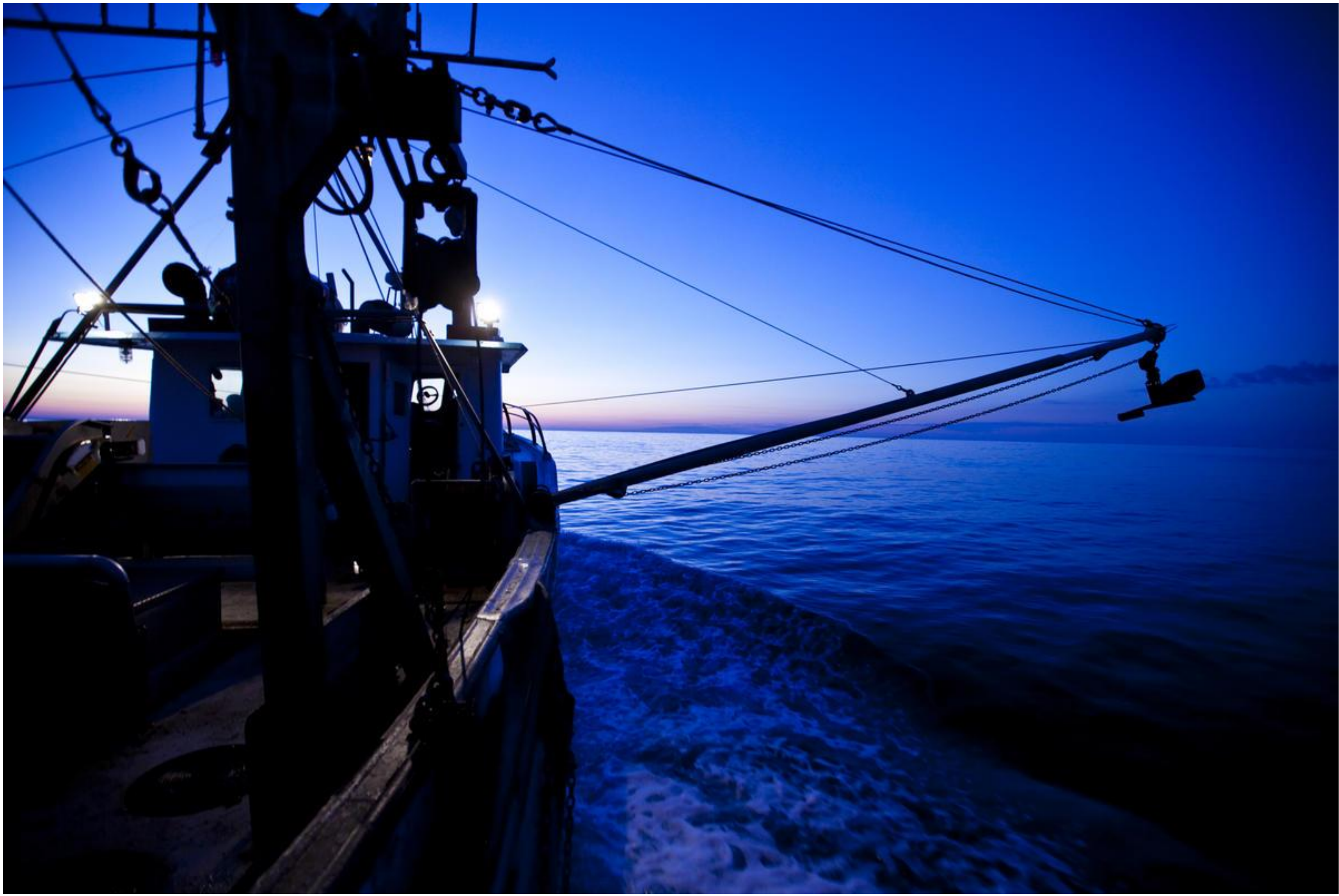
The implementation of EM programs, and thus potential cost savings, is being impacted by the allocation of costs between NOAA and the fishing industry. The NOAA Office of Science and Technology (OST) produced a policy on cost allocation in EM programs which states that NOAA will be responsible for the administrative costs and the fishing industry will be responsible for all other costs (sampling costs). This policy directive defines administrative costs as including the cost of setting standards for EM programs, monitoring program performance, and providing administrative support to address science, enforcement and management needs.[33] The agency has a stated objective to work with the regional Councils and stakeholders to develop plans that transition EM sampling costs to the fishing industry. NOAA policy even states that "no electronic technology-based fishery-dependent data collection program will be approved by NOAA if its provisions create an unfunded or unsustainable cost of implementation".[34]

While well intentioned, this policy creates a disadvantage for EM programs compared to human observer programs, because no such directive exists for all human observer programs. This creates a situation where fishermen are incentivized to politically support maintaining human observer programs and oppose EM programs to avoid being allocated responsibility for sampling costs. In fact, EM uptake and fishermen support have been almost exclusively limited to those fisheries that require fishermen to pay for human observer costs. For some fisheries, EM represents a more cost-efficient monitoring solution with potential for greater coverage, but this perverse incentive pits fishermen's personal economic well-being against programmatic cost efficiency. NOAA's Catch Share Policy does have a "cost recovery" component, which requires fishermen to pay for the additional government costs associated with management, data collection and analysis, and enforcement of limited access privilege programs.[35] However, this policy only applies to the seventeen fisheries operating under a catch share program.[36] NOAA should establish compatible policy directives for EM and human observer programs to create an even playing field and align fishermen's interests with cost efficiency.

The Northeast groundfish fishery illustrates another example of how well-intentioned policy can lead to a disconnect between fishermen's personal interests and the overall cost efficiency of the program. The cost of observer coverage and EM programs in this fishery are quite large relative to the revenues of the many small-scale fishing operations. To ease this burden, fishermen are reimbursed for monitoring program costs through annual congressional appropriations, regardless of which type of monitoring they opt into. Typically, decisions regarding commercial fishing operations are primarily driven by the cost incentive, but this incentive is not present with full reimbursement of costs. Without the cost incentive factoring into their decisions, fishermen are influenced by other factors when selecting EM versus observers, such as choosing whichever monitoring program is least disruptive to daily operations. The EM program currently requires fishermen to adjust catch handling protocols. This may deter some captains from participating. On the other hand, many captains prefer the flexibility afforded by EM where they don't have to carry an observer on their small vessel. Some fishermen are opposed to EM due to their mistrust in how the data is used.[37] Regardless of the reason, some Northeast groundfish fishermen have demonstrated a preference for maintaining observer coverage instead of transitioning to EM. As of 2023 less than 20% of the fleet participated in the EM program.[38]

This is an unfortunate result, especially considering that EM is estimated to be a more cost-efficient alternative to the observer program.[39] The reimbursement process should be redesigned such that fishing vessel captains are incentivized by the overall programmatic cost when deciding between an observer program and an EM program. This could potentially be accomplished by setting a flat rate for sea day reimbursement and allowing Sectors to pocket any surplus above the actual cost of fisheries monitoring. In this way, fishermen would be incentivized to select the fisheries monitoring method that is least costly. Over time, NOAA could then reduce the flat rate for sea day reimbursements.[40]

Furthermore, the current approach in the Northeast groundfish fishery, where congressional appropriations fund fisheries observers and EM, has not incentivized NOAA to prioritize cost efficiency. Some program decisions have overlooked cost concerns, as evidenced by the four simultaneous EM and observer programs in operation in 2023. It appears that this reimbursement model lacks incentives for keeping costs low. Given the high-profile nature of the Northeast groundfish EM program, improving cost efficiency should be a priority to serve as a good model for improving cost efficiency across all EM programs.



Case study: Hawai‘i longline fisheries

This case study examines how the cost-saving recommendations from subsections 1.1–1.5 can be applied to the Hawai‘i longline fisheries.

Background on the fishery

Fisheries monitoring is a crucial element of maintaining sustainable management of the Hawai‘i longline fisheries. There are five species of turtle and one cetacean that are listed as threatened or endangered under the ESA and several other cetaceans protected by the MMPA that are incidentally caught in the Hawai‘i longline fisheries. Most critically, under the requirements of an ESA Biological Opinion, if two false killer whales are killed or seriously injured due to interactions with longline gear, it triggers a large area closure in the southern exclusion zone.[41] Effective science-based management of these fisheries hinges upon effective fisheries monitoring, which to date has been through an observer program. The NOAA Pacific Islands Regional Office's (PIRO) decision to reduce observer coverage rates in the deep-set longline fishery — from 20% in 2023 to 13% in 2024, and further down to 7% in 2025 — raises serious concerns, with additional reductions likely if the agency fails to implement cost-effective measures to maintain coverage.[42] In response, the Electronic Technologies Steering Committee (ETSC), the Western Pacific Fishery Management Council and NOAA are assessing the potential of implementing an EM program to support monitoring requirements in the Hawai‘i longline fisheries.

The Hawai‘i longline fleet consists of approximately 150 fishing vessels. The deep-set fishery targets bigeye tuna, and the shallow-set fishery primarily targets swordfish. Yellowfin tuna, opah, blue marlin and other pelagic commercially viable species are retained when caught. The average lengths of deep-set and shallow-set longline fishing trips are 23 and 32 days, respectively. Protected species such as marine mammals, sea turtles, and sea birds are occasionally caught as bycatch.

Maximizing EM cost savings through strategic fishery selection

Prioritizing EM for the Hawai‘i shallow-set longline fishery—where the target observer coverage is 100%—could maximize NOAA’s return on investment, as EM is often more cost-effective than human observers at higher coverage rates. EM is especially cost-efficient for geographically dispersed fisheries, like Hawai‘i’s longline fishery, which span vast areas with moderately dispersed ports. While most vessels depart from Honolulu, some use other ports in Hawai‘i, California, or American Samoa, raising logistical costs for human observers.[43] Observers are paid per sea day regardless of fishing activity, which adds costs given the long transit times in this fishery. The shallow-set longline fishery in particular has an extensive area spanning from much of the northeast side of the Hawai‘i island chain to the edge of the California EEZ. Shifting to EM would reduce these costs, and by comparison, data retrieval and equipment maintenance costs are more manageable. Therefore, implementing EM in both Hawai‘i’s shallow-set and deep-set longline fisheries could yield substantial cost savings over the current observer program.

Streamlining program design to achieve cost efficiency

To optimize cost-effective EM video review, NOAA must balance adequate review rates with the need to monitor protected species interactions effectively. PIRO staff highlighted that the ability of EM to detect interactions with sea turtles and cetaceans is essential. Research shows that EM can accurately identify protected species and release conditions when species are onboard or close to the vessel, but accuracy declines beyond 20 feet.[44] However, this limitation is comparable to observer challenges at similar distances. Moreover, any visibility issues with EM may be offset by the increased monitoring coverage in the deep-set longline fishery if species handling guidelines are followed within the camera's view. With existing observer coverage set at a target rate of 7% in the deep-set longline fishery, extrapolation of data trends from this limited sample produces uncertainty. This uncertainty may even be exacerbated by differences in fishermen's behavior when a trip is observed versus unobserved (i.e., in how they operate their fishing gear and how they report elogs). For example, fishermen are incentivized to not report an interaction with a cetacean for fear of triggering an area closure. From 2017 to 2023, 64 of the 67 recorded false killer whale gear interactions have been reported when an observer is on board with the remaining three instances occurring when an observer was not present.[45] This clear discrepancy exists even though observer coverage only ranged from 15% to 20% during those years.[46] While EM's capacity to monitor protected species may not be perfect, the alternative of limited observer coverage in the deep-set fishery is likely to be even less effective, as long as EM video review rates are high enough to generate accurate estimates. Determining EM review rates in Hawaiʻi longline fisheries should weigh scientific accuracy against cost efficiency and be reassessed periodically.

Cost and operational efficiency should factor into NOAA's decision to either contract out the responsibility of managing EM installation and operations or keep it in house as a federally run program. If NOAA pursues a third-party model, as much as possible, data should be reported in tabular form as opposed to requiring the reporting of raw video data to keep federal data storage costs low. In addition, prior to transitioning to an EM program, existing data reporting requirements should be reassessed. Furthermore, prior to EM implementation, NOAA should streamline data requirements by removing non-essential fields.

The EM video data transmission plan should also factor in cost and operational efficiency. Most landings are brought to one auction site,[47] likely making it more cost efficient to exchange hard drives as opposed to wireless transmission. However, as AI continues to develop, there may be opportunities to slim down raw footage into key data elements, which may make wireless transmission a more convenient and affordable option. This will be discussed in greater detail below.

Supporting AI development in EM for long-term cost savings

The Pacific Islands Fisheries Science Center (PIFSC) is exploring operational and cost efficiencies from AI algorithms applied to EM data. PIFSC is building their own library of images collected via EM to assist in the development of AI models to automatically detect catch events, with particular focus on protected species interactions.[48] In the Hawaiʻi longline deep-set fishery, gear retrieval can take up to 14 hours, and 90% of hooks do not have any catch.[49] If successful, an algorithm could significantly reduce EM video review time and costs.

The ETSC should consult with other fisheries managers who administer EM programs to determine if it is feasible to standardize elements such as camera field of view, camera distance from the scene, camera angle and catch handling practices. Standardization of these elements may enable the broader application of AI algorithms in other fisheries with minimal additional AI training. While developing activity recognition or species identification algorithms can be expensive, the return on investment can be maximized if minimal additional training is needed in new applications. The ETSC should expand upon its existing collaboration with the Atlantic HMS longline fishery, which has fleetwide implementation of EM. While there are differences between the two fisheries, there are opportunities for synergy since the Atlantic HMS fleet is the closest fishery to resemble the Hawaiʻi longline fishery. Additionally, the ETSC should continue to seek out collaboration with other current or future EM programs that annotate protected species interactions.

Further, Hawaiʻi longline EM data could contribute to an open-access repository of annotated imagery, encouraging broader AI collaboration across EM programs. However, this recommendation is likely to face challenges. Some fishermen already consider EM to be an intrusion into their private working space,[50] so there is likely to be resistance to making this data publicly accessible. Early and sustained engagement will be needed to establish trust and to convey the importance of this endeavor. Steps such as removing vessel identifiers and specific locations from annotated EM data can also help assuage concerns over data confidentiality. The cost allocation for this EM program remains undecided, but if the industry shares some costs, they may be motivated to pursue long-term AI efficiencies.

Consolidating EM and observer programs to reduce administrative burden

The ETSC and PIFSC have closely analyzed EM's ability to meet monitoring goals for Hawaiʻi longline fisheries, demonstrating that most observer-collected data can be reliably captured by EM.[51] Some of the remaining data elements could be collected through establishment of a vessel monitoring plan that details how fishermen handle gear, protected species, retained catch and bycatch to align with the viewpoint of EM cameras. The observer collected data elements flagged as challenging to collect via EM are included in Appendix I (Table 1) along with comments on how an EM system or alternative methods might be optimized to collect that data. Perhaps the most challenging data stream to replace is biological specimen collections and research opportunities to apply metal flipper and satellite tags to endangered sea turtles. Dockside intercepts could enable collection of biological samples from commercially valuable and retained species, but biological samples from discarded species and protected species would still represent a challenge. A limited observer program could focus solely on these biological collections, leveraging observers' unique expertise and equipment, as fully replicating this capability would require large-scale chartering of the fishing fleet.

With EM under consideration in the Hawaiʻi longline fisheries, fisheries managers should be planning how to consolidate rather than duplicate fisheries monitoring efforts. Our analysis of the deep-set longline fleet indicates that elimination of the observer program and full implementation of EM with a 25% video review rate would result in approximately $4.7 million in federal cost annual savings (Appendix II). Recognizing that complete elimination of the observer program is neither practical nor politically feasible, costs were estimated for a program with observer coverage reduced to 10%, and EM systems implemented on the remaining 90% of the fleet. In this scenario, projected annual savings ranged from roughly $145,000 to $447,000. In a third scenario, EM coverage could remain at 100% with observer coverage at 5% of the fleet solely dedicated to biological specimen collection. In this way, biological specimen collection levels could be maintained or possibly even increased with a smaller amount of observer deployments. While PIRO staff have not yet determined what the minimum observer coverage rate would need to be to still meet the scientific goals of the program, they indicated that a range of 5–10% would likely be appropriate.[52] In this scenario, projected annual savings ranged from roughly $1.6 million to $2.1 million. A potential benefit of this shift in observer responsibilities would be redefining the often-contentious relationship between observers and crew. If observers only collect biological specimens and leave catch monitoring to cameras, the policing aspect of their role could be eliminated, thereby reducing tensions between observers and fishing crews. Scenario three is our preferred scenario and represents significant cost savings while increasing monitoring coverage and maintaining the collection of valuable at-sea data that cannot be collected via EM alone.

Against a backdrop of rising costs to the observer program and an uncertain future for funding, we recommend that NOAA consider a partial transition from observers to EM to maintain a robust fisheries monitoring program for Hawaiʻi's longline fleet.

Aligning fishermen's cost incentives with federal cost savings

While it is encouraging that supplementing the observer program with EM in the deep-set longline fishery is projected to result in cost savings, this fact alone does not guarantee the program will be implemented. Fishing industry support for EM is integral to success, and decisions regarding allocation of costs likely weigh heavily on fishermen's minds. Thus far, the observer program has been funded through the Fisheries Information System (FIS) program.[53] To ensure that the EM program has a chance of being considered on equal terms as an alternative to observers, PIRO should maintain equal cost reimbursement or cost responsibility policies for both EM and the observer program**.** This ties back into the recommendation that if NOAA policy requires fishermen to cover the cost of EM, it should also do so for observer coverage. If this action is not taken, it is very likely that fishermen will not opt into EM and the cost savings potential will not be realized.

2. ELECTRONIC REPORTING

While EM is still facing hurdles to widespread use, the adoption of ER is largely underway. In commercial fisheries, ER has already proven its ability to reduce reporting burdens for fishermen, reduce the time it takes to integrate information into decision making, and reduce costs. For example, NOAA estimates that the switch to ER in the New England region reduced the time it takes to process trip data from 30 days to three.[54] Efficiency gains like these have led to new programs across the country and now more than 3,000 commercial fishing vessels have transitioned to ER. Current momentum will ensure this number continues to grow. The primary need now is not necessarily to encourage broader adoption of ER in commercial fisheries, but rather to make existing programs more efficient and make more effective use of the data by standardizing how it is collected and better integrating it with other data streams. While this can require changes in data management structures and investment, the impacts of failing to do so are significant. For example, stock assessors and in-season managers currently spend substantial time quality checking ER data and matching it with other data sources including dealer reports, observer data, dockside sampling, EM and vessel monitoring systems (VMS). Stock assessors in our interviews estimated that approximately 30% of their time is spent on this kind of basic quality control and data linking.[55] Not only does this have a cost to taxpayers, but it can translate to fewer and delayed stock assessments, unresponsive in-season management, and ultimately less resilient fisheries. NOAA has recognized this, and some regions have begun to take steps to modernize and integrate data collection efforts. Additionally, NOAA's FIS program has provided some limited funding to data improvement and integration efforts. This section outlines some of the key actions that can help overcome the inefficiencies that managers and scientists face. It also provides examples of regional projects aimed at addressing these inefficiencies and the benefits and cost savings that could be realized through greater national support.

2.1 Improve the efficiency of ER in the commercial sector

Design less complex and error prone systems

A notable example of inefficient electronic reporting is the dealer report that fish buyers are required to submit on the East Coast. While the weight information contained in dealer reports is vital to science and management, the submission system is unnecessarily complicated and produces unreliable data that requires significant time and staff resources to correct. Part of the challenge is that dealer reports arrive at the Greater Atlantic Regional Fisheries Office (GARFO) through a variety of channels. Some dealers report through the Atlantic Coastal Cooperative Statistics Program (ACCSP) which collects data through multiple apps and provides that data to GARFO. Other dealers report directly to GARFO through the *Fish Online* application, and until recently, still other dealer reports were submitted via a third-party application and transmitted to the Northeast Fishery Science Center (NEFSC), where it was processed and sent to GARFO. Validation standards vary between these channels and errors must be corrected manually at GARFO. Specifically, errors in vessel permit numbers and trip identifiers frequently lead to mismatches with the data from vessels, causing time intensive quality assurance and quality control (QA/QC) work for GARFO staff. Currently, seven NOAA Port Agents spend approximately 35% of their time on data reconciliation.[56]

That equates to approximately 100 hours a week or about 2.5 full-time equivalents (FTEs), equating to approximately $250,000 per year. Not only is this a waste of taxpayer dollars, but the limited availability of staff to conduct QA/QC can mean significant delays in providing data to managers. Finally, the databases in which dealer reports are stored are inefficiently structured, resulting in slow, resource-heavy queries.

GARFO is currently seeking to address these challenges by developing a new streamlined API-based submission process, similar to what it recently developed for vessel trip reports. The API is a software interface that ensures that only data that meets standards (all fields are completed, within range and consistent) can be submitted. This would reduce QA/QC costs, facilitate the matching of vessel and dealer reports, and significantly improve science and management responsiveness. While these circumstances are specific to dealer reporting at GARFO, they are illustrative of the structural challenges that other regional ER programs around the country face.

Streamline development of ER applications

Another efficiency challenge NOAA faces is the diversity of reporting platforms that are available to fishermen and dealers. While this diversity helps foster innovation and provides options for users, it can also create program management, data quality and formatting issues that take staff time to address. It also leads to significant duplication of effort as new apps are created across regions. What is needed is a NOAA-endorsed framework to help ensure that applications are developed in a consistent way that not only meets data collection standards, but also submission, design, interface and service standards. Such a framework would reduce the overhead associated with application development by providing pre-approved application components and documentation for software developers to build and manage progressive web applications. This includes standardized, ready-made components such as page routing, APIs, security, accessibility and branding. This would allow developers to focus on the business rules rather than the architecture and base components of an application. A coalition of regional offices including the Southeast Regional Office (SERO), Southeast Fisheries Science Center (SEFSC), the Atlantic HMS Division and GARFO are now seeking to develop such a framework known as React Application Development Framework for Fisheries (RADfish).[57] Frameworks such as this would not only reduce agency program development costs but would also create a more seamless reporting experience for fishermen.

Consolidate back-end data management

Beyond app development, there is also significant duplication of effort and cost when it comes to the management of the data that the apps generate. Sometimes for a single trip, East Coast fishermen are reporting to SERO, HMS and GARFO, each of which currently maintain their own databases on local servers. A single system integrating the various reporting requirements from all logbooks on the East Coast would reduce the overhead associated with quality control, data management and reporting and would generate long-term cost savings for taxpayers. With additional investment and planning, this approach may be scalable to additional East Coast fishery-dependent data collection programs, and possibly the incorporation of all NOAA fishery-dependent collections nationwide. Project leads at the SEFSC were able to secure Inflation Reduction Act (IRA) funding in 2024 to advance the first stage of this work.[58]

Despite the foundational nature and cross-regional value of these back-end data streamlining efforts, it has been the regions rather than the national program that are surfacing and advancing them. Moreover, they are doing so by cobbling together limited FIS funds to explore these new innovative approaches while keeping cumbersome legacy programs up and running. More dedicated funding and national leadership are needed to ensure that these efforts and others like them have the support and resources they need to be successful and scale more broadly. This kind of national investment will not only improve management but will ultimately lead to cost savings and increased efficiency within the agency.

2.2 Make greater use of ER in the recreational sector

While the use of ER in the commercial sector is widespread, there is opportunity and interest to expand and enhance its use in both the private and for-hire recreational sectors to improve management efficiency.

Standardize reporting in the private sector

Advancing ER in the private recreational sector has historically been a challenge and remains difficult given the reluctance of managers to broadly mandate any required reporting for private anglers. However, the rise of smartphone applications now makes reporting in the private sector a potentially valuable supplemental source of data. Since it is supplemental, it does not directly lead to cost savings by replacing other data collection efforts, but if collected properly, the data can play an important role in enhancing management. What is essential is that these ER efforts are efficiently designed and collect data that can actually be used by managers. Over recent years, the number of private recreational reporting applications has increased dramatically.[59] While this reflects growing interest in and willingness from recreational anglers to use ER, it also creates significant data standardization issues and risks duplication of effort across projects.

Credit: Katie Haukebo Photography

While NOAA has created data collection standards for recreational fisheries, they are often not adhered to. Additionally, new ER programs are often created without capitalizing on prior efforts and lessons related to technology and data management. To help address this, ACCSP created a new mobile app development framework called SciFish. Its goal is to streamline development of new reporting programs and help ensure they are adhering to data collection standards. SciFish provides a single platform for multiple data collection projects and allows researchers to create new, standardized ER projects with minimal resources. The standardization ensures that these projects are also made more effective at addressing current data gaps and encourages collaboration between scientists and fishermen. Efforts such as SciFish should be expanded to other regions to help ensure that new ER programs that adhere to NOAA's data collection standards are efficiently and consistently developed.

Make broader and more effective use of mandatory ER in the private sector

There are only a few examples of private recreational fisheries with mandatory ER requirements. This is largely due to practical hurdles and cultural and political resistance to requiring ER for the sector. However, in some fisheries such as Atlantic bluefin tuna or golden and blueline tilefish, private recreational fishermen are required to electronically report as a means of informing catch estimates. While reporting with NOAA approved apps is mandatory, compliance has been relatively low, with 42% compliance estimated for the bluefin fishery.[60] To make broader use of mandatory ER, existing programs like these first need to be made into successful examples. Authors of a 2023 study interviewed participating bluefin fishermen to identify means of increasing compliance rates and found that key strategies should include: 1) increasing awareness of the reporting requirement; 2) increasing the user-friendliness of the reporting technology; 3) better communicating the reasons for/benefits of self-reporting; and 4) using positive incentives and working with recreational leaders to foster a culture of reporting.[61] Increasing penalties for non-compliance is another strategy to consider. Once these reporting programs serve as effective models, making broader use of mandatory reporting in the private sector could enhance the data that is available to managers to produce more efficient and timelier in-season estimates of catch and effort.

Continue to pursue vessel tracking in the charter sector

ER is well-established in the for-hire sector with programs on the East Coast, the South Atlantic, Alaska and California. Until recently, there was also a unique program in the Gulf of Mexico that included a VMS component that served to corroborate trip declarations and the effort data contained in the logbook. NOAA OST and several states conduct for-hire surveys to assess fishing efforts levels to inform total catch estimates. However, the surveys have had a non-contact percentage of up to 32% since 2019, which results in substantial uncertainty in catch estimates, wasted personnel time and slower in-season management.[62] The VMS component was aimed at validating effort, facilitating law enforcement and improving dockside intercept efficiency to verify catch.

However, in February of 2023, the U.S. Fifth Circuit Court of Appeals issued a ruling which invalidated NOAA's use of VMS in the program. The court reasoned that NOAA had not sufficiently articulated how VMS was necessary to advance the goals of the MSA and that the benefits of the program did not outweigh the costs. The court also held that recreational fishing is not a "closely regulated" industry, meaning the recreational charter fleet has a greater constitutional expectation of privacy on their vessels than the commercial fleet and that NOAA had not addressed concerns regarding privacy raised during the rulemaking process. In response to the ruling, NOAA halted implementation of the program and the Gulf of Mexico Fishery Management Council (GMFMC) is assessing how to revamp it in light of the court's decision. As NOAA and the GMFMC consider how to move forward, we propose that the Fifth Circuit's ruling should not be broadly construed as precluding the use of vessel tracking as part of ER programs in the for-hire sector. The issues associated with the Gulf program's administrative record are curable and the benefits of including automated and reliable effort and spatial data in ER can be better articulated. In addition, there are alternatives to the use of expensive, continuously operating VMS including low-cost GPS-based tracking devices with geofencing options, and the simple use of the integrated GPS capabilities of any device running a NOAA-approved ER app. By using alternate approaches to tracking, a well-designed replacement ER program can balance operators' need for privacy when the vessel isn't fishing, and the agency's need for good data when it is. This will translate to more responsive management, reduced need for expensive follow-up surveys, and streamlined reporting for operators.

2.3 Better integrate ER data with other data streams

In addition to improving how ER data is collected, better integrating it with other fishery-dependent data streams can also lead to government savings and more responsive management. As noted, stock assessors indicated they spent roughly a third of their time on data matching. This integration with other data streams is often referred to as 'interoperability' and would allow stock assessors and managers to easily associate and analyze all the data generated by a given fishing trip including data from logbooks, observers, dealer reports and VMS. However, achieving interoperability has been a challenge given that these various data streams evolved separately over time.

Modernize underlying data streams

The Net Gains Alliance released a useful report in 2023 focused on the need for interoperability and incremental approaches for achieving it. A central premise was that interoperability happens to a large extent through modernizing the individual data streams that need to be integrated. This is because interoperability can't be imposed upon siloed legacy data systems that can't easily communicate. Progress builds over time and each step toward modernizing the system makes it easier for the next piece to fall into place. An ongoing effort to create a permit registry on the East Coast is a good example. Fishermen in the Atlantic, the Gulf of Mexico and Caribbean often hold permits on the same vessel from multiple regions. While it's essential for NOAA to be able to identify a unique vessel, its permits and reporting obligations, currently there is no efficient way to do so across multiple permit systems. Currently, identifying cross-region vessels is cumbersome and labor intensive, requiring data requests, data compilation and manual matching. The creation of a shared federal vessel registry is therefore a fundamental precursor step to streamlining data accessibility, reducing the burden of ER for the fishing industry, and increasing the efficiency of data management for the government. Efforts are getting underway to develop such a system in which each region will be able to maintain their own permitting system while still being able to efficiently match information across these systems. NOAA's OST will host the registry and allow access to the partners such as the Fishery Information Networks. While efforts such as these are not explicitly aimed at interoperability, they create the essential enabling conditions for it by modernizing the underlying structure, making it queryable, responsive and less siloed.

Another illustration is NOAA's use of vessel tracking data. Some fisheries are beginning to use low-cost GPS trackers as an efficient means of collecting fishing effort data. For example, in 2023 a vessel tracking program was implemented for federally permitted American lobster vessels.[63] This tracking data is a form of automated electronic reporting, providing managers with valuable spatial data for stock assessments, bycatch avoidance efforts and marine spatial planning. The initiation of new programs like these highlights both the utility of automated, low-cost spatial reporting and the reality that current VMS data is underutilized. While over 4,000 vessels are currently required to carry VMS,[64] the program is administered by the NOAA Office of Law Enforcement (OLE) and the data is not widely used in science and management. This is largely due to challenges managers and scientists have in accessing it and in integrating with other data sources.[65] Nevertheless, these VMS programs come with significant costs. In 2020, the overall cost of the national VMS program was $7 million out of an overall OLE budget of $74 million.[66] While the role of VMS as an enforcement tool is important, there are ongoing discussions within NOAA regarding how to make greater use of the funding and the data. These discussions include the potential benefits of moving the management of VMS out of OLE and into OST. While such a transition could maintain the enforcement use of VMS, it could also enable the better integration of VMS with other data sources for science and management purposes. The move could also facilitate broader use of less expensive GPS trackers like those now being used in the lobster fishery instead of expensive VMS units in fisheries without real-time enforcement needs. Overall, the move could translate to better integration with other data sets leading to better management and broader taxpayer benefits.

Build and maintain data integration platforms

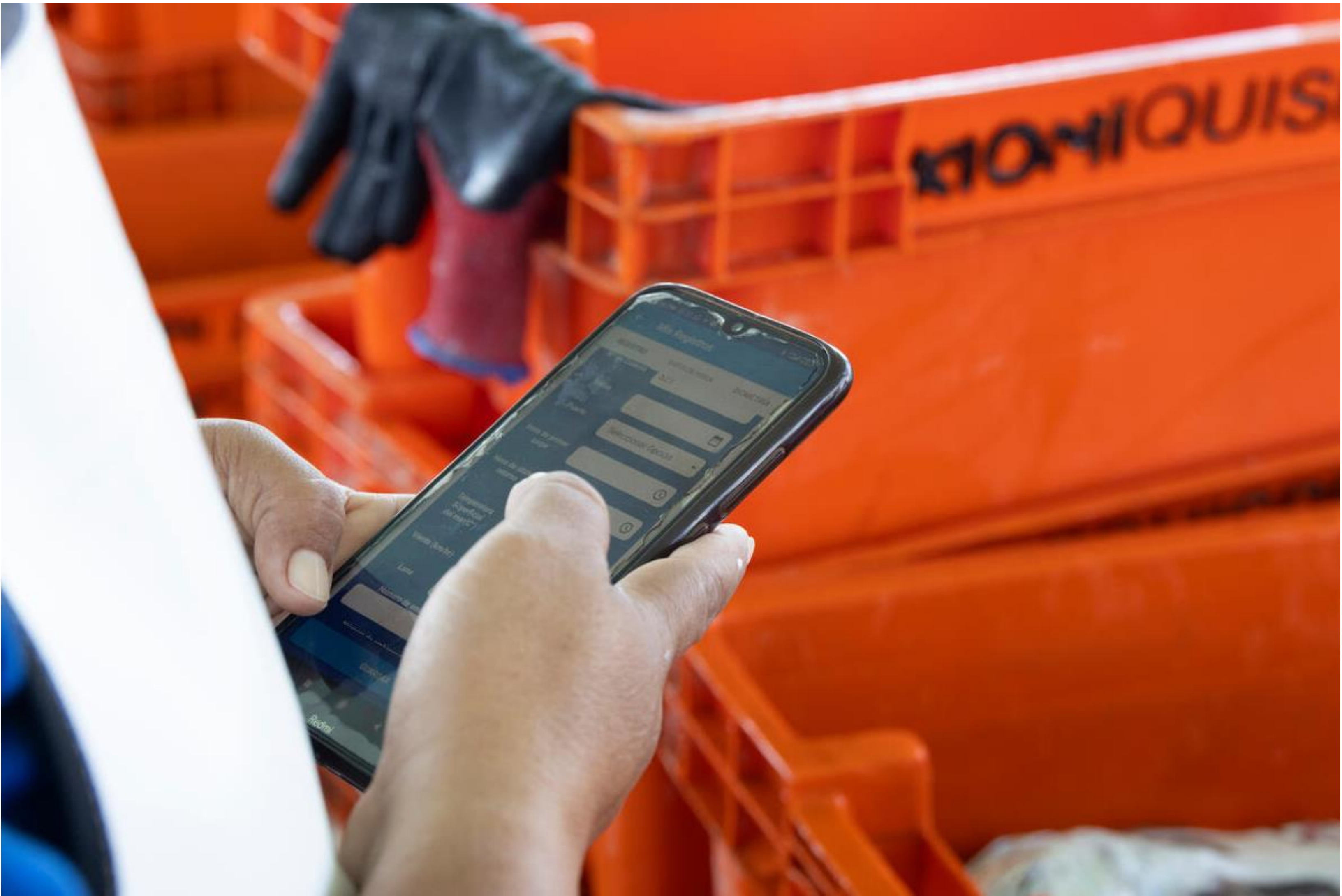
In addition to modernizing the underlying data management architecture, there are ongoing efforts specifically aimed at stitching diverse data sets together to enhance interoperability. For example, on the West Coast, the Pacific States Marine Fisheries Commission (PSMFC) and the Northwest Fisheries Science Center (NWFSC) are collaborating to develop a new integrated data platform that integrates ER data with a range of other data sources including landing receipts, observer data, VMS tracks and revenue information. The project aims to overcome the challenge that these data are collected for different purposes, with different coverage rates, and must be obtained from disparate sources and combined by researchers in a time-consuming and one-off process for a particular research project. The pre-integration of these data sets will allow much more rapid and replicable analyses of fishing effort, management action evaluation, prediction and economic analyses. The uses of such an integrated database include supporting stock assessment, understanding fishery behavior, supporting the protection of marine mammals and understanding the economic trade-offs involved with offshore wind siting.

While the platform is still being developed, VMS tracks and ER data have now been combined to map fishing effort in the Pacific Fishing Effort Mapping (PacFEM) project. The immediate goal of PacFEM is to inform offshore wind siting, but it will also be used in ecosystem management initiatives like Essential Fish Habitat (EFH) processes. A publicly accessible fishing effort mapping tool is currently being developed and will be an effective and topical illustration of the value of this kind of data integration. And as the underlying integration work continues and additional data sets are brought together, the platform is anticipated to be used more broadly by West Coast science centers, regional offices and state partners. This integration represents a long-term undertaking that will eventually re-shape how PSMFC stores and delivers data. However, it will ultimately lead to significant efficiency gains for scientists and managers and better management for fishermen and the public. To date, the effort has largely been carried out with ad-hoc funding from FIS. More dedicated and sustained funding is needed to advance data interoperability on the West Coast and beyond.

2.4 Help scale ER to state fisheries

State-managed fisheries nearshore are still struggling to update their fishery dependent data collection efforts and make the transition to ER. The products and ER expertise gained by NOAA should be actively shared with states. While this may not lead to immediate cost savings for the federal government, it would serve to distribute the benefit of prior federal investment more broadly. Additionally, strong state-based data collection efforts can be synergistic with and complementary to federal fisheries management and benefit the same coastal communities.

NOAA’s OST is currently engaged in a recreational data re-envisioning process to clarify how Gulf states and NOAA will work together to collect vital catch and effort data. While this process is about recreational data collection and use broadly, it is also an opportunity to integrate standards-based ER, drawing from the lessons learned elsewhere at the federal level.



3. SUMMARY OF RECOMMENDATIONS AND FINDINGS

The implementation of EM and ER provides significant opportunities to enhance the efficiency and cost-effectiveness of fisheries management, ultimately leading to substantial savings in taxpayer dollars. Strategic deployment of these tools, tailored to the specific needs of different fisheries, can lead to significant savings in at-sea monitoring costs while maintaining robust data collection and accountability. For example, in just the deep-set Hawaiʻi longline fishery, we estimate annual savings of $1.6 million to $2.1 million are within reach. Long-term benefits will rely on investments in artificial intelligence, data integration and program design optimization. Moreover, aligning cost incentives between fishermen and regulatory bodies, alongside greater leadership in modernizing fisheries data infrastructure, is essential for ensuring these technologies reach their full potential. With focused effort and collaboration, EM and ER can transform fisheries management into a more sustainable, cost-efficient system while driving future innovation. Key recommendations for realizing potential cost savings from EM and ER include:

3.1 Electronic Monitoring

Maximize EM cost savings through strategic fishery selection

- Prioritize use of EM in fisheries where observer coverage rates and monitoring costs are already high or where there is a newly identified monitoring need and the cost of developing an observer program would be high.
- Prioritize use of EM in geographically dispersed fisheries where maintaining a network of observers is costly.

Streamline EM program design

- Use an audit model approach that requires the submission of self-reported logbook data alongside 100% EM capture, using the lowest video review rate feasible while still meeting core accountability goals.
- Only require short video retention periods. Do not let overly conservative law enforcement concerns drive up data storage timelines and costs.
- Optimize EM video data transmission strategies for cost-effective monitoring. Explore options for using AI to recognize the portion of video that needs to be transmitted wirelessly.
- Stay laser-focused on program goals and avoid mission creep.

Support AI development in EM for long-term cost savings

- Invest in AI algorithms to automate video review and further reduce costs.
- Standardize vessel monitoring plans and EM camera setups to improve AI performance across different vessels and fisheries.
- Collaborate with initiatives like Fishnet.AI to create a global repository of annotated EM imagery.

Consolidate or supplement observer programs with EM

- Consolidate observer and EM programs to reduce administrative burden when data collection efforts are redundant.

- Supplement observer programs with EM when aspects of fisheries monitoring like catch accounting can be done more cost efficiently by EM and direct observers to collect data that EM has difficulty collecting.

Align fishermen's cost incentives with federal cost savings

- Establish policy directives for observer programs similar to those for EM to balance cost responsibilities between NOAA and the fishing industry.

3.2 Electronic Reporting

Improve the efficiency of ER in the commercial sector

- Design less complex and error prone ER systems that require significant QA/QC by agency staff.
- Streamline and standardize the development of new ER applications by providing packaged tools to developers.
- Reduce redundancy and costs by consolidating the back-end management of regional ER programs.
- Highlight efficiency gains from ER in NOAA's reporting to Congress.

Make greater use of ER in the recreational sector

- Require new data collection programs to adhere to data collection standards and develop technical guidance for ER programs to streamline data.
- Support broader and more effective use of ER in the private sector.
- Continue to advance vessel tracking strategies and technologies in the charter sector.

Make better use of ER data by improving integration with other data streams

- Modernize underlying data streams so that systems are able to communicate and integrate.
- Increase efficiency by creating platforms that integrate data sources for stock assessors, in-season managers, and marine spatial planners.

Provide greater funding and leadership for data modernization

- Increased staffing and funding will allow for needed engagement in multi-year planning and problem solving. This includes hiring and retaining FTEs with institutional knowledge, expanding FIS program funding, and providing more dedicated funding to key data modernization projects.
- Advance a national plan that provides a cohesive vision, steps and timeline will help attract resources and ensure that they are directed in a strategic way.

Implementing these recommendations can help build upon existing efforts and encourage greater investment of the time, resources and leadership needed to expand the use of EM and ER and modernize fisheries data collection and management.

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APPENDIX I. EVALUATING DATA COLLECTION REQUIREMENTS AND ENHANCING METHODS IN HAWAI‘I LONGLINE FISHERIES

Appendix I describes current data collection needs for the Hawai‘i longline fishery and which data fields might be feasible to collect with EM or other non-observer means. This table builds from Stahl et al. (2024) and includes EDF’s assessment of whether EM could feasibly collect certain data and under what conditions. EM may not be a viable means to satisfy all data needs under current regulatory requirements or fishing operations, however, in many cases, a simple regulatory change or slightly modified crew behavior on the back deck (e.g., through a Vessel Monitoring Plan [VMP]) could facilitate the ability of EM to collect necessary information. In this appendix we have included only those data fields for which Stahl et al. described EM as not being able to collect the data or having low accuracy.

TABLE 1. **Data collectable using EM systems compared to at-sea observers in the Hawai'i longline fisheries.**

Data Field	Collectible With EM	Accuracy	Other Sources	Notes	EDF Comments
Any high-grading during the trip?	Yes	Low	No	Low accuracy – only determined if discards occur during hauling and within camera views.	Requiring cameras to operate at all times with a low randomized review rate for non-haul times could create strong disincentives to high-grade. In addition, all discards could be required to occur at a designated point. In our view, EM could readily collect this information with minor regulatory and vessel operation adjustments that have been demonstrated to be effective in other fisheries.
Protected species interactions during setting	No	N/A	No	Cameras are not configured to record during setting but can depend on priorities. Camera views may need to be adjusted with view of stern to collect protected species data during setting.	We agree. If cameras were required to record during setting, they could likely capture protected species interactions that would have also been visible to an observer. Basically, if an observer can see it, a well-designed camera system probably can too. More importantly, cameras could be configured to ensure that gear helpful/required to minimize ETP interactions during setting was actually onboard and being used correctly.
Number of floats	Yes	High	No	High accuracy if doing a full video review. High accuracy if using artificial intelligence (AI) to detect buoys but will need to develop models.	We agree and note another cost-effective means of accurately collecting this data would be to require skippers to record the information in their logbooks and audit a random sample for accuracy.
Species code	Yes	High	Dealer; elogs	High accuracy with EM video for most species. Moderate accuracy from elogs for retained species. Moderate accuracy from elogs for discarded sharks and low accuracy for other discarded species. High accuracy from dealer data for retained species.	Depending on the importance of collecting the shark and other non-retained species data, a vessel monitoring plan could be developed that would require handling procedures that facilitated species ID using EM.
Kept/return code	Yes	Moderate	Dealer; elogs	Moderate accuracy for EM as some catch may be discarded out of the camera's view, such as bycatch species or smaller fish. It may also be difficult to tell the condition of some species especially if not boarded.	Depending on the perceived management risk of unknown discards, the EM system could be designed to require all discards to occur within camera view. This is a typical requirement of a VMP.

Data Field	Collectible With EM	Accuracy	Other Sources	Notes	EDF Comments
Gender code	Yes (only in special cases)	Low/high	No	Low accuracy for elasmobranch species. If the shark/ray ventral side is in camera view then may be able to tell the presence or absence of claspers. However, this would be more difficult for juveniles.	Observers would likewise have a difficult time determining gender for juveniles if the claspers were not visible. A singular discard point or location at the rail where release occurs along with a requirement to discard belly up with a camera placed to clearly view the area should enable comparable accuracy to human observers.
Length measurements	Yes	Low	Dealer	Low accuracy with approximate length estimates possible using objects (e.g. floats, fishermen) of known length for comparison. In the future, more precise length measurements may be possible through EM system modifications (e.g. stereo cameras, cameras calibrated to measuring boards) and fisher handling requirements or through development of AI algorithms. Dealer data processed weights can be converted to round weight and then length for retained species using conversion keys.	For retained catch a measure board could be an effective solution. AI is increasingly demonstrating the ability to accurately assess lengths even for bent and flopping fish.
Set	Yes	High	Elogs	Low accuracy for elogs as sea turtles are usually not recorded and may be misidentified. If recorded, can obtain the set number.	Recommend requiring turtles to be recorded.
Captured date and time	Yes	High	Elogs	Low accuracy for elogs as sea turtles are usually not recorded and may be misidentified. If recorded, can obtain haul start and end date and time.	Regulatory fix – Recommend requiring turtles to be recorded.
Release date and time	Yes	Moderate	No	Fishermen sometimes wait to release sea turtles after the haul, so appropriate thresholds need to be set for sensors to trigger cameras to record.	Alternatively, require cameras to run 100% of the time, review a random sample, require reporting and identification of turtles (e.g. in logs), and punish those caught cheating.
Hooked location code	Yes	Moderate/ High	No	High accuracy when boarded and hooked in the body. Moderate accuracy when released in water and/or when boarded and hooked in mouth as more challenging to obtain specific location which could lead to a more conservative mortality estimate and necessary to assume “worst case scenario.” May need to use “mouth unknown” code more often than observer data. However, this code does not include beak, so a new code may need to be developed of “beak/mouth unknown”.	Could establish VMP and require specific discard locations/procedures to facilitate greater accuracy.

APPENDIX II. EM AND OBSERVER PROGRAM COST SAVINGS ANALYSIS

The costs shown below in Table 2 represent a federal model, meaning all video review and operations oversight is conducted by NOAA, as opposed to a third-party EM provider model. The costs in this table are estimates based on an example of the annual cost structure. The many assumptions incorporated into this analysis are detailed in the "comments" column.

TABLE 2. Projected costs of EM for the Hawai'i deep-set longline fishery.

Sampling Costs				
EM System and Monitoring Plan	**Cost of 100% EM Coverage[a]**	**Cost of 90% EM Coverage[b]**	**Fixed or Variable Cost**	**Comments**
Equipment purchase, leasing, and installation	$533,333	$480,000	Variable	Cost for EM systems on the entire Hawai'i-based longline fleet with 160 vessels. Assumed cost is $10,000 per system with life expectancy estimated at 3 years. This estimate is considered conservative with other EM programs, such as the Northeast groundfish fishery, replacing EM systems after 5 years.
Maintenance, system upgrades, and repairs	$321,000	$288,900	Variable	Salary and overhead for 3 technicians at $107,000 each.
Training for captain and crew	$0			Performed by technicians. Included in costs for "maintenance, system upgrades, and repairs".
Development of Vessel Monitoring Plans	$0			Performed by technicians and EM Project Manager. Included in costs for "maintenance, system upgrades, and repairs" and "service provider fees and contract".
Subtotals	**$854,333**	**$768,900**		
EM Data and Provider Services	**Cost of 100% EM Coverage**	**Cost of 90% EM Coverage**	**Fixed or Variable Cost**	**Comments**
Video and data transmission	$158	$142	Variable	No transmission needed for Hawai'i landings; these data will be collected by technicians in Honolulu and are included in the costs for "Maintenance, system upgrades, and repairs". Data from California landings will be mailed at $7.50 per mailing. Projected costs were based on 21 California landings in 2019.
Video review and processing - 25% of sets reviewed	$749,000	$674,100	Variable	Cost for 7 EM reviewers at $107,000 each
Storage of imagery and data	$20,000	$18,000	Variable	Storage of EM data within the normal sampling life cycle. $20,000 is an estimate for physical storage, cloud storage is estimated as $57,600
Service provider fees and contract	$125,000	$125,000	Fixed	Cost for one EM Project Manager to coordinate EM data collection and contracts for any system installation, maintenance, or EM video review.

Other (software developer/maintenance)	$180,000	$180,000	Fixed	Cost for federal (FTE ZP4 DEV) software developer. After the first couple of years, this cost would likely be reduced without the need of dedicated staff.
Subtotals	**$1,074,158**	**$997,242**		
Total sampling costs	**$1,928,491**	**$1,766,142**		
Administrative Costs				
Program Support	**Cost of 100% EM Coverage**	**Cost of 90% EM Coverage**	**Fixed or Variable Cost**	**Comments**
Council support, rulemakings, and permitting	$25,000	$25,000	Fixed	EM Outreach and Review Manager to work with Council and other staff to provide guidance on rulemaking and permitting for EM. Costs are estimated at 20% of $125,000.
Staff time to review equipment on vessels and VMPs	$18,750	$16,875	Variable	EM Outreach and Review Manager to review installed EM systems and ensure compliance with VMPs.
Facilitate communications with participants and EM providers	$75,000	$71,250	50% Fixed 50% Variable	EM Outreach and Review Manager will provide EM outreach and feedback to fishermen from video review and audit to improve data collection, as well as communications with fishermen and EM providers to perform installation, maintenance, disk retrieval. Costs are 60% of the time of EM Outreach and Review Manager at total cost of $125,000.
Manage vessel/video review selection	$62,500	$56,250	Variable	EM Outreach and Review Manager will coordinate with review staff to appropriately sample 25% of vessels. Costs are 50% of the time of EM Outreach and Review Manager at total cost $125,000.
Subtotals	**$181,250**	**$169,375**		
Certification of EM Provides	**Cost of 100% EM Coverage**	**Cost of 90% EM Coverage**	**Fixed or Variable Cost**	**Comments**
Review provider contracts	$31,250	$28,125	Variable	EM provider certification contract review. Certification would allow providers to apply for federal contracts. Certification could occur on a 3-year life cycle, so annual costs are shown spread between 3 years based on total costs for certification support at 25% of $125,000.
Examine software, hardware, and data reports	$93,750	$93,750	Fixed	EM provider certification system review. Certification would allow providers to apply for federal contracts. Certification could occur on a 3-year life cycle, so annual costs are shown spread between 3 years based on total costs for certification support at 75% of $125,000.
Subtotals	**$125,000**	**$121,875**		
EM Program Performance Monitoring	**Cost of 100% EM Coverage**	**Cost of 90% EM Coverage**	**Fixed or Variable Cost**	**Comments**
Auditing	$75,000	$67,500	Variable	Review of 10% of the 25% video reviewed. Video review is ~$749,000 at 10%.

Reviewing video and data to optimize sampling rates	$25,000	$25,000	Fixed	NOAA EM analyst will review selected EM video footage to determine if adjustments need to occur with the 25% sampling rates. For example, is more sampling needed to represent protected species interactions? Costs are for a portion of the total salary ($100,000) of one NOAA EM analyst at 25% time.
Analyzing data and integrating into monitoring program	$25,000	$25,000	Fixed	NOAA EM analyst will analyze EM data and work with PIFSC/PIRO staff to properly integrate EM data into monitoring. Costs are for a portion of the total salary ($100,000) of one NOAA EM analyst at 25% time.
Subtotals	**$125,000**	**$117,500**		
Video and Data Storage	**Cost of 100% EM Coverage**	**Cost of 90% EM Coverage**	**Fixed or Variable Cost**	**Comments**
Video storage and access	$0			Costs for storage of federal records that are maintained past the normal sampling life cycle. For example, protected species footage.
Other (database development)	$62,500	$62,500	Fixed	Support for the development of an EM database to store and extract EM data. This would include the costs of technical staff to develop the database with the assistance of the EM analyst. Costs include 6 months of staff time for development. This cost would only be needed for the first year.
EM database maintenance	$25,000	$25,000	Fixed	Costs for annual EM database support.
Subtotals	**$87,500**	**$87,500**		
Total administrative costs	**$518,750**	**$496,250**		
Total program costs	**$2,447,241**	**$2,262,392**		

[a] All costs in column 2 were pulled from the Pacific Islands Region Electronic Technologies Implementation Plan, with some small corrections when percentages and dollar values did not align.[67]
[b] The costs in column 3 were estimated based on an assessment of whether the cost is likely to be fixed or variable with changes in fleet participation. The cost was reduced to 90% of the original cost if the cost was deemed to be variable.

TABLE 3. Projected costs of the observer program for the Hawai'i deep-set longline fishery.

Administrative Costs					
Observer Program Costs	**Cost of 18% Observer Coverage[a]**	**Cost of 10% Observer Coverage[b]**	**Cost of 5% Observer Coverage[b]**	**Fixed or Variable Cost**	**Comments**
Labor costs	$1,061,322	$589,623	$294,812	Variable	Cost of staff salaries that manage the observer program.
Facility costs	$283,270	$283,270	$283,270	Fixed	Rent (Obs. Inouye Regional Center), utilities, security, maintenance, etc.
Acquisitions and Grants Office fee	$35,853	Est. $21,512 – $23,106	Est. $12,549 – $15,138	Variable	Acquisitions and Grants Office takes a flat percentage to cover the costs associated with processing and maintaining contracts.
Database management costs	$61,000	$61,000	$61,000	Fixed	The observer program pays for 1/2 of the cost of IT support for the PIRO Program System
Total administrative costs	**$1,441,446**	**Est. $955,406 – $956,999**	**Est. $651,631 – $654,220**		
Sampling Costs					
Observer Program Costs	**Cost of 18% Observer Coverage**	**Cost of 10% Observer Coverage**	**Cost of 5% Observer Coverage**	**Fixed or Variable Cost**	**Comments**
Observer contract cost	$6,087,219	Est. $3,652,331 – $3,922,874	Est. $2,130,527 – $2,570,159	80–90% Variable	Cost of the contract with observer provider Lynker is $6,496,497 and includes shallow-set and the deep-set longline observer programs. To arrive at a cost attributable to just the deep-set longline fishery we estimated the proportion of observer sea days for each fishery. PIRO was unable to provide observer sea days by fishery for 2023. Instead, trip length averages from years 2018-2022 were multiplied by the number of observed trips for each fishery. In this manner, the proportion of deep-set longline observed sea days to total observed sea days for 2023 was estimated to be 93.7%. 93.7% of the total contract cost equals $6,087,219. Lynker shared fixed costs range at about 10-20% of total contract cost, including reimbursable line items. Most costs are variable because they are associated with the observer hourly wage.
Equipment and supplies	$163,828	$163,828	$163,828	Fixed	This contract line item is a direct reimbursable meaning the observer provider does not make any profit from purchasing supplies, etc. This cost also covers the gear shack where the observer gear is housed and the freezers (and electricity) that contain biological samples including turtles, for PIFSC scientists.

Total sampling costs	**$6,251,047**	**Est. $3,816,159 – $4,086,702**	**Est. $2,294,355 – $2,733,987**
Total program costs	**$7,692,493**	**Est. $4,771,565 – $5,043,702**	**Est. $2,945,986 – $3,388,207**

[a] Column 2 displays the realized costs for the observer program during the 2023 fiscal year obtained via personal communication with NOAA PIRO staff.[68]
[b] The observer costs in columns 3 and 4 were estimated assuming a 10% and 5% coverage rate and were adjusted if they were assumed to vary with coverage rate. If a cost was assumed to be fixed, then the costs remained the same in columns 2, 3 and 4.

TABLE 3. Projected annual cost savings from complete replacement of the Hawai'i deep-set longline observer program with EM.

Scenario 1	Costs	Comments
Total observer costs 2023	$7,692,493	
Facility costs	$283,270	Rent (Obs. Inouye Regional Center), utilities, security, maintenance, etc.
Savings from elimination of the observer program	**$7,409,223**	Subtracted the cost of the Obs. Inouye Regional Center from the observer costs, because this is a fixed cost.
Total projected EM costs 2021	$2,447,241	
EM costs adjusted for inflation[a]	**$2,676,277**	We used the Bureau of Labor Statistics CPI inflation calculator with August 2021 (date the report that projected EM costs was published) and January 2023 (date the 2023 observer coverage plan went into effect)
Total projected annual savings	**$4,732,946**	

[a] The observer costs were quoted from 2023 and the projected EM costs were quoted from 2021, so the EM costs were adjusted to 2023 prices accounting for inflation for a more accurate comparison.

TABLE 4. Projected annual cost savings from supplementation of the Hawai'i deep-set longline observer program (10% coverage) with EM (90% coverage).

Scenario 2	Costs	Comments
Total estimated observer costs for 10% coverage	$4,771,565 – $5,043,702	The range in cost savings is due to the uncertainty around fixed versus variable costs in the observer program.
Total observer costs 2023	$7,692,493	
Savings from reducing observer coverage from 18% to 10%	**$2,648,791 – $2,920,928**	Subtracted "Total Estimated Observer Costs for 10% coverage" from "Total Observer Costs 2023". The range is due to lower and higher projected observer costs.
Total projected EM costs 2021 (90% coverage)	$2,262,392	
EM costs adjusted for inflation	**$2,474,128**	We used the Bureau of Labor Statistics CPI inflation calculator with August 2021 (date the report that projected EM costs was published) and January 2023 (date the 2023 observer coverage plan went into effect)
Total projected annual savings	**$174,663 – $446,800**	**Savings from reduced observer program less the cost of 90% EM coverage. The range is due to lower and higher projected observer costs.**

TABLE 5. Projected annual cost savings from EM implementation (100% coverage) with reduced observer program (5% coverage) for biological specimen collection.

Scenario 3	Costs	Comments
Total estimated observer costs for 5% coverage (lower projected observer costs)	$2,945,986 – $3,388,207	The range in cost savings is due to the uncertainty around fixed versus variable costs in the observer program.
Total observer costs 2023	$7,692,493	
Savings from reducing observer coverage from 18% to 5% (range of projected observer costs)	**$4,304,286 – $4,746,507**	Subtracted "Total Estimated Observer Costs for 5% coverage" from "Total Observer Costs 2023". The range is due to lower and higher projected observer costs.
Total Projected EM Costs 2021 (100% coverage)	$2,447,241	
EM costs adjusted for inflation	**$2,676,277**	We used the Bureau of Labor Statistics CPI inflation calculator with August 2021 (date the report that projected EM costs was published) and January 2023 (date the 2023 observer coverage plan went into effect)
Total projected annual savings (range of projected observer costs)	**$1,628,009 – $2,070,230**	**Savings from reduced observer program less the cost of 100% EM coverage. The range is due to lower and higher projected observer costs.**

APPENDIX III. INTERVIEWEES AND ADVISORS

Name(s)	Organization(s)
Heather Nelson	NOAA Fisheries Pacific Islands Regional Office
Brett Alger	NOAA Fisheries Office of Science and Technology
Joshua Lee	NOAA Fisheries Northeast Fisheries Science Center
Chris McGuire	The Nature Conservancy
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Farron Wallace	NOAA Southeast Fisheries Science Center, Division of Fisheries, Assessment, Technology, and Engineering Support Division
Fran Karp	Harbor Light Software
Barry Clifford	Greater Atlantic Regional Fisheries Office, Analysis and Program Support Division
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Daniel Studt	NOAA Fisheries West Coast Regional Office
Scott Hickman	Charter Boat Captain
Julie Defilippi Simpson, Geoffrey White, Alex DiJohnson	Atlantic Coastal Cooperative Statistics Program
Claire Fitz-Gerald, Heather Nelson, Nichole Rossi, Mark Grant, Chad Demerest, Katherine McArdle	NOAA Pacific Islands Regional Office and Greater Atlantic Regional Fisheries Office
Keith Bigelow	NOAA Fisheries Pacific Islands Fisheries Science Center
Chris Hawkins, Kevin Donnelly	Lynker Technologies
Meredith Moore	Ocean Conservancy
John Field, E.J. Dick	Southwest Fisheries Science Center
Torey Adler	Greater Atlantic Regional Fisheries Office
Josh Keaton	Alaska Regional Office
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Richard Kupfer	NOAA Fisheries Pacific Islands Regional Office
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Brad McHale	NOAA Office of Sustainable Fisheries