

Accelerating & Communicating Government Fisheries Data Modernization

An analysis of barriers, best practices, and opportunities to advance modernization of government fisheries data systems around the world



About Future of Fish

Future of Fish is an international non-profit that supports small-scale fisheries and communities impacted by overfishing to build sustainable livelihoods while also protecting fish, a critical source of protein for billions of people worldwide. www.futureoffish.org

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Disclaimer

The ideas presented here reflect insights and enormous intellectual contribution from our colleagues, as shared with us through both written products and over 60 interviews. In particular, we would like to recognize the work of CEA Consulting (CEA) on this topic and the expertise contributed by Kate Wing as a consultant for this publication. In acknowledging the contributions of these experts, we hereby take full responsibility for the content of this report, which reflects our current understanding of a complex and dynamic space. We expect to continue to refine and advance the concepts presented here and offer this report as a working draft. We look forward to input and updates from the sustainable seafood, technology, and governance communities. .

Funding to conduct this work was generously provided by the Kingfisher Foundation. The report below is the outcome of FoF research, and does not necessarily represent the views of any other individuals referenced or acknowledged within the document.

Recommended Citation

Future of Fish. Accelerating and Communicating Government Data Modernization. 2021.

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Executive Summary

OVERVIEW

Today, there are more efforts to improve data capture and sharing systems for wild caught seafood than ever before. This is a positive trend, as better data is key to unlocking sustainable fisheries: for generating the information needed for effective management and enforcement; to provide business intelligence that can support a more economically viable and responsible seafood trade; and to drive bottom-up solutions that alleviate enforcement burdens on government agencies, allowing more focus on better science and adaptive management.

Unfortunately, current data modernization efforts are not translating into more effective, adaptive fisheries management at a fast enough rate. A key stuck point appears to be a lag within governments where inefficiencies, redundancies, and data errors from paper-based record-keeping and/or poorly designed systems are prevalent.

This report aims to advance the field of fisheries data modernization within governments by providing insights from case studies, interviews with global experts, and a review of existing literature and online resources.

We propose the following holistic, working definition of data modernization:

Government fisheries data modernization is any initiative or process that results in more **accurate** data and/or more efficient and **timely data delivery and analyses** that support **both** improved governance (management, science, and enforcement) and serves industry and public needs for the long term.

This definition includes three core elements—accuracy of, timeliness of, and access to data and analyses—for government, industry, and public stakeholders. The definition does not restrict data modernization to technological improvements. Improved protocols for data capture and sharing in paper-based systems is considered modernization if the protocols facilitate better management and insight for stakeholders. That said, technology, and especially electronic systems, are best positioned to provide the efficiencies and data QA/QC that is needed. But technology alone is not enough. In fact, piecemeal technology adoption without a holistic plan for integration of newly generated data often creates more problems.

To advance government fisheries data modernization around the world requires the following first steps: 1) build awareness of the value of data modernization for fisheries (communication and messaging to governments and funders); 2) increase understanding of where things are stuck (barriers) and where progress has been made (design principles and strategies for success); and 3) identify how modernization unfolds (process framework and tools, see Figure 3).

BUILDING AWARENESS AND ENGAGING GOVERNMENTS

The nascent state of government fisheries data modernization means many countries lack awareness of how data modernization could improve their fisheries management and seafood trade. Research to identify promising communication approaches to reach government stakeholders revealed five key communication insights and five strategic entry points to help introduce government agencies to the data modernization concept.

Communication Insights: How to Spark Interest

Science and Enforcement Divisions are Promising Gatekeepers

The Challenge: Governments often struggle to accept outside expertise for many reasons: prior bad experiences with NGOs or development agencies; fear of looking unprepared or lacking experience; or, a strong cultural preference for working internally.

The Strategy: The science and enforcement arms of government currently appear as the most open to data modernization solutions for fisheries challenges. Leverage the interest in these departments to reach the fisheries managers.

Workshop Your Way In

The Challenge: Governments are often resistant to outside assistance. As a newcomer to the space, finding a way to initially gain access to key decision-makers can be challenging.

The Strategy: In-person symposiums or workshops provide venues to detail and share the benefits of an approach, tool set, or strategy in a specific fisheries context, and serve as an effective approach for initially engaging important government officials.

Multi-pronged approaches are a must

The Challenge: Government organizational structures are fragmented and often siloed. Thus, no one decision-maker can push through an idea from concept to implementation.

The Strategy: Plan for a multi-pronged communication campaign that targets the needs of each critical individual and brings them together after initial interest is peaked.

Focus on Acute Needs

The Challenge: The people and departments executing projects are most likely resource strapped, under deadline, and worried about the project failing in public. These conditions create a sense of urgency and often a singularity of focus on existing work and resolving current issues.

The Strategy: Begin engagement with governments by: a) learning what their pain points are in order of importance; and b) understanding how to address their most urgent needs or concerns quickly, effectively, and in-person.

Prove it

The Challenge: There is a demand for evidence that holistic data modernization works—testimonials or proof of concepts from implementation in the field.

The Strategy: Harness wins within the broad umbrella of data modernization. Showcase successful EM pilots, examples of new markets unlocked through traceable fish, or leverage existing resources such as the US Federal Data Maturity Model as “baselines” to show progress over time.

Strategic Entry Points: Align with Existing Values

The following strategic lines may help accelerate progress by:

1. Assisting practitioners within or outside government to identify positive incentives or goals that may attract the attention and support of needed government staff and leaders;
2. Helping steer funders towards projects that serve as promising stepping stones into larger fisheries data modernization conversation and action.

Robust Fisheries Management for Resource Security

Target: Fisheries or state agencies, Department of Public Health (nutrition and food security); Department of Labor (job creation and employment rates)

The Push: International development finance institutions provide significant resources to countries to target poverty alleviation, food security, and economic growth, including linkages to global markets. The health of local fisheries are inherently tied to these issues, especially through nutrition, livelihoods, and even ecotourism.

The Potential: With appropriate design and deal structuring, a percentage of development financing could be explicitly channeled to spark and support holistic data modernization efforts within fisheries divisions as a means to drive better fisheries management that in turn secures livelihoods and improves the stability and sustainable growth of the sector's output. The longer time horizons of these development programs (5-10 years) allows for the continued support needed to build capacity, weather government turnovers, and execute a comprehensive vision.

Trade and Tourism

Target: Department of Commerce; Department of Agriculture

The Push: New and stricter trade regulations (e.g. US SIMP and EU import laws), continued growth of FIPs and certifications, increased interest in mariculture, and in some regions, increased consumer demand for ethical seafood, are pushing industry and government reforms. In addition, with coastal and marine tourism expected to be the largest value-adding segment of the ocean economy by 2030, countries are beginning to recognize the importance (and value) of restoring and preserving healthy marine environments to their local economies.

The Potential: To meet both the opportunities and demands of the trade and tourism sectors requires that governments have better and more timely information to effectively and efficiently monitor and manage their fisheries—creating a strong case for data modernization.

Electronic Monitoring and Reporting Initiatives

Target: Fisheries division; Government IT department or CTOs.

The Push: EM and ER technologies and systems are gaining traction in fisheries around the world.

The Potential: EM and ER provide scores of new information, creating a need for new data storage and analyses—such capacity needs can be a great opportunity to build out a holistic data management system for the country, including consideration for:

- (For EM), establishing a broad vision for how data can be used to achieve compliance and science/management goals; one clear purpose may be needed to launch a pilot (such as compliance-focused initiative) but building in future capacity to leverage these systems to their full effect will allow for maximum benefits. Benefits to industry are also key, and may include things such as worker safety and insurance against false claims of IUU.

- More data without enforcement achieves nothing. Ensure strategies are developed so that information from EM and ER can be used for management, science, and enforcement.
- Fear of EM/ER impacts on employment is common. Knowing how to anticipate and address this can help with building trust and buy-in.

National and Maritime Security

Target: Department of Defense, Homeland Security, and Coast Guard Agencies

The Push: Efforts to more effectively protect national waters and resources from illicit activities, from piracy to drug trafficking, are gaining traction in many developing regions of the world.

The Potential: As nations collaborate and invest in technical and analytical capabilities to better monitor and enforce their national waters, there is opportunity to bring training and capacity into the fisheries realm, as critical data comes from fishing fleets; also, there is often overlap in jurisdiction and responsibility between maritime security and fisheries enforcement agencies.

Consider the Role of Data Modernization Initiatives as a Risk Mitigation Tool

Target: Military/Department of Defense; Tax Departments (relief funds); National Fisheries Agencies

The Push: A lack of coordination and data accessibility restricts government capacity to effectively and rapidly utilize and apply information for the benefits of their constituents—especially in response to change. In fact, these inefficiencies limit the ability of both governments and industry to better mitigate negative impacts from catastrophic events (such as market and trade disruptions due to COVID-19), climate change-induced impacts on stock health, location, or abundance, or political upheavals that impact rules and regulations. In some cases, the lack of efficient data coordination exacerbates these negative impacts, such as the case we see illustrated by the *impacts of Brexit* on UK fishers who are now required to fill out over 70 pages of paperwork for every shipment entering the EU.

The Potential: While strong, co-designed data frameworks and technologies cannot prevent these major disruptions, we believe they can provide a way for governments and industry to rapidly assess and respond to acute changes in fishery stocks and market and supply chain disruptions. For example, during COVID-19, more integrated data systems could support struggling fishers to process logbook information to help provide access to relief funds; provide fishers with the information and resources needed to find available buyers; determine viable species for diversification options; and assess opportunities for aggregate sales with local partners. Accessible, integrated data allows everyone involved to better achieve the full potential benefits of data analyses and application, including crisis response.

INCREASE UNDERSTANDING: BARRIERS TO IMPLEMENTATION

Comparisons across case studies and existing reports surfaced eight widespread barriers to data modernization efforts, independent of geographic location, fishery, or initiative structure.

B1. Lack of Long-Term Planning & Vision

Specific projects to address a discrete issue are developed in the absence of overarching strategy or vision. The ability to appropriately budget and leverage one project to advance another is lost under these circumstances, as are other types of economies of scale.

B2. Inflexible and Rigid Systems

Passing new protocols or policies to secure resources and execute a pilot are heavier lifts within governance bodies; legacy systems and staffers can make change hard.

B3. Capacity Missing for Tech Adoption

Modern data systems require IT expertise, infrastructure, and at least some level of literacy. Unfortunately, these conditions are often not met.

B4. Policy Prevents Progress

Logistical hurdles in hiring outside experts, conflicting decision-making practices among departments or across jurisdictions—such obstacles impede data modernization initiatives.

B5. Data Ownership Confusion

Stakeholders from both industry and government sectors continue to be confused and often misled in their understanding of data ownership and sharing.

B6. Missing and/or Perverse Incentives to Attract Participation

The benefit and the need for better data are often unrealized and thus, unrecognized; scarce resources make it difficult to retain talent or impose new tasks on already-overburdened staff.

B7. Insufficient In-house Expertise

Current models are limited in how they leverage pilots to build internal expertise—a resource that would return benefits again and again as data modernization progresses. Instead, limited resources, overburdened staff, inadequate training, and missing expertise reduce success of data modernization initiatives; language and cultural factors also limit effectiveness of outside experts.

B8. Most-Recently Elected Leaders Want All The Credit

New administrations have an aversion to inheriting former projects. This, combined with high turnover rates, poses a threat to long-term investment and execution of data modernization initiatives, which require longer time horizons to achieve success.

INCREASE UNDERSTANDING: DESIGN PRINCIPLES FOR SUCCESS

In addition to barriers, our research also unpacked the characteristics of robust systems and implementation processes. We identify best practices based on past and ongoing initiatives, synthesizing strategies, design principles, and practical solutions that emerged in the case study research and literature review.¹ We looked for underlying, universal concepts in order to name opportunity areas that are scalable to multiple locations and conditions; however, recommendations will be more or less applicable depending on existing enabling conditions and attributes of the system. Table 2 provides an overview of the 24 design principles, according to the stage of project development where they apply.

1. There are a number of existing best practice guidelines and design principles offered for EM/ER projects, Digital Investment, Fisheries Monitoring, and Government IT Modernization. EDF's *Designing and Implementing Electronic Monitoring Systems for Fisheries*, Stanford's *Digital Impact Toolkit*, Bradley et. al's *Opportunities to improve fisheries management through innovative technology and advanced data systems*, and IBM's *A Roadmap for IT Modernization in Government* are just a few examples. There are significant overlaps and similarities in principles encountered across these types of publications that a) point to a range of different organizations reaching similar conclusions independently, both within and external to the sustainable fisheries industry, and b) directly supports findings from the case study interview stage of our work, the results of which are presented here. For additional information regarding existing resources and how they can be utilized in the Fisheries Data Modernization space, please see *Part 4: Tools and Resources*.

Table 2. Summary of Design Principles by Implementation Stage (see framework, Figure 3). We have categorized these design principles by stage, but the majority cross multiple stages. Each design principle is listed in the stage where it begins—for example, “be transparent regarding expectations around timelines” is found within stage 1 (initiate), although it also applies across all later phases of implementation.

Stage 1 (Initiate)	Stage 2 (Pilot)	Stage 3 (Establish)	Stage 4 (Scale)
Set A Clear And Holistic Vision	Define Software And Hardware Parameters	Provide Enforcement Mechanisms At Every Step In The Supply Chain	Build Proactive Components Into All Aspects Of Legislation And Data Systems
Be Transparent Regarding Expectations Around Timelines	Establish Pilots As Learning Opportunities	Create Ongoing Training For All Supply Chain Actors	Balance Top Down With Bottom Up
Embed Adaptive Learning Into Strategy	Be Transparent With Data Flows And Share Data Quickly	Ensure Trainings Are Wide And Deep To Grow Institutional Knowledge	Use Policy To Promote Stability
Set Interdisciplinary Focus And Map Roles And Responsibilities From The Start	Engage Mentors For In-person Trainings And Long-term Support	Promote Technological Communication	Focus On The “How” And “Why” Of Success In Order To Scale
Foster Relationships Between Key Leaders And Champions	Enlist Experts Who Can Talk Cross-sector (It, Fish, And Policy)	Anticipate And Budget For System Upgrades	
Resource Beyond Pilot		Balance Stability and Adaptability of IT Solutions	
Consider The Role Of An Intermediary			
Employ Human-centered Design (HCD) And Co-design			
Utilize Existing Experts			

THE PROCESS FRAMEWORK

Our framework (Figure 3) maps seven attributes that impact success of a holistic data modernization approach: Primary Drivers, Enabling Conditions, Funding, Leadership, Barriers, Tools, and Timelines. By analyzing how attributes manifest within each of four stages, practitioners can better design holistic data modernization approaches and anticipate where barriers may impede progress. This work builds upon and incorporates multiple studies that provide roadmaps for discrete elements of the data modernization process.

CONCLUSION AND NEXT STEPS

Modernization of government fisheries data systems offers great opportunity for advancing sustainable fisheries: when coupled with appropriate fisheries management frameworks, a robust data system enables effective fisheries science, management, and enforcement by providing accurate and timely information flow across diverse governance divisions. The key is to build an aligned and appropriately-resourced movement to create impact at scale. The following areas of opportunity aim to address core barriers by building the enabling conditions and supportive structures necessary to achieve long-term and larger-scale government data modernization systems for fisheries.

Advance a Central Fisheries Data Modernization Hub

The Need: Hundreds of reports, guides, toolkits, presentations, case studies, technology platforms, initiatives, awards, and events exist that can support specific stages or aspects of the data modernization.

While websites such as *SALT* and *EM4Fish* provide a promising step forward for aggregating these resources, content remains difficult to find, access, and apply due to a number of challenges. To advance the field, curated and multilingual content, as well as expertise, that is easily found and accessed by a diverse set of users is needed.

The Opportunity: Create a single, accessible, electronic forum that houses information for a broad range of data modernization needs and includes the following elements:

- *Curated and vetted list of data modernization resources* that are searchable and sortable.
- *Interactive Visual Map:* Map tools have been successfully used in other sectors such as the *timber industry* and are becoming more common *in seafood*. These visual guides provide means for users to both see where initiatives are happening as well as sort through information such as technology type, data platforms, technology vendors, existing laws and policies, species, or desired export market.
- *Translation of existing resources into other languages*
- *Reformat lengthy and dense materials* into visual/short guides and toolkits that are accessible to laymen.
- *Directory of experts:* A searchable database of experts in the data modernization field, including (where appropriate) contact information for practitioners.

Launch a Global Modernization Mentorship Program

The Need: Most governments lack in-house IT expertise to provide assistance, mentorship, and guidance to those implementing projects over the long-term time horizons necessary for scaled success. And, because every government has its own unique structural, policy, and process constraints, it remains challenging to adapt and apply existing tools and resources.

The Opportunity: What if government officials looking to implement data modernization had expert, customized, long-term support from a network of colleagues with experience in the unique challenges of government settings? Across the globe, there are individuals and agencies that have reached more advanced stages of implementation and have valuable expertise through learned experiences. A formalized mentorship program can streamline access to experts with the skills necessary to guide the design and implementation of new systems while effectively transferring knowledge, abilities, and experiences to local stakeholders. Over time, “mentees” maintain the project and share their experiences and expertise with others in the future.

Encourage Knowledge Sharing and Connect Experts

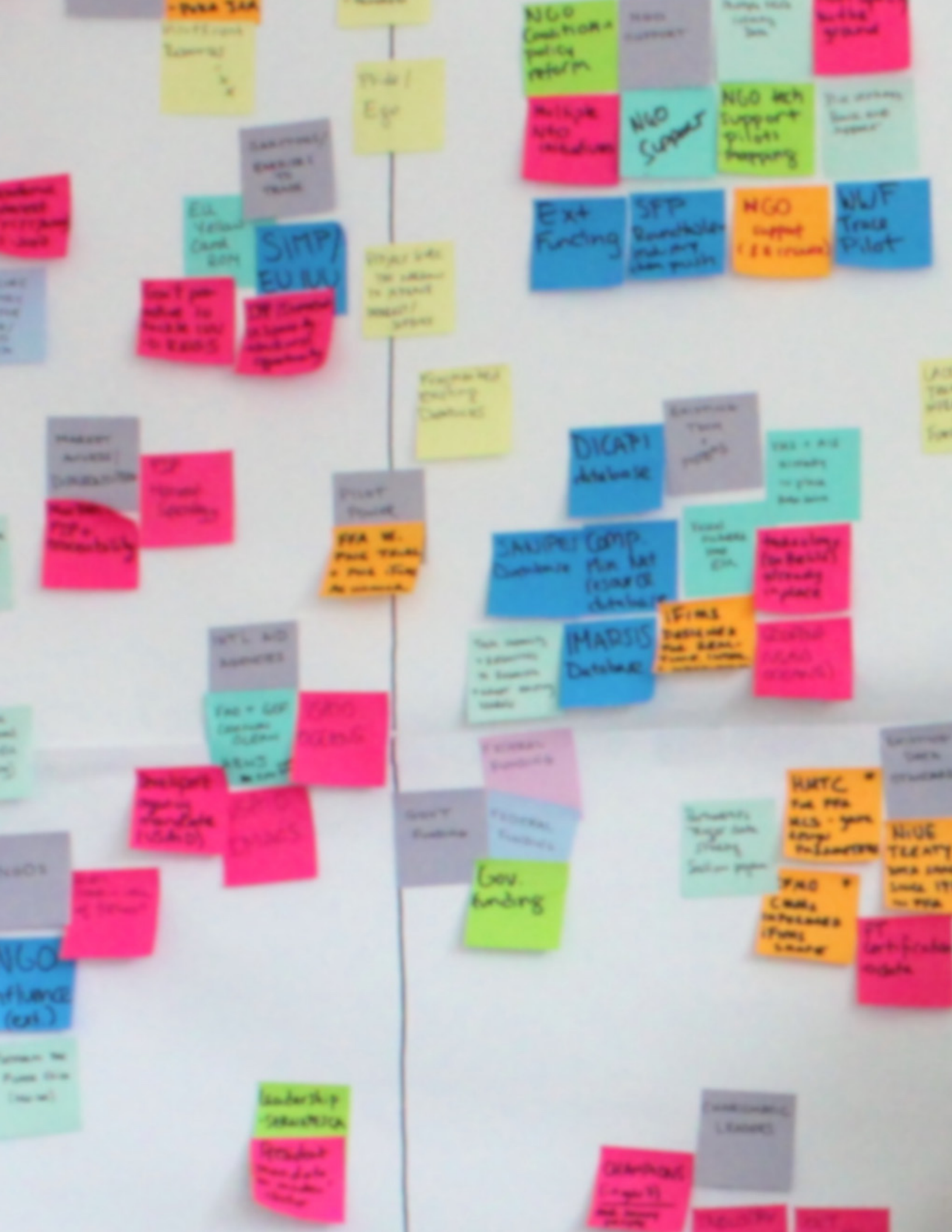
The Need: High touch, customized support is critical, but will take time to scale. Meanwhile, there is an immediate need to increase effectiveness of existing support systems for data modernization. At the moment, stakeholder support falls to two players: NGOs (efforts focused on shifting policy and process); and technology vendors (engage with the system at a very technical level). More often than not, these two groups lack alignment and are often engaging in the space for vastly different reasons, leading to conflicting, incomplete, or unclear information communicated to participants.

The Opportunity: Establish in-country support systems, which will look different for each country. For example, tailored support could come from: 1) use of an intermediary who can align and coordinate efforts among various stakeholders; 2) conducting research to identify the best approach to cultivating in-country expertise; or 3), developing a support program that champions government officials with interest in improving data. Additionally, prioritization of the following at a global scale can help build conditions for greater success, including:

- *Creating a common language around data modernization initiatives:* Define key terms, processes,

technologies, and project stages that can be utilized and recognized across technologies and geographies, by all stakeholders.

- *Providing training resources for technology vendors:* Equipping vendors with training in some of the tools and resources that already exist, as well as the strategy and mission of the project, can help to align messaging to government agencies about key issues such as data collection and sharing, verification mechanisms, or how and when to make technical changes to the system.
- *Support cross-sector information sharing:* The seafood sector potentially has much to learn from the systems that already exist for other commodities, such as timber, beef, or soy. A variety of tools and technologies ranging from field-based training materials to satellites, drones, and cameras, to DNA testing or RFID tags and AI are all already in use in parallel commodity markets; lessons learned from the implementation of these systems have tremendous potential value for the fisheries world.



Introduction

Modern data collection and sharing systems are critical to sustainable fisheries: information generated by “data-rich” fisheries and supply chains is necessary for effective fisheries management and enforcement, especially in regions where limited capacity demands more strategic direction and deployment of resources. Importantly, data-rich fisheries also can provide business intelligence in ways that encourage more responsible practices, helping to drive bottom-up solutions that can take pressure off government agencies, allowing more focus on better science and adaptive management.

Today, a multitude of initiatives are tackling various aspects of fisheries data modernization around the world, ranging from tech-driven solutions to coalitions focused on standard-setting to policy developments (Table 1a). For the seafood industry, modern exposés highlighting fraud, illegal sourcing, and human rights abuses in supply chains around the world have placed significant pressure on companies to reform. This additional scrutiny, combined with long-standing efforts to engage end-buyers in sustainable sourcing commitments, has pushed many of the major seafood companies in North America, Europe, and increasingly South East Asia, to move towards greater transparency and traceability.

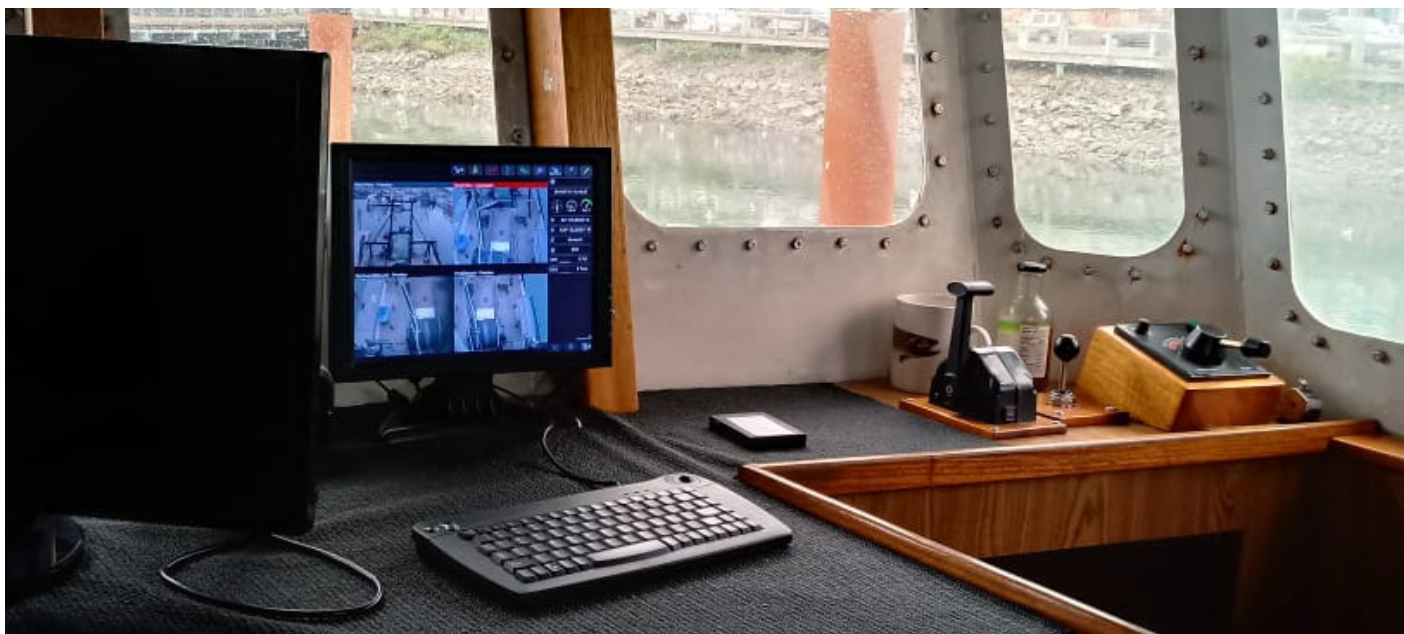
Table 1a. Overview of different types of fisheries data modernization initiatives.

Category	Example initiatives	Key stakeholders
Electronic supply-chain traceability (general)	*Belize lobster cooperative, NFC *ANOVA & MDPI tuna	NGOs, fisher cooperative, technology vendor
Blockchain	*WWF and SeaQuest Fiji tuna *Pacifical MSC tuna *Bumblebee Anova tuna	NGOs, technology vendors, seafood companies
KDE standards setting	*Global Dialogue for Seafood Traceability *GS1	Industry, NGOs, technology vendors
Certifications	*Fair Trade Mexican blue shrimp *Fair Trade Alaskan Salmon *MSC Certified Tuna (Chicken of the Sea)	NGOs, government, consumers
Electronic Monitoring	*ABNJ Oceans project in Fiji and Ghana *Pacific Groundfish Trawl Fishery	Government, NGOs, industry
Electronic Reporting	*Alaskan Fisheries (NOAA) *EU ERS System	Government, industry, NGOs
Vessel Monitoring Systems	*Global Fishing Watch *West Coast Groundfish	Government, industry, NGOs
National Policy	*Chile’s Data Modernization Law *Japan’s Fisheries Reform Act	Government, industry, NGOs

These modernization initiatives span both industry and government sectors; however, progress is not happening quickly enough to meet natural resource management demands—including secure livelihoods and conservation needs. To accelerate government fisheries data modernization at a global scale requires the following critical first steps: 1) increase awareness of the value of data modernization for fisheries (communication and messaging to governments and funders); 2) build understanding of where things are stuck (barriers) and where progress has been made (design principles and strategies for success); and 3) identify how modernization unfolds (process framework and tools, Figure 3).

PART 1

Communicating Government Data Modernization



The first step in communicating about data modernization is to be able to define what it is. Currently, no single definition of data modernization exists. Our findings include the following proposed holistic definition to help align missions and root strategy in common goals:

Government fisheries data modernization is any initiative or process that results in more **accurate** data and/or more efficient and **timely data delivery and analyses** that support **both** improved governance (management, science, and enforcement) and serves industry and public needs for the long term.

This definition includes three core elements—*accuracy*, *timeliness*, and *access* to data and analyses—for three core stakeholder groups: government, industry, *and* public stakeholders. The definition does not restrict data modernization to technological improvements. Improved protocols for data capture and sharing in paper-based systems would be considered modernization if those protocols facilitated better management and insight for stakeholders. That said, technology, and especially electronic systems, are best positioned to provide the efficiencies and data QA/QC that is needed. But technology alone is not enough. **In fact, piecemeal technology adoption without a holistic plan for integration and analysis of newly generated data often creates more problems.**

A detailed analysis of fisheries information systems around the world is beyond the scope of this report; however, we provide a schematic (Figure 1) to describe the major data flows, processes, and decision-making that might be enabled by a holistic government fisheries data modernization process that could achieve these three goals.

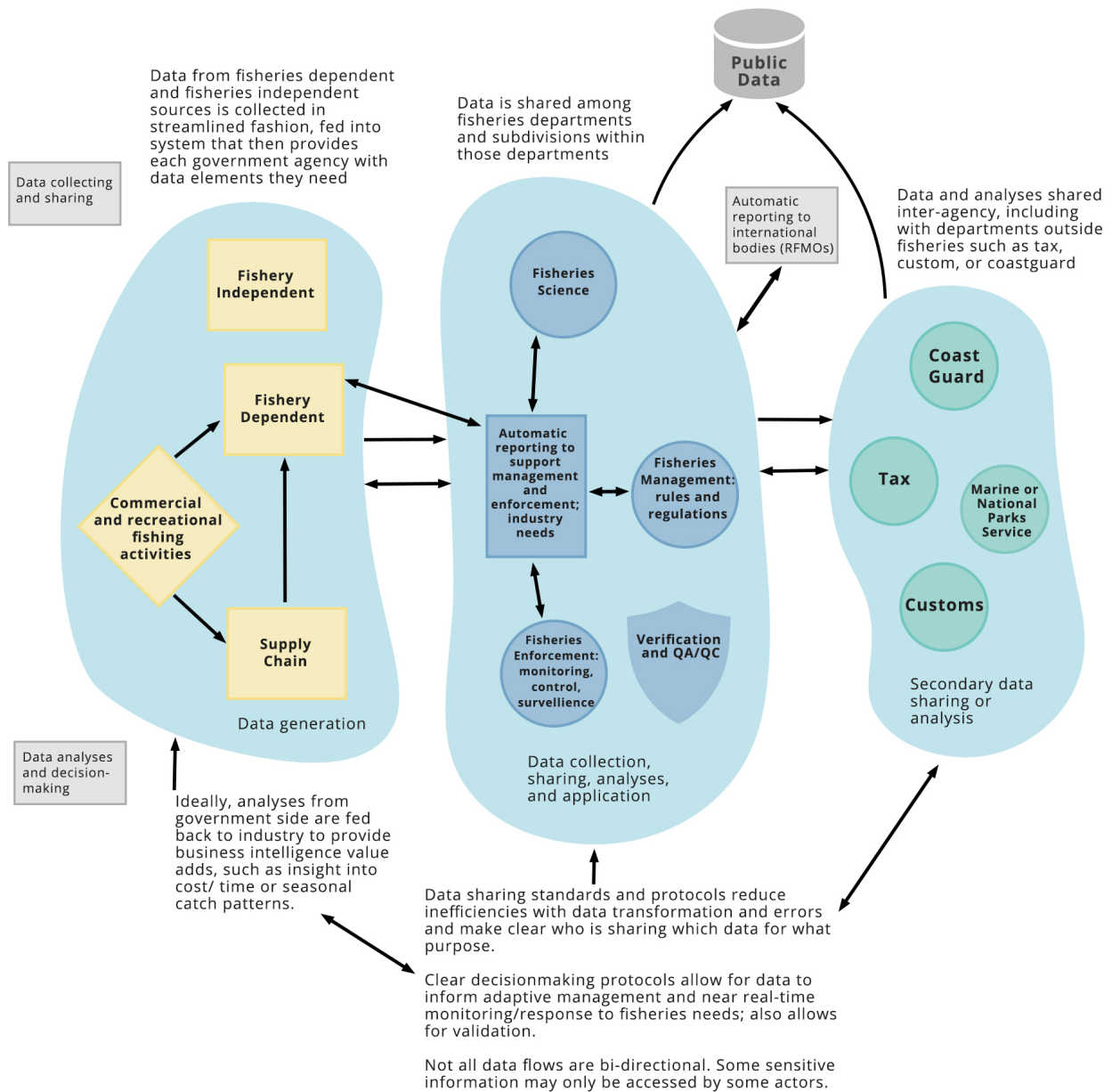


Figure 1. Simplified schematic of modernized fisheries data systems and the decision-making such systems support.

Robust design, including change management, in addition to new software and hardware integration, is key to success. Studies exploring barriers to technology uptake and interoperability in the fisheries and seafood sector have highlighted the critical role of relationship dynamics, cultural factors, learning curves, and work habits in preventing technology adoption.¹ As in any system, technology must be viewed as a tool, not the solution in and of itself. It is the successful application of technology that matters—and that requires sound strategy and design incorporating the human elements of the problem.

1. See for example, Hardt et al., 2016. Current Barriers to Large-scale Interoperability of Traceability Technology in the seafood sector. *Journal of Food Science*, 82(S1):A3-A12; Bhatt T, Cusack C, Dent B, Gooch M, Jones D, Newsome R, Stitzinger J, Sylvia G, Zhang J. 2016. Traceability technology architecture: issues brief. *Comp Rev Food Sci Food Saf* 15:392–429.

BUILDING AWARENESS AND ENGAGING GOVERNMENTS

The nascent state of government fisheries data modernization means many agencies lack awareness of not only what fisheries data modernization entails, but how data modernization could improve fisheries management and the long-term seafood trade of their country. Research to identify promising communication approaches to reach government stakeholders revealed five key **communication insights** and four **strategic entry points** that may help introduce government agencies to the data modernization concept. The insights provided here can be applied (and in fact, are being applied!) by a number of groups leading initiatives to promote a range of data modernization efforts at a global scale, including The Seafood Alliance for Legality and Traceability (*SALT*); The Global Dialogue on Seafood Traceability (*GDST*); Seafood and Fisheries Emerging Technologies (*SAFET*); The Small Scale Fisheries Hub (*SSF Hub*), and an *emerging partnership* between Global Fishing Watch and Human Rights at Sea.

Communication Insights: How to Spark Interest

Science and Enforcement Divisions are Promising Gatekeepers

The Challenge: Governments often struggle to accept outside expertise, due to a range of reasons: prior bad experiences with NGOs or development agencies; fear of looking unprepared or lacking experience; or a strong cultural preference for working internally.

The Strategy: The science and enforcement arms of government currently appear most open to collaboration and exploration of modernization solutions for fisheries challenges. Leverage the interest in these departments to reach the fisheries managers and decision-makers.

Workshop Your Way In

The Challenge: Governments are often resistant to outside assistance. As a newcomer to the space, finding a way to initially gain access to key decision-makers can be challenging.

The Strategy: In-person symposiums or workshops provide venues to detail and share the benefits of an approach, tool set, or strategy in a specific fisheries context, and serve as an effective approach for initially engaging important government officials.

Multi-pronged approaches are a must

The Challenge: Government organizational structures are fragmented and often siloed. Thus, no one decision-maker can push through an idea from concept to implementation.

The Strategy: Plan for a multi-pronged communication campaign that targets the needs of each critical individual and brings them together after initial interest is peaked.

Focus on Acute Needs

The Challenge: As governments begin down the path of data modernization, they are bound to hit sticking points—particularly as projects start to get off the ground.

In addition, the people and departments executing these projects are most likely resource strapped, under deadline, and worried about being publicly embarrassed if their pilot projects and initiatives are unsuccessful. These conditions combined to create a sense of urgency and often a singularity of focus, whereby attention to anything other than resolving the immediate problem is impossible.

The Strategy: The most effective way to begin engagement with governments involves: a) learning what pain points are in order of importance and b) understanding how to address the most urgent needs or concerns quickly, effectively, and in-person.

Strategic Entry Points: Align with Existing Values

In addition to identifying best practices, our initial analysis also surfaced several “strategic entry points” that appear ripe either to engage governments to initiate fisheries data modernization efforts, or as opportunities to expand a current effort into a more holistic endeavor. These strategic lines may help accelerate progress by:

1. Assisting practitioners within or outside government to identify positive incentives or goals that may attract the attention and support of needed government staff and leaders
2. Helping steer funders who wish to push more holistic fisheries data modernization towards projects that serve as promising stepping stones into larger fisheries data modernization conversation and action.

For each of these entry points, we have identified target stakeholders that may be most interested and incentivized, and the rationale behind and potential of the strategy. For the target, note we use USA-specific descriptions but intend equivalent agencies for countries with different government structures.

Robust Fisheries Management for Resource Security

Target: Fisheries or state agencies, Department of Public Health (nutrition and food security); Department of Labor (job creation and employment rates)

The Push: Enormous resources are poured into countries via international development finance institutions targeting poverty alleviation, food security, and economic growth and linkage to global markets. The health of local fisheries are inherently tied to these issues, especially in countries where large portions of the population participate in or rely upon local, artisanal fisheries or ecotourism for their food or livelihoods.

The Potential: With appropriate design and deal structuring, a percentage of development financing could be explicitly channeled to spark and support holistic data modernization efforts within fisheries divisions as a means to drive better fisheries management that in turn secures livelihoods and improves the stability and sustainable growth of the sector’s output. The longer time horizons of these development programs (5-10 years) allows for the continued support needed to build capacity, weather government turnovers, and execute a comprehensive vision.

Trade and Tourism

Target: Department of Commerce; Department of Agriculture.

The Push: New and stricter trade regulations (e.g. US SIMP and EU import laws), continued growth of FIPs and certifications, increased interest in mariculture, and in some regions, increased consumer demand for ethical seafood, are pushing industry

and government reforms. In addition, with coastal and marine tourism expected to be the largest value-adding segment of the ocean economy by 2030, countries are beginning to recognize the importance (and value) of restoring and preserving healthy marine environments to their local economies.

The Potential: To meet both the opportunities and demands of the trade and tourism sectors requires that governments have better and more timely information to effectively and efficiently monitor and manage their fisheries—creating a strong case for data modernization.

Electronic Monitoring and Reporting Initiatives

Target: Fisheries division; Government IT department or CTOs.

The Push: EM and ER technologies and systems are gaining traction in fisheries around the world. Technology is becoming smaller, less expensive, and new processes are reducing the time required to effectively analyze the data.

The Potential: EM and ER provide scores of new information, creating a need for new data storage and analyses—such capacity needs can be a great opportunity to build out a holistic data management system for the country. Consideration for the following may be especially useful in sparking this expansion:

- For EM, establish a broad vision for how data can be used to achieve compliance and science/management goals; one clear purpose may be needed to launch a pilot (such as compliance-focused initiative) but building in future-capacity to leverage these systems to their full effect will allow for maximum benefits. Benefits to industry are also key, and may include things such as worker safety and insurance against false claims of IUU.
- More data without enforcement achieves nothing. Ensure strategies are developed so that information from EM and ER can be used for management, science, and enforcement.
- Fear of EM/ER impacts on employment is common. Knowing how to anticipate and address this can help with building trust and buy-in.

National and Maritime Security

Target: Department of Defense, Homeland Security, and Coast Guard Agencies.

The Push: Efforts to more effectively protect national waters and resources from illicit activities, from piracy to drug trafficking, are gaining traction in many developing regions of the world.

The Potential: As nations collaborate and invest in technical and analytical capabilities to better monitor and enforce their national waters, there is opportunity to bring training and capacity into the fisheries realm, as some critical data comes from fishing fleets; also, there is often overlap in jurisdiction and responsibility between maritime security and fisheries enforcement agencies

Communicating and gaining the government’s attention, however, is just the first step. Part 2 of this report dives into best practices (and known barriers to look out for) in designing and implementing effective modernization strategies.

Consider the Role of Data Modernization Initiatives as a Risk Mitigation Tool

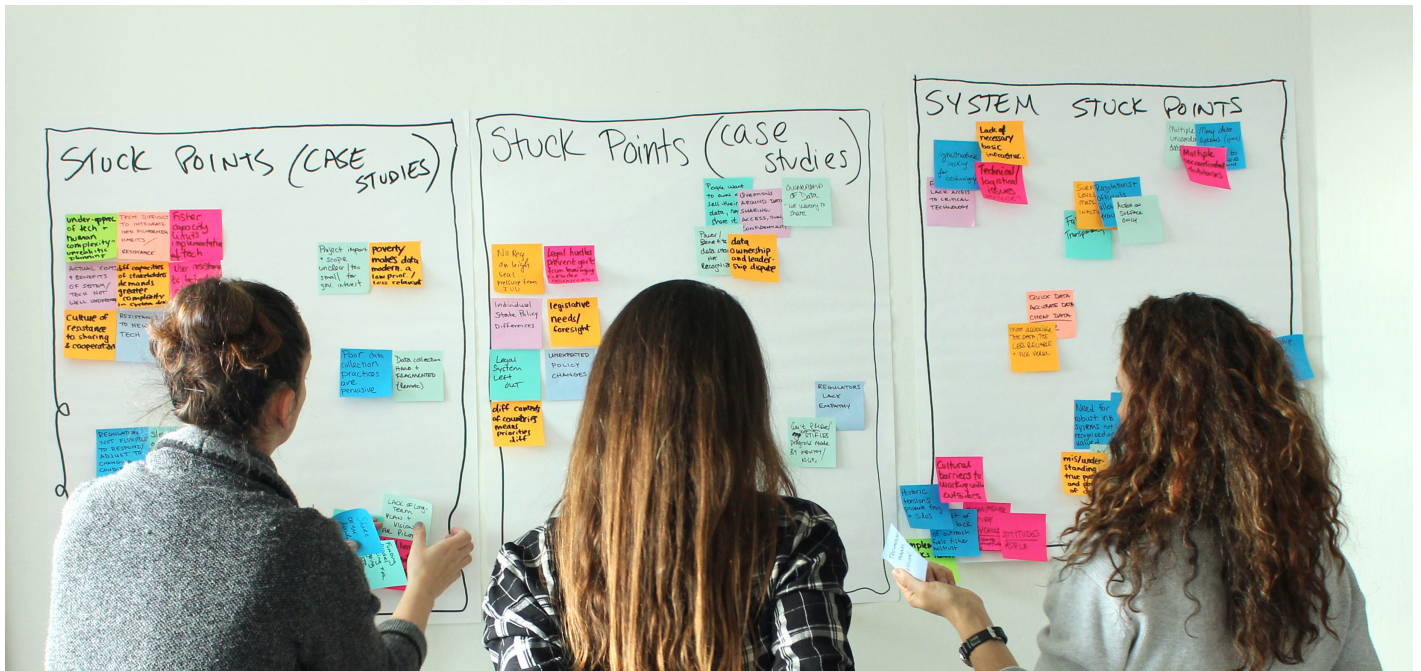
Target: Military/Department of Defense; Tax Departments (relief funds); National Fisheries Agencies.

The Push: A lack of coordination and data accessibility restricts government capacity to effectively and rapidly utilize and apply information for the benefits of their constituents—especially in response to change. In fact, these inefficiencies limit the ability of both governments and industry to better mitigate negative impacts from catastrophic events (such as market and trade disruptions due to COVID-19), climate change-induced impacts on stock health, location, or abundance, or political upheavals that impact rules and regulations. In some cases, the lack of efficient data coordination exacerbates these negative impacts, such as the case we see illustrated by the impacts of Brexit on UK fishers who are now required to fill out over 70 pages of paperwork for every shipment entering the EU.

The Potential: While strong, co-designed data frameworks and technologies cannot protect against these major disruptions, we believe they *can* provide a way for governments and industry to rapidly assess and respond to acute changes in fishery stocks and market and supply chain disruptions. For example, during COVID-19, more integrated data systems could support struggling fishers to process logbook information to help provide access to relief funds; provide fishers with the information and resources needed to find available buyers; determine viable species for diversification options; and assess opportunities for aggregate sales with local partners. Accessible, integrated data allows *everyone* involved to better achieve the full potential benefits of data analyses and application, including crisis response.

PART 2

Government Fisheries Data Modernization Landscape



Gaining audience and interest with governments to consider data modernization is the first step. But once interested, the first question is nearly always: So, what does this whole process look like? The following section provides an overview of the current fisheries data modernization landscape, including a generalized framework that articulates key elements of the process; we also provide insights into design principles that can help overcome known barriers to the successful implementation. The fisheries data modernization space is highly dynamic, and there exist multiple frameworks and process guides, many directed at a specific element of data modernization (such as electronic monitoring or apps for fishers). We have aimed to incorporate elements of these frameworks into our synthesis, and invite further discussions as we work to refine and develop harmonized approaches to meet the diverse needs of governments around the world.

THE PROCESS: STRUCTURE AND ATTRIBUTES OF GOVERNMENT FISHERIES DATA MODERNIZATION

In order to better understand how government fisheries data modernization works, and where the process becomes stuck, we looked across eight different case studies of government fisheries data modernization around the world. From this global view, we distilled patterns in how the modernization process unfolds and key attributes of these systems, including the human barriers to progress. We offer here a draft framework (see Figure 3) that encapsulates these high-level commonalities, which can be used to inform a holistic strategy for implementing fisheries data modernization.

The Four Stages

The framework includes four stages—Initiate, Pilot, Establish, Scale—through which government fisheries data modernization generally progresses (Figure 2). In reality, the process is not so uni-directional. Instead, within any stage, new ideas or concepts may emerge that spark a new and separate work initiative that will undergo its own evolution; likewise, most launched initiatives are born from the convergence of multiple factors, making a “starting point” difficult to define. Regressions can occur where an initiative stalls and another, similar project with duplication of effort and redundancies emerges. However, for the sake of discussion—and potential strategy development—we find these four stages useful in thinking through what is needed for a fisheries data modernization idea or concept to progress to an established, functioning, and (ideally) scaled solution within the context of governing agencies.²

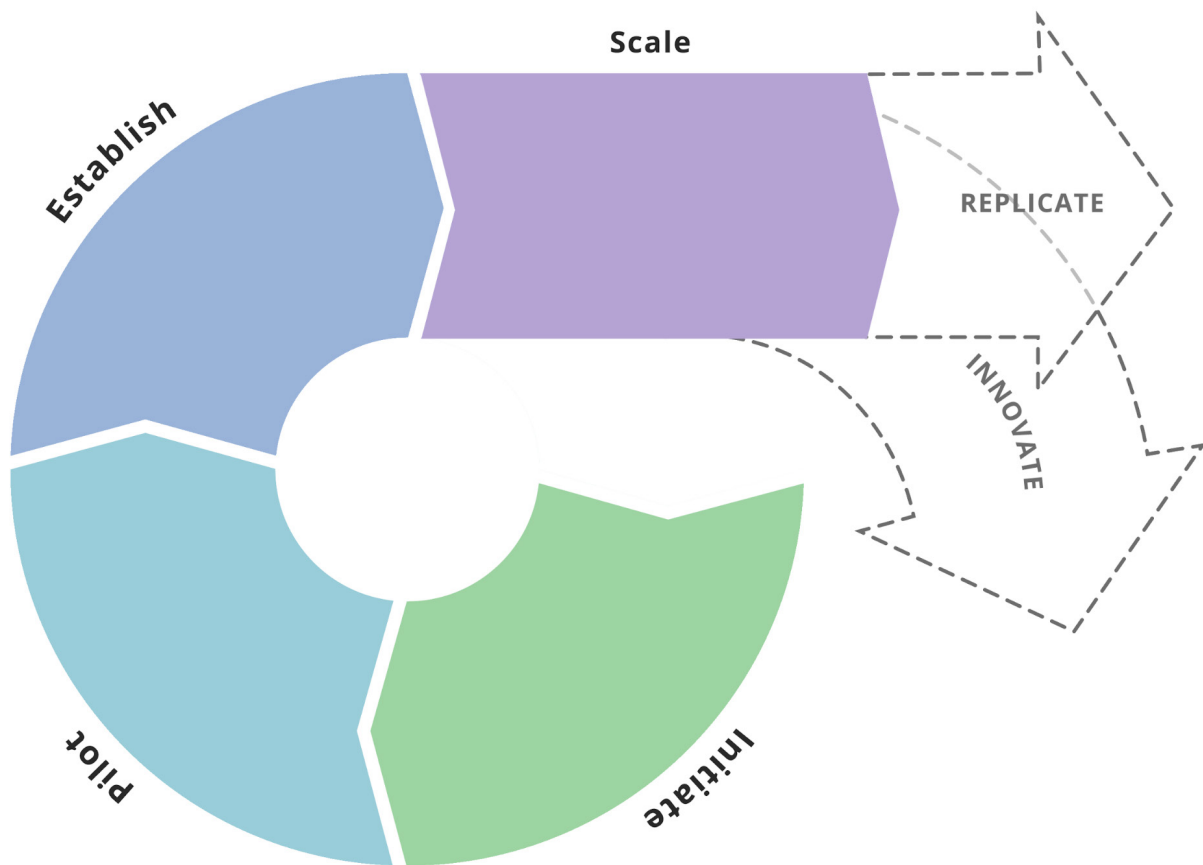


Figure 2. The four Stages of a generalized government fisheries data modernization process. Stage 1: Initiate; Stage 2: Pilot; Stage 3: Establish and Stage 4: Scale. The process is not always so uni-directional, with many new ideas surfacing during Stage 2 and 3, which may kick-off a new process cycle; likewise, stalled initiatives often wind up reverting back to Stage 1 to regain momentum. When new initiatives emerge out of Stage 4, they often will progress through the cycle again, creating the next layer of a spiral; or, they may be a replication of a solution into more fisheries and fleets with little need to pilot and thus, don't re-enter the spiral.

2. The Environmental Defense Fund's *Fisheries Monitoring Roadmap*, and *Designing and Implementing Electronic Monitoring Systems for Fisheries*, as well as TWDI's *Data Maturity Model* offer variations on the Four Stages identified in this report, with different models ranging from 5 to 8 phases.



Stage 1: Initiate. The first stage is where an idea or concept is first ignited and then socialized to garner interest, engage experts, and secure the support necessary to turn the idea into a testable pilot or working draft. It's about ideation, brainstorming, and shaping an idea or concept into a plan. In some instances, ideas may be “pushed” onto an agency by an outside party that may be a poor fit for the capacity or needs of the system. Careful assessment during this phase is critical to evaluate which ideas are appropriate to move forward and which are not.



Stage 2: Pilot. The second stage in the process is where the idea moves from theory to a testable prototype. For initiatives focused on technology deployment, this stage is often a pilot project; for policy developments, it may be initial drafts or committee meetings to vet and organize ideas. This stage involves more doing, less talking. It also often involves capturing lessons learned and refinement of original approaches to make them more effective. Proof of concept and associated benefits may occur at small scales.



Stage 3: Establish. During this stage, the initiative or program takes root and becomes embedded in the day-to-day of an agency or individual's workload. The data modernization initiative or program is no longer viewed as a pilot or temporary exercise but instead is now a part of regular operations. During this stage, benefits from the modernization process are realized and shared with multiple stakeholders.



Stage 4: Scale. The fourth stage of the process is when a data modernization effort is refined, replicated, or applied in a novel context. This may mean expansion of a technology to a new fishery or fleet; it may mean incorporating a new type of analysis or feedback mechanism to increase the value generated by existing data; or it may be adding a new technology or tool. This is the stage where stakeholders no longer question if they should modernize, but begin to explore how they can continue to do so. Often, this stage generates ideas that loop us back to the beginning in terms of process (Innovate arrow), but expand the scope of modernization by building out on what has already been accomplished (represented by the next layer of the spiral). As modernization progresses we anticipate that the drivers and enabling conditions may look different in more mature parts of the cycle. Scale can also occur when a solution is simply expanded to other fisheries or geographies without the need for further testing or refinement (Replicate arrow).

The Attributes

For each stage, we also identify seven attributes of the data modernization process that are important to account for when planning and implementing initiatives—consideration for each can help inform successful design of projects or programs. For every scenario, the nature and number of factors within each attribute will vary; however, there are some key factors that appear to be common and thus, potentially critical for success, in each stage. These are noted in Table 1b-1g and shown in Figure 3.

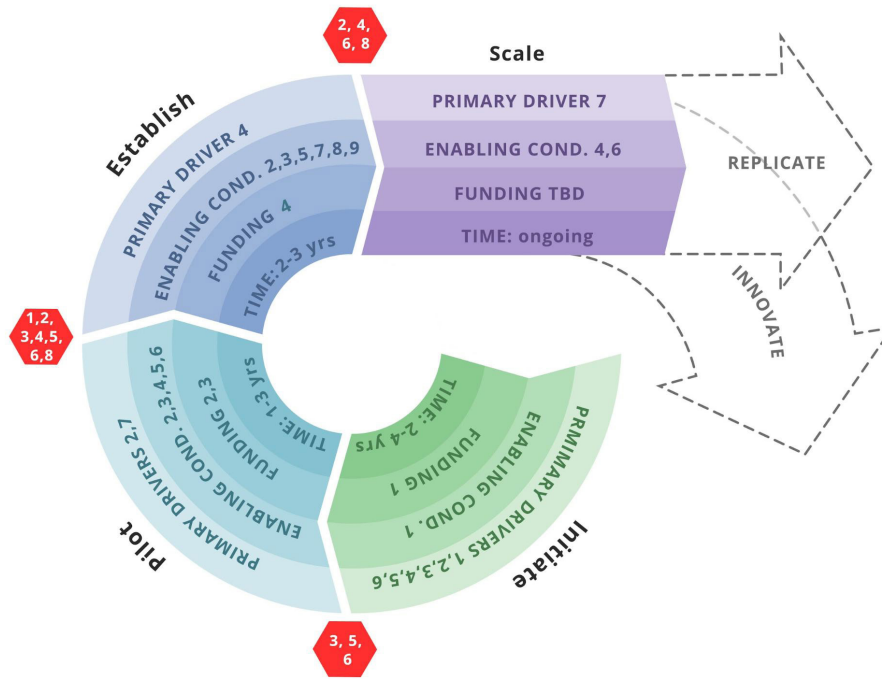


Figure 3. Framework for government fisheries data modernization. Red Octagons note where numbered System Barriers tend to manifest during the process. The specific attributes for each stage are included with detailed descriptions provided in the text. For Stage 4, funding type depends largely upon the type of scaling to occur and thus has been left as TBD. See Table 1d for further details on funding types.

Attribute 1: Primary Driver (PD). The catalyst that gives the initiative the initial or additional momentum required to maintain forward progress. There are often more than one primary drivers at play (Table 1b). They may take the form of a catalytic event or may be a tipping point reached after a slow build up of energy or effort. Primary drivers are critical in Stage 1, but can also be important levers to move a project into Stage 3.

Table 1b. Key Primary Drivers and Stage where we see them manifest

Primary Driver (PD)	Initiate	Pilot	Establish	Scale
PD1. National Policy: legislative action that provides regulatory or top-down pressure to execute an aspect of data modernization. This could also apply to state or province-level regulations.	X			
PD2. NGO or Industry Proof of Concept: organization outside of government leads on moving forward a pilot or initiative into execution. Care must be taken with this driver to ensure the concept is a best-fit for the system.	X	X		
PD3. Recognition of problems rooted in data gaps/ issues: growing awareness among stakeholders or the public that missing data or poor data quality is impacting livelihoods and health of the marine environment. This may be via published reports or simply discussions during meetings or conferences.	X			

Primary Driver (PD)	Initiate	Pilot	Establish	Scale
PD4. Sanctions/ Trade barriers: Strong market drivers such as US SIMP, EU yellow or red cards, even Seafood Watch rankings that can deter or block trade can serve as major motivation for engaging in a data modernization initiative to prove compliance and legality	X		X	
PD5. Market Differentiations: Interest in certifications or otherwise distinguishing product in the marketplace via robust, verifiable data on product's pedigree.	X			
PD6. Cross-jurisdiction needs: These are requirements that demand coordination and data sharing among multiple parties/jurisdictions and may be at national (among states) or international (among countries) scales	X			
PD7. On-the-ground NGO support: aid in the form of expertise, capacity building and training, and even salaries for staff can all come from NGOs and help push a specific concept into being. Similar risk applies here as PD2.		X		X

Attribute 2: Enabling Conditions. These are factors that nurture and support the progress of an idea or initiative. Without these factors in place, initiatives would run out of steam (Table 1c). These conditions also provide the critical resources necessary for any idea or initiative to realize its potential within a given stage.

Table 1c. Key Enabling Conditions and Stage where we see them manifest

Enabling Conditions (EC)	Initiate	Pilot	Establish	Scale
EC1. Minimum viable participant group: Engaged stakeholders from the start helps build trust, a sense of ownership, and helps de-risk projects and get them off the ground.	X			
EC2. Existing Willingness and Comfort with Tech: means fewer resources are spent on basic training and more effort can be put toward developing skills around specific modernization initiative		X	X	
EC3. Existing data sharing protocols and initiatives: accelerates the rate at which new system or technology can be incorporated		X	X	
EC4. Recognition of broader benefits informs strategy: Having knowledge and capacity to frame data modernization as a way to meet needs and generate valued benefits can help attract interest and secure participation. Also, adapting strategic plans to capitalize on benefits that are most valued (or take advantage of unexpected benefits that emerge) can help inform new directions and scale success.		X		X
EC5. Stakeholders set and maintain commitments: Roles and responsibilities are articulated and individuals and entities agree to being held accountable to execute. This may be through formal agreements or MOUs or more informal, but must be a clear and recognized process.		X	X	
EC6. Expertise, at least "borrowed": short-term engagement of a consultant or other type of professional (expert from another sector, or country) to provide training and support over the course of the pilot or for refining an idea. In rarer circumstances, this expertise is available in-house.		X		X
EC7. Government Assumes responsibility: Government builds into budget and staffing roles capacity to continue to engage and incorporate modernization initiative into daily routines. Often, this condition is evidenced by support for a program manager.			X	
EC8. Appropriate tech identified through pilot: Processes are built into the pilot stage that allow for appropriate screening and selection of technology, so that best-fit solutions are identified prior to implementing throughout a department/division or across departments.			X	
EC9. Communication and feedback loops: frequent, trusted, and transparent processes for soliciting user feedback on benefits and challenges of new systems are critical to identifying incentives and design elements that can increase likelihood of a smooth adoption of the new system throughout a department or division.			X	

Attribute 3: Funding. Different types and sources of funding are critical for long-term progress of data modernization initiatives. Understanding what kinds of support are needed at each stage is necessary to design and execute a realistic implementation plan (Table 1d).

Table 1d. Key Funding Types (FT) and Stage where we see them manifest

Initiate	Pilot	Establish	Scale
FT1. Discretionary: “extra” resources that can be used to support idea-generation or networking to gain exposure to new developments in the field	FT2. Dedicated: funding that is allocated for the specific project and secured for this purpose (not transferable) FT3. International Aid- this may be the source of the dedicated funding.	FT4. Internal: at least some level of dedicated government funding from within the region or country where the modernization initiative (and benefits) occur	TBD. Anticipate: Combination of Internal and often International funding. The latter brings additional capacity to build off successful models or evidence of dedication/ investment from a country. This funding will depend on type of scaling (replication or innovation) as well as which layer of the spiral.

Attribute 4: Leadership. Success for all stages hinges on strong leadership. However, the type of leadership that is most effective varies across stages (Table 1e). As most government agencies are hampered by staff operating at overcapacity, having the right kind of leadership to motivate participation and attract key stakeholders is critical. Understanding these nuances in leadership needs can help practitioners identify who to engage, for what purposes, when.

Table 1e. Key Leadership Types and Stage where we see them manifest.

Initiate	Pilot	Establish	Scale
Amplified Voice: individual with passion, platform, and persuasive powers to turn ideas into action	Patient Execution: authority to use, access, and deploy resources as needed to achieve specific goals Community leader participation	Task-Master: in-country dedicated project manager under government support to help align, coordinate, and hold actors accountable Translator: push benefits of pilot to daily operations	Visionary: forward-thinking that can anticipate developments and needs coming down the pike and be proactive with testing and trialing solutions

Attribute 5. Barriers (B1-8). These are the common and underlying challenges that emerged across multiple case studies. See the next section, “The Challenges,” for details on each barrier and Figure 3 for where they manifest in the modernization process.

Attribute 6. Tools. Each stage of the data modernization process requires different knowledge, skills, and resources. Through research into existing tools and resources, we uncovered a vast wealth of reports, toolkits, platforms and guides that can help with different aspects of government fisheries data modernization.

Table 1f provides a select list of tools that could be used to support data modernization efforts, from Initiation through Scale. Part 3 and Annex III of this report provide additional information regarding tools research, including a complete initial list of resources available for data modernization practitioners as well as an assessment of remaining gaps and system needs.

Table 1f. Tools and Resources by Implementation Phase³

Initiate (Tools provide background information guidance, and rationale for data modernization efforts)	Pilot (Tools provide technological and implementation guidance through research or lessons learned)	Establish (Tools provide platform for assessment and expansion of existing data modernization systems)	Scale (Platforms or events for larger expansion, creation, and connection)
<p><u>*Fisheries Monitoring Roadmap</u></p> <p><u>*Challenges, Opportunities, and Costs of Electronic Fisheries Monitoring</u></p> <p><u>*Guiding Principles for Development of Effective Monitoring Programs</u></p> <p><u>*Catalyzing the Growth of Electronic Monitoring in Fisheries: Building Greater Transparency and Accountability at Sea</u></p> <p><u>*Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally-Managed Fisheries, Discussion Draft</u></p> <p><u>*Electronic Monitoring White Papers</u></p> <p><u>*Electronic Monitoring Program Toolkit: A Guide for Designing and Implementing Electronic Monitoring Programs</u></p> <p><u>*Getting There from Here: A Guide for Companies Implementing Seafood Supply-Chain Traceability Technology</u></p> <p><u>*Good Practice Guidelines (GPG) on National Seafood Traceability Systems</u></p>	<p><u>*Fisheries Digital Data Collection Guide</u></p> <p><u>*An Inventory of New Technologies in Fisheries</u></p> <p><u>*Tools and Technologies for the Monitoring, Control and Surveillance of Unwanted Catches</u></p> <p><u>*Evaluating Electronic Methods of Fisheries Monitoring, Control, and Surveillance</u></p> <p><u>*Technology for Fisheries Monitoring and Surveillance</u></p> <p><u>*OECD Issue on Inventory of new technologies in fisheries (2017)</u></p> <p><u>*FOCUS (Fisheries Open Source Community Software)</u></p> <p><u>*Fishing Data Innovation Taskforce</u></p> <p><u>*The Ocean Data Alliance</u></p> <p><u>*Open Data Kit</u></p>	<p><u>*Cost Recovery Guidelines for Monitoring Services</u></p> <p><u>*Project to Develop an Interoperable Seafood Traceability Technology Architecture: Issues Brief</u></p> <p><u>*Global Fishing Watch</u></p>	<p><u>*Too Big To Ignore: Global Partnership for Small-Scale Fisheries</u></p> <p><u>*Fisheries Innovation Fund</u></p> <p><u>*Fish 2.0</u></p> <p><u>*Fishtech Awards</u></p> <p><u>*The Marine Protection Prize</u></p> <p><u>*The Techstars Sustainability Accelerator</u></p> <p><u>*Fishackathon</u></p> <p><u>*Seafood and Fisheries Emerging Technologies (SAFET) Conference</u></p> <p><u>Seafood Alliance for Legality and Traceability (SALT)</u></p>

Attribute 7. Timeframe. Expectation management and appropriate budgeting are critical to ANY project success—and both require a realistic estimate of how long a project or phase will take. Because government fisheries data modernization is not a single process, but may be initiated and built upon via multiple diverse initiatives, it is impossible to define a specific timeframe for any stage in the process. The following are the minimum time horizons over which the different case studies progressed—on average—through these stages, noting that often, multiple initiatives operating over different time scales were happening simultaneously:

1. Initiate: 2-4 years
2. Pilot: 1-3 years
3. Establish: 2-3 years
4. Scale: ongoing

3. This is not a comprehensive list of Tools and Resources, rather, this a representation of the current availability of resources by phase. For a complete list, please see Annex III.

THE CHALLENGES

We define barriers as the underlying roots of a problem. Stuck points may include risks that are symptoms of larger failings or inefficiencies in the way a system works, so as to prevent optimal functioning. These barriers are not immutable conditions; they must be moveable and changeable.

Often, these barriers are challenges individual actors in the system are trying to resolve, but the integrated solution required is beyond the capacity of any single actor to implement. During our analyses, we noted the barriers that existed within each case study. We then looked for commonalities behind these barriers to identify recurring themes that emerged across multiple case studies. We call these System Barriers, and they point to critical challenges in the government fisheries data modernization space, which, if successfully resolved, could pave the way for real progress.



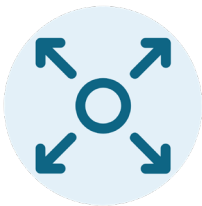
B1. Lack of Long-Term Planning & Vision

The concept of holistic data modernization is largely absent from government discourse. Instead, specific projects to address a discrete issue or threat are developed in the absence of any overarching strategy or vision. During Stages 1 and 2, little to no resources are spent on developing a financial plan to support long-term integration and adoption of new technologies, protocols, or analyses. The ability to appropriately budget and leverage one project to advance another is lost under these circumstances, as are other types of economies of scale.



B2. Inflexible and Rigid Systems

Governments are notoriously slow to change. Passing new protocols or policies, cutting through the red tape to secure resources and execute a pilot—all these things are heavier lifts within governance bodies. Add to this long-term staffers who have a vested interest to protect the status quo—especially if they've built or managed a legacy system and are considered the go-to expert—and introducing any change is really hard.



B3. Capacity Missing for Tech Adoption

Modern data systems require IT expertise, infrastructure, and at least some level of literacy. Unfortunately, these conditions are often not met in the system, limiting the viability of tech-based solutions until improvements can be secured around these conditions. This barrier is also related to general lack of resources in many countries where fisheries management—and especially modernization—are simply not a priority.



B4. Policy Prevents Progress

There are multiple ways that aspects of policy can thwart data modernization efforts. These range from simple logistical hurdles in hiring outside experts to conflicting decision-making practices among departments or across jurisdictions. Changes in policies—especially unexpected ones—as well as a lack of consideration for legislative consequences, can quickly and entirely derail initiatives. Again and again, we saw case studies where factors related to policy became major stuck points in the data modernization process.



B5. Data Ownership Confusion

Despite being inundated with data at every turn, in general, most people are not experts in strategic use of data. Whether it's refusing to trust data protocols to protect sensitive information or only seeing value in data ownership, stakeholders from both industry and government sectors continue to be confused and often misled in their understanding of data ownership and sharing, creating a major hurdle to modernization initiatives, which depend on clear roles and responsibilities, as well as agreements (oftentimes, formal) around data ownership, contributions, and access.



B6. Missing and/or Perverse Incentives to Attract Participation

The benefit and the need for better data are often unrealized and thus, unrecognized by many actors in the space. In some places, this is due to a lack of regulatory or public demand; in others, scarce resources make it difficult to retain talent or impose new tasks on already-overburdened staff. Fear around consequences for sharing imperfect data—in government and industry sectors—also results in reluctance of stakeholders to engage. Similarly, fear of too much transparency can deter some from participation in a project.



B7. Insufficient In-house Expertise

Scarce resources, overburdened staff, inadequate training, and missing expertise all reduce effectiveness of data modernization initiatives. Currently, the vast majority of projects rely on outside expertise to provide IT support and training on data systems and analytics. This reliance increases costs and reduces learning opportunities as the experts are available only for a limited time and for specific duties. Language and cultural factors can also limit the effectiveness of outside experts who come in for one-off projects and don't understand the local context. Developing skills and expertise with IT and data systems takes time, and is a worthwhile investment, but current models are limited in how they leverage pilots to build internal expertise—a resource that would return benefits again and again as data modernization progressed.



B8. Most-Recently Elected Leader Wants All The Credit

Whether it is within a sub-sector of a government fisheries agency or a ministry official or the president of a country, leaders want recognition for creating and executing impactful, sexy projects. Taking on the work of a previous administration is inherently unattractive from a PR lens. This aversion to inheriting former projects, combined with high government and leadership turnover rates in many countries, poses a threat to long-term investment and execution of data modernization initiatives which require longer time horizons to achieve success.

DESIGN PRINCIPLES BY PHASE

The following recommendations are based on synthesis of strategies, design principles, and practical solutions that emerged in the case study research. During our analysis, we worked to identify the underlying, universal concept that was being employed in order to craft a recommendation that is scalable to multiple locations and conditions. That said, some of these recommendations will be more or less applicable depending on existing enabling conditions and other attributes of and resources in the system.⁴ Additionally, while we have categorized these design principles by stage, the majority cross multiple phases, such as “be transparent regarding expectations around timelines”. Where this occurs, we have categorized the design principle within the phase where it begins. For example, “be transparent regarding expectations around timelines” is found within stage 1 (Initiate), although it also applies across all later phases of implementation.

Table 2. Summary of Design Principles by Implementation Stage

Stage 1 (Initiate)	Stage 2 (Pilot)	Stage 3 (Establish)	Stage 4 (Scale)
Set A Clear And Holistic Vision	Define Software And Hardware Parameters	Provide Enforcement Mechanisms at Every Step in supply chain	Build Legislation and Data Systems in Parallel
Be Transparent Regarding Expectations Around Timelines	Establish Pilots As Learning Opportunities	Create Ongoing Training For All Supply Chain Actors	Balance Top Down With Bottom Up
Embed Adaptive Learning Into Strategy	Be Transparent With Data Flows and Share Data Quickly	Ensure Trainings Are Wide and Deep to Grow Institutional Knowledge	Focus On The “How” And “Why” Of Success In Order To Scale
Set Interdisciplinary Focus And Map Roles And Responsibilities From The Start	Engage Mentors For In-person Trainings And Long-term Support	Promote Technological Communication	
Foster Relationships Between Key Leaders And Champions	Enlist Experts Who Can Talk Cross-sector (It, Fish, And Policy)	Anticipate And Budget For System Upgrades	
Resource Beyond Pilot	Make Data Accessible and Useable as Quickly as Possible	Balance Stability with Adaptability	
Consider The Role Of An Intermediary			
Employ Human-centered Design (HCD) And Co-design			
Utilize Existing Experts			

4. There are a number of existing best practice guidelines and design principles offered for EM/ER projects, Digital Investment, Fisheries Monitoring, and Government IT Modernization. EDF’s *Designing and Implementing Electronic Monitoring Systems for Fisheries*, Stanford’s *Digital Impact Toolkit*, Bradley et. al’s *Opportunities to improve fisheries management through innovative technology and advanced data systems*, and IBM’s *A Roadmap for IT Modernization in Government* are just a few examples. There are significant overlaps and similarities in principles encountered across these types of publications that a) point to a range of different organizations reaching similar conclusions independently, both within and external to the sustainable fisheries industry, and b) directly supports findings from the interview stage of our work, the results of which are presented here. For additional information regarding existing resources and how they can be utilized in the fisheries data modernization space, please see Part 4: Tools and Resources.

STAGE 1: INITIATE

Set a Clear and Holistic Vision

Define the purpose of the modernization effort, why it is needed, and the vision for how it will support management and industry. Elements of a sound fisheries data modernization vision include:

- Real-time or near real-time data management and benefits this brings to managers and industry
- Sufficient (sometimes very simple) data to support management of data-limited fisheries
- Reduced data entry and reporting burdens through automation
- Seamless data sharing (interoperability) and useability across stakeholders
- Advanced analytics to generate intelligence to support industry and government interests
- Multi-stakeholder engagement and accountabilities
- Verification and enforcement mechanisms in place
- Embedded into fisheries management policy
- Built-in ability for system and vision expansion and revision
- Benefits to society

An effective vision also provides an opportunity to ensure industry stakeholders see benefit to their participation in the process. Fisheries managers, NGOs, and scientists often are the main advocates for modernized data collection and reporting technologies (e.g., electronic data, electronic monitoring, mobile applications) because they see the potential for obtaining more accurate, complete, and timely information, which can support more effective conservation and management. However, the fishermen and dealers who would be tasked with implementing those new technologies rarely share the same level of enthusiasm. A holistic vision-setting process must articulate the need for a new system, address users' concerns, and finally, highlight benefits for all users.

Be Transparent Regarding Expectations Around Timelines

Strategy needs to be built upon realistic timelines to ensure alignment with stakeholder capacity, workflows, and expectations of participants. As noted in the framework, most stages require two years and up to achieve success and progress to the next stage. Helping participants understand the long-term play, and the short-term benefits that can be realized, is important to building trust and lasting partnerships.

Embed Adaptive Learning into Strategy

Build in capacity for updating strategy to allow for refinement, pivots, and adjustments based on changing contexts; including scientific, policy, and technology landscapes. Rigid systems lacking the ability to respond to evolving conditions will inevitably become outdated and unused.

Set Interdisciplinary Focus and Map Roles and Responsibilities from the Start

Engage key stakeholders from multiple divisions of government, industry, regional bodies, and civil society early on in the process to identify how the data modernization could benefit them and what concerns or challenges may need to be addressed. Consider:

- Who collects, uses, and shares or reports on fisheries-related data, and how this initiative could assist in meeting their data needs.
- Judiciary aspects—laws and regulations must be updated to be able to accept modernized data sources such as for evidence in court. Ensure experts from this sector are able to participate in project development.
- Industry engagement is key, especially in sharing the purpose of a project and how it could benefit them.

Generating commitment to specific roles and responsibilities will help shape the strategy for

moving workstreams forward. However, roles need to be crafted to fit existing capacity and abilities among participants, something that may take time to understand and define. Accountability must also be built in to ensure such responsibilities are being met.

Foster Relationships Between Key Leaders and Champions

Prioritize relationship-building to promote trust and generate a strong steering committee that can drive strategy forward. Creating alignment among leadership helps mitigate risk of efforts collapsing when a single champion is replaced or removed from the system. Slow, steady commitment to consensus building has been valuable in moving forward data modernization across multiple stakeholders and often is best done through in-person relationship-building.

Resource Beyond Pilot

While it is likely impossible to finance a full-sweeping data modernization initiative from the start, it is critical that a funding strategy accounts for resource needs beyond a small-scale pilot (Stage 2). Planning for embedding learnings, systems, and processes into daily operations will help leverage momentum from pilots to support longer-term progress and scaling of solutions.

Such strategy should include support for ongoing training for all supply chain actors; including both the rationale behind the use of new technologies as well as how to utilize new systems.

Consider the Role of An Intermediary

An independent group that can serve as a neutral, third-party data collection, storage, sharing and analysis hub can help increase trust, gain efficiencies, and support improved QA/QC of data. There are several examples where such an entity has played a critical role in shepherding multiple data modernization initiatives forward (PacFIN, ACCSP, National MIFC in Madagascar). This entity can be funded by the government without being a government body itself. Independence from

government, NGO, or industry can prove powerful in expediting system design, building trust, and allowing for transparency in how data is collected, used, and shared.

Employ Human-Centered Design (HCD) and Co-Design

No technology or policy is perfect, so good design includes strong incentives for good behavior. HCD engages stakeholders, especially industry, to map their pain points and identify solutions that can help address these pressing needs. Other elements of HCD include strong feedback loops to continue to inform and gauge stakeholder response, as well as rapid prototyping to allow for continued refinement and improvement of the system based on user-feedback.

- HCD can also surface other fears and concerns and give space to address them within pilot design.
- Stakeholders do not always know what options exist to improve their system, so they do not know what to ask for. HCD can help stakeholders self-identify their specific needs.
- HCD can also ensure projects clearly identify incentives for all users, including short-term gains. For example, for industry, publicly promote market and crew-safety benefits; for government fisheries scientists and managers, lead with data quality; for upper management, appeal to self-interest.

Utilize Existing Experts

A lot can be learned from those who have succeeded at developing collaborative data platforms, and those experts should be approached to consult on new projects attempting to achieve similar outcomes. These experts may be found in other sectors outside fisheries, or other countries. Similarly, leveraging existing models and refining them to suit regional and national needs can be a way to save on costs and increase likelihood of success by building on proven systems.

STAGE 2: PILOT

Define Software and Hardware Parameters

Understanding the project goals—improved data collection? increase in stock sustainability? defense against IUU product? —as well as who the users will be (fishers, middlemen, fisheries scientists, fisheries managers, enforcement officers, etc.) will enable the implementing party to more effectively determine the type of software and hardware needs for the specific system. Consider the use of a public RFP process to solicit tech vendor support and force articulation of data and system needs.

Establish Pilots as Learning Opportunities

There is risk—for government officials as well as industry participants—to engaging in initiatives that can expose poor practice or imperfect data. To mitigate this risk and increase participation, fisheries data modernization projects can create clear MOUs (or other structures) to protect and benefit participants. Such structures and agreements state any infractions or poor practices that are observed are used as a learning opportunity, but cannot be used at that time for any penalty or prosecution. Examples of successful models include data amnesties for up to two years or ability to fish under a “research fishing permit” which can offer certain tax benefits.

Be Transparent with Data Flows and Share Data Quickly

Build into the modernization process a pathway for users to understand how and where data is generated, captured, and shared. This includes clear explanation and proof of how confidential data is secured. Processes also need to be put into place that allow stakeholders to see the results of implementation as soon as possible so they can verify the process is working as expected. In addition, information may be of value to industry before it is useful for governments—something officials can take advantage of to provide a service to seafood companies. Some potential ways to do this include:

- Hold interviews with stakeholders to ask about what kinds of information is of value and in what format. Examples of valuable information may include summary data relevant for trip-planning, such as price of fuel/month, catch volume, or price over time.
- Utilize tools such as Tableau or other simple, easy-to-use visualization software
- Ensure pathways for those who submit data to be able to access their own data (and basic analyses on that data) early in project lifespan.

Engage Mentors for In-person Trainings and Long-term Support

Often technology companies will provide one or maybe two training sessions at the launch of a project, but long-term support is often at expensive rates and done virtually. The lack of in-house IT expertise in most countries demands greater, customized, and personal support of staff who are working to implement new systems that require new skills and tools. Close working relationships between an experienced fisheries IT professional and inexperienced officials can help build long-term capacity in culturally appropriate ways.

Enlist Experts Who Can Talk Cross-sector (IT, Fish, And Policy)

The need for interdisciplinary approach to government fisheries data modernization means that inherently, there will be participants that do not speak one another’s language. Data and tech experts don’t understand seafood industry and fisheries KDEs; fisheries managers may not grock the technical aspects of a pilot; and policy experts don’t necessarily understand practical limitations or needs on the ground. Having experts that can effectively bridge the gaps among disciplines can help accelerate progress during implementation of a pilot or initiative.

Make Data Accessible and Useable as Quickly as Possible

Even if a pilot or initiative will require months to generate information that is impactful in terms of

management or compliance, sharing newly generated data or analyses right away helps to build a sense of transparency and trust with participants. In addition, information may be of value to industry before it is useful for governments—something officials can take advantage of to provide a service to seafood companies. Some potential ways to do this include:

- Hold interviews with stakeholders to ask about what kinds of information is of value and in what format. Examples of valuable information may include summary data relevant for trip-planning, such as price of fuel/month; catch volume or price over time.
- Utilize tools such as Tableau or other simple, easy-to-use visualization software
- Ensure pathways for those who submit data to be able to access their own data (and basic analyses on that data) early in projects' lifespan.

STAGE 3: ESTABLISH

Provide Enforcement Mechanisms to Ensure Compliance at Every Step in the Supply Chain

On-the-ground enforcement and verification mechanisms (human and mechanical) are necessary at each step in the supply chain to ensure new data and technology policies are carried out in practice, in order to quickly clamp down on cheaters (and learn how to refine system) and to avoid potential greenwashing.

Create Ongoing Training For all Supply Chain Actors

Training supply chain actors on both the rationale behind the use of new technologies as well as how to utilize new systems is especially helpful to get a pilot launched (Stage 2) and to move from pilot into more established phase (Stage 3). As new systems are tested and integrated in operations, new benefits as well as potential challenges will emerge. Industry actors need to be kept abreast of these developments so they can take advantage of benefits, help mitigate risks, and be reminded of the purpose (and long-term vision) of this work.

Ensure Trainings are Wide and Deep To Grow Institutional Knowledge

Include both high level (heads of MCS, science or statistics) and also mid-level, career professionals that are not political appointees in training and capacity-building during data modernization initiatives. Leadership brings legitimacy and helps secure a bigger vision by exposing leaders to the potential of new processes and systems. Career professionals can continue to share and train others as administrations change over time.

Promote Technological Communication

Enthusiasm about the promise of emergent technology to solve data problems can tend to discount or ignore the challenges associated with actually implementing that technology in a useful way. The ability to design and improve a data management program requires good communication among decision-makers, stakeholders, program implementers, and technologies. When information is not sufficiently articulated or understood, problems arise and resources are wasted. Technological communication, especially as it relates to data integration and the combining of disparate data streams, requires both human understanding (e.g., data requirements, purpose, goals) and machine understanding (e.g., standardized data fields, formats, programming language, etc.).

Anticipate and Budget for System Upgrades

Systems (and budget) to accommodate software upgrades—they always come, and it's helpful to have planned for it.

Balance Stability with Adaptability

Pick a system and stay the course to allow for mastery by analysts and familiarity by users. However, in picking the system, government fisheries data modernization initiatives benefit from forward-thinking and proactive design that anticipates needs and demands as well as solutions coming down the pike. Conduct regular checks-in to assess where change may be needed, but limit time scales over which this happens to at least a year or two.

STAGE 4: SCALE

Build Legislation and Data Systems in Parallel

Create nimble policies and data systems that can both respond to emergent opportunities (technological or otherwise) and encourage the creation of future initiatives that support data modernization. Policy and data systems need to be designed in tandem to create the enabling conditions necessary for continued innovation. Staff turnover creates inefficiencies and capacity loss which hinder long term visions and project outcomes--once a system has been established, new policies can cement progress over the life of one administration to the next.

Balance Top Down With Bottom Up

Top down ideas (such as national-level policies or enforcement mechanisms) require the buy-in of all stakeholders, including project managers and community members. The same holds true for bottom-up initiatives (often the result of pilot programs). The ability to scale as projects progress is dependent upon participation and buy-in from all players throughout the design as well as implementation process.

Focus on the "how" and "why" of success in order to scale

Understanding why a system was successful (e.g., it solved specific problems; it increased efficiency; it allowed for real-time data collection) allows for practitioners to identify new contexts where the system could bring success. Similarly, it is equally important to understand the "how" of success (government support, influx of funding) before attempting to grow or replicate a system.



Modernization of government fisheries data systems offers great opportunity for advancing sustainable fisheries: when coupled with appropriate fisheries management frameworks, a robust data system enables effective fisheries science, management, and enforcement by providing accurate and timely information flow across diverse governance divisions. Building a more aligned and appropriately-resourced movement in order to create impact at scale is an opportunity that cannot be wasted.

Our findings reveal that key barriers to adoption and implementation of government fisheries data modernization cannot be solved by more tools; instead, there is a significant need for in-person, customized, dynamic training and support services. This need is not surprising given the nascent state of the fisheries modernization space.

The following areas of opportunity aim to address core barriers by building the enabling conditions and supportive structures necessary to achieve long-term and larger-scale government data modernization systems for fisheries.¹ With smart design, these systems can also return valuable information to the seafood industry and communities, providing positive incentives for collaboration and participation.

1. California Environmental Associates (CEA) and The Nature Conservancy (TNC)'s report *Catalyzing the Growth of Electronic Monitoring in Fisheries* offers some of the only guiding principles we encountered for scaling projects at a global level. Several of the opportunity areas listed in this report can advance or incorporate elements of their core findings, including *Promote and Facilitate Multi-stakeholder Groups to Inform Program Design in Major Growth Regions*, *Build A Global Expert Working Group To Provide Technical Assistance To Fisheries Designing New EM Programs*, and *Facilitate Regulator Convenings and Information Sessions to Allow for Transfer of Best Practices*.



Advance a Central Fisheries Data Modernization Hub

The Need: Hundreds of reports, guides, toolkits, presentations, case study write-ups, technology platforms, initiatives, awards, and events exist that can support specific stages or aspects of the data modernization. Unfortunately, these resources remain difficult to find, access, and apply due to a number of challenges including:

- **Lack of consistent terminology:** searches for “full supply chain electronic traceability” do not retrieve reports focused on “electronic monitoring and recording programs.”
- **Buried treasure:** the valuable information and knowledge is often buried in long white papers, reports, or presentations that contain highly technical language
- **No Instructions:** resources fail to provide clear indicators of when and how exactly they should be applied
- **English only:** Reach and efficacy of tools is limited by availability of predominantly English-only versions of materials, and creates an additional hurdle for those who might otherwise champion data modernization efforts
- **Later Stage MIA:** overall, there is a general dearth of resources available for data modernization past the pilot phase, aside from grants or events specifically targeted towards technological implementation.

The Opportunity: Create a single, accessible, electronic forum that houses information for a broad range of data modernization initiative needs. Websites such as SALT and EM4Fish are a significant step forward in terms of aggregating the enormous volume of literature related to data modernization in fisheries. We recommend the following actions to support greater accessibility and use of existing resources, while supporting continued understanding and adoption of electronic Catch Documentation and Traceability system (eCDT) in government contexts:

- **Curated and vetted list of tools:** A curated, expertly vetted, and continually maintained library of data modernization resources that are searchable and sortable, especially by type of modernization initiative and stage. Ideally, filters for enabling conditions and primary drivers could also be included.
- **Interactive Visual Map:** Map tools have been successfully used in other sectors such as the timber industry and are becoming more common in seafood, these visual guides provide means for users to both see where initiatives are happening as well as sort through information such as technology type, data platforms, technology vendors, existing laws and policies, species, or desired export market.
- **Translation of existing resources into other languages:** There is an urgent need to translate a number of existing resources into foreign languages to improve visibility and accessibility.
- **Reformatting:** Transfer of lengthy documents/presentations to visual/short guides and toolkits that are accessible to laymen.
- **Directory of experts:** A searchable database of experts, and their specific expertise, in the data modernization field, including (where appropriate) contact information for practitioners. This resource would link to the Global Mentorship Program, described below.



Launch A Global Modernization Mentorship Program

The Need: Most governments lack in-house IT expertise to provide assistance, mentorship, and guidance to those implementing projects on the ground over the long-term time horizons necessary for scaled success. And, because every government has its own unique structure, policy, and process constraints, adapting the tools and resources that do exist to apply them to specific contexts, remains a challenge.

The Opportunity: Imagine if government officials looking to implement data modernization had expert, customized, long-term support from a network of colleagues that had experience and detailed understanding of the unique challenges of government settings? Across the globe, in regions such as New Zealand, the United States, or Europe, individuals and agencies have reached more advanced stages of implementation. Individuals within these agencies have developed valuable expertise through learned experiences; they also understand the privacy and constraints unique to government contexts. Connecting these existing experts with emerging projects is a powerful opportunity to advance data modernization for fisheries, providing project specific support while building the long-term professional and personal relationships required for scaling.

A formalized mentorship program can streamline access to experts with the skills necessary to guide the design and implementation of new systems while effectively transferring knowledge, abilities, and experiences to local stakeholders. These “mentees” can then maintain the project over time and share their experiences and expertise with others in the future.



Encourage Knowledge Sharing and Connect Experts

The Need: High touch, customized support is critical, but will take time to scale. Meanwhile, there is an immediate need to increase effectiveness of existing support systems for data modernization. At the moment, stakeholder support largely falls to two players: NGOs, who tend to focus their efforts on shifting policy and process; and the technology vendors themselves, who engage with the system at a very technical, on-the ground level. More often than not, these two groups lack alignment and are often engaging in the space for vastly different reasons, leading to conflicting, incomplete, or unclear information communicated to participants.

The Opportunity: Establish in-country support systems, which will look different for each country. For example, tailored support can be achieved in several ways, including: 1) use of an intermediary who can align and coordinate efforts among various stakeholders; 2) conducting research to identify the best approach to cultivating in-country expertise; and 3), developing a support program that champions government officials with interest in improving data. Additionally, we recommend the three following actions be prioritized at a global scale to create alignment and build conditions for greater success, including:

- **Creating a common language around data modernization initiatives:** Define key terms, processes, technologies, and project stages that can be utilized and recognized across technologies and geographies, by all stakeholders.
- **Providing training resources for technology vendors:** Equipping vendors with training in some of the tools and resources that already exist, as well as the

strategy and mission of the project, can help to align messaging to government agencies about key issues such as data collection and sharing, verification mechanisms, or how and when to make technical changes to the system.

- **Support cross-sector information sharing:** The seafood sector potentially has much to learn from the systems that already exist for other commodities, such as timber, beef, or soy. A variety of tools and technologies ranging from field-based training materials to satellites, drones, and cameras, to DNA testing or RFID tags and AI are all already in use in parallel commodity markets; lessons learned from the implementation of these systems have tremendous potential value for the fisheries world.

NEXT STEPS

Successful government fisheries data modernization efforts can only succeed through the collaborative efforts of a range of stakeholders with various expertise. One of the key messages we heard echoed across 60 interviews was that resources are not enough—personal assistance for governments to be able to understand, refine, and implement these tools and guides within complex political, social, and environmental settings is urgently needed.

Collecting data may be a technological issue, but choosing how to analyze and apply this data, and understanding how to do so effectively and in service to all stakeholders (diverse government agencies, the supply chain, the public) remains a uniquely human purview. Future of Fish will continue to work to support both the human and technological design challenges of fisheries data modernization, building off the learnings shared in this report. Given the dynamic nature of the data and technology space in general and in fisheries, we welcome feedback on the insights and recommendations of this report so we can continue to iterate and advance this critical work.

Organizations and individuals interested in helping to build out the opportunities mentioned here, please contact us for more information: fmulligan@futureoffish.org.

Appendices



APPENDIX I: Summary of Methods

Two different research approaches were used to develop the insights shared in this report.

DATA PROGRAM IMPLEMENTATION TOOLS FOR GOVERNMENTS (2018-2019):

A six month research study to distill key learnings from existing fisheries data modernization efforts around the world. The project aimed to advance and support sustainable fisheries management by identifying best practices for government data modernization, including recommendations for design and execution of an ideal modernization process. To achieve this goal, Future of Fish conducted 45 expert interviews and built eight high-level case studies that examined government fisheries data modernization efforts around the world and identified challenges and solutions within those case studies.

We used the results of interviews and case study analyses to inform investigation of underlying common barriers and strategies for progress. We applied a qualitative pattern-finding analysis to identify commonalities in challenges within and among case studies—these system-level barriers indicate where multiple stakeholders are tackling the same kind of problem and often point to a problem that no one individual can solve on their own. Instead, there is a need for coordinated, collective action in order to achieve change.

Similar to identifying common barriers, we also looked for patterns in where progress was being made across the different case studies. In particular, we identify common processes or strategies that seemed to be linked with achieving progress in one or more aspects of data modernization. These insights into system barriers and strategies for progress informed a second-level analysis of best practices and enabling conditions for success. We then held a small workshop with two data modernization experts to receive critical feedback and refine our preliminary findings.

In addition to the system level analyses and case study work, we also reviewed the current landscape of tools and resources that support fisheries data modernization generally, and identified key challenges and opportunities for increasing effectiveness of these existing resources. Desk-based research and targeted questions during interviews were used to gather information on existing resources; only English-language and publicly available resources and tools were considered for this project.

Once we completed our interview and research phase, we ran a high-level (though not exhaustive) analysis to determine if a) our results were supported by existing publications, and b) evaluate any additional information that should be considered for inclusion in future reports. This comparison of our findings with other available reports and guides indicated that multiple, independent studies have surfaced many of the same major findings in terms of barriers and best practices. While the terminology used may differ, core principles such as *Set a Clear and Holistic Vision, Be Transparent with Data and Process, or Set an Interdisciplinary Focus and Map Roles and Responsibilities from the Start* are found across almost all resources referenced. In addition, there is a clear central theme that can be summarized as “this is a people problem, not a technology problem, and any advancements made will only happen through active collaboration, which is extremely challenging given the complexity and stakeholder diversity found in seafood supply chains.”

Additionally, we also looked to understand not only the phase where design principles were applied, but also the intent behind the principle. For example, within Phase 2 (Implementation) there are principles designed for technical implementation and behavioral change; in Phase 4 (Scale) we some principles apply to national versus international strategies.

DEVELOPING COMMUNICATION AND SYSTEM STRATEGIES FOR ACCELERATING GOVERNMENT DATA MODERNIZATION (2019):

After completing our initial research, we conducted a second phase of analysis to assess how and to whom we should communicate these results to maximize impact and spur more holistic modernization efforts. We identified three target countries, and built a strategic outreach and engagement plan for each. We also identified common similarities and differences among these strategies, and used this insight to develop system-level solutions to support government data modernization at a global scale.

Research and interviews were conducted to identify promising communication strategies for engaging governments in data modernization discussions. Interview information was used to inform the the SpitFire *SmartChart tool* for development of strategic communication strategies.

APPENDIX II:

Case Studies

INTRODUCTION

In order to identify the system-level trends discussed in Part 1, we looked at advancements in data collection, sharing, and analyses across a diversity of contexts, to help ensure that findings could be applicable regardless of geography or project type. Our team intentionally looked for case studies across a range of criteria, including:

- Geography
- Scope (fleet, number of fisheries, species, inclusion of supply chain)
- Driver (external pressure from import requirements, NGOs, EM/ER policy, etc.)
- Degree of implementation: early or late stage
- Diversity of technologies
- Accessibility/Language

We spoke with several experts to help identify promising initiatives in addition to conducting online research. From an original list of seventeen candidates, we selected eight case studies to pursue in detail. For each, we conducted interviews and background research to surface drivers, enabling conditions, stuck points, and strategies for success.

Table 3. Summary of interviews completed across various stakeholder categories for each Case Study

Case Study	Number of interviews conducted				
	Government	NGO	Industry	Consultant	TOTAL
General Expert	0			2	2
ACCSP- USA			2	1	3
Chile	3	1	1		5
Ghana	3			2	5
Indonesia		5		4	9
Madagascar		3			4
PacFin - US	1			3	6
Peru	3	2		1	6
PNA Tuna	2	2	1	3	5
TOTAL INTERVIEWS					45

ATLANTIC COASTAL COOPERATIVE STATISTICS PROGRAM (ACCSP)

Stage: Scale (4)

Background: The Atlantic Coastal Cooperative Statistical Program (ACCSP) is one of five regional Fishery Information Networks (FINs) in the United States tasked with collecting, managing, and sharing fisheries data. ACCSP was created in 1995 as a multi-stakeholder collaboration to create consistency among state and federal fisheries data systems in order to meet the data needs of managers, scientists, and fishermen, and enhance fisheries management along the Atlantic coast. Program partners include representatives from 23 state, regional, and federal agencies. The creation of the ACCSP was motivated in large part by the need for reliable fisheries data in order to comply with federal regulations. The Magnuson Fishery Conservation and Management Act of 1976 created regional councils, mandated a national fishery data management program, and tasked the councils with using data to establish fishery management plans for fisheries within the EEZ or federal waters. For “interjurisdictional” fishery resources along the Atlantic Coast, interstate fishery management plans were created by the Atlantic States Marine Fisheries Commission (established by Congress as a nongovernmental entity).

Nearly two decades later, in 1993, the Atlantic Coastal Fisheries Cooperative Management Act enabled the states to “mutually and cooperatively” manage those interjurisdictional fisheries under interstate fishery management plans. Mutual and cooperative management requires data integration among partnering states, which didn’t exist at that point. Thus, ACCSP was created to establish standardized codes, formats, and protocols that would enable coordinated collection, reporting, integration, and analysis of accurate fishery-dependent data in order to meet the data needs of managers, scientists, regulators, and other land-use and water-use decision-makers. Using a committee-based approach, ACCSP works specifically to (a) standardize data collection activities among partners, (b) streamline electronic trip and dealer reporting and data processing using mobile and web applications via SAFIS (the Standard Atlantic Fisheries Information System), (c) integrate all fisheries-dependent data into a single, unified online database (the Data Warehouse) and make it accessible to stakeholders through user-friendly interfaces, and (d) provide funding support for innovation in data collection and data management activities among partner data projects.

System Attributes:

- **Primary Drivers:** National Policy; Cross-jurisdiction needs (national)
- **Enabling Conditions:** Existing Data Sharing Protocols and Initiatives; Government Assumes Responsibility
- **Funding:** Dedicated; Internal
- **Leadership:** Patient Execution; Task-Master
- **Timeframe:** Ongoing (Initial stages 1-3 took over 20 years)

Stakeholder Engagement & Technology Deployment: ACCSP’s Standard Atlantic Fisheries Information System (SAFIS) was launched in 2003 as a low-cost, real-time, web-based data entry system for dealer reporting of commercial landings. Since then, it has evolved into a comprehensive module-based data collection tool featuring a

number of web-based and mobile applications for both commercial and recreational fishing activities:

- eTrips/Online collects catch and effort data from commercial harvesters using a web browser
- eTrips/Mobile is intended for use by commercial harvesters at-sea with a tablet application, regardless of whether an internet connection is available
- eDR/Online and eDR/Mobile electronically collect landings and economic data from dealers using a web browser and mobile application (no internet required), respectively. eDR/Mobile allows for harvester swipe cards, which pre-populate data fields unique to a particular harvester. eDR allows the price of a species to be saved for 14 days and enables dealers to view the history of landings through an interactive report feature
- eLogbook is a voluntary reporting application that collects catch and effort data from recreational anglers.

CHILE

Stage: Initiate-Pilot (1-2)

Background: Chile's Fisheries Law of 2013 required all industrial vessels to implement electronic monitoring (EM) by the end of 2018, simultaneously reducing fishing quotas across Chile's fisheries. After the law was established, illegal fishing began to increase precipitously as fishermen struggled to adjust to the new quota allocations. While artisanal fishers want a legal fishery, reduced quotas are perceived as a challenge to their livelihoods, coupled with a lack of enforcement that makes it difficult for compliant fishers to compete, especially when tonnes of illegal fish are flowing through supply chains with minimal oversight.

In late 2018, Chile passed a SERNAPESCA (Ministry of Economics, Development, and Tourism) modernization law as a supplement to the initial Fisheries Law, which provides SERNAPESCA with additional resources (and responsibility) to combat IUU, particularly in regard to overfished or exploited fisheries. This policy, combined with the need to implement electronic monitoring in the industrial fleet, has driven interest in more holistic fisheries data modernization efforts in order to accommodate increased data flows and deal with the inefficiencies and inaccuracies that currently limit enforcement and management activities.

System Attributes:

- **Primary Drivers:** Market Differentiations; Sanctions/Trade Barriers (SIMP and EU IUU), On-the Ground NGO Support
- **Enabling Conditions:** Government Assumes Responsibility; Minimum Viable Participant Group
- **Funding:** Dedicated; Internal
- **Leadership:** Amplified Voice; Patient Execution
- **Timeframe:** 4 years (Stage 1), 1 year + ongoing (Stage 2) = 5+ years

Stakeholder Engagement & Technology Deployment: A select EM team within SERNAPESCA has been working with vendors to identify, select and pilot cameras on boats with select industrial fishers over the last two years. Part of this effort has included extensive research into the technical requirements that the government would need to meet in order to collect, retain, and regularly access as much scientific as well as compliance data as possible.

GHANA

Stage: Pilot (2)

Background: In 2015, in response to an EU yellow card in 2013, Ghana was eager to participate in an EM pilot program run by FAO and GEF's Common Oceans Areas Beyond National Jurisdiction (ABNJ) project. The goal was to have transparency in their tuna purse seine fleet via EMS, and prove they were catching tuna in compliance with national and international regulations. Working with World Wildlife Foundation (WWF) and the International Seafood Sustainability Foundation (ISSF), the Ghana Fisheries Commission implemented electronic monitoring (cameras, VMS, and Sat-Modem) on 14 boats, monitoring location, fishing activity, and catch-related data. A costs-benefits analysis has been conducted to help build the argument for expansion of this system in Ghana's fleets. Ghana is also piloting data collection via tablets at a few select landing sites.

System Attributes:

- **Primary Driver:** Sanctions/ Trade Barrier (EU yellow card);
- **Enabling Conditions:** Minimum Viable Participants; Existing Willingness and Comfort with Tech; Recognition of Benefits Informs Strategy
- **Funding:** International Aid
- **Leadership:** Patient Execution
- **Timeframe:** 2 years (Stage 1), 3 years (Stage 2) = 5 years

Stakeholder Engagement & Technology Deployment: Interest in a pilot existed within both government and industry from the start as the EU yellow card threatened major international trade (tuna). Government officials worked with one company that was already using EM on six vessels to help convince other vessel owners of the benefits of technology. Significant effort went into easing industry concerns about how data would be used: created MOUs with industry that during pilot, no information would be used for prosecution, only for learnings; industry also could request copies of all their data. One strategy was to use the analogy of CCTV as "everyone" understands the purpose of that technology is surveillance and the data is protected.

Technology was chosen by FAO and the ABNJ team and used DOS, a Spanish company. A one-week in-country training was done by DOS for industry. The NGO ISSF supported training of land-based observers. Upper management focused on retaining institutional memory by handpicking some people within the fisheries commission itself, seven part time (Ghanean government employees) and two permanent staff (biology and statistics). This group of individuals now holds the training and analysis skill set and can pass that on; this approach reduced the risk of hiring someone from

the outside who would take all the training and learning with them when the contract ended.

INDONESIA

Stage: Establish-Scale (3-4)

Background: A number of initiatives have and are being implemented in Indonesia to improve tuna fisheries data and data systems, from the large-scale longline and purse-seine fisheries to the medium to small-scale handline and pole-and-line fisheries. This case study focused on improvements implemented in the handline yellowfin tuna fishery since 2012. This fishery consists of small (<5 gross tons) canoe-like vessels and usually manned by 1 to 2 fishermen. Fishing trips are one-day long and fishermen fish on both free-school and fishing aggregating devices (FADs). Catch is usually landed on beaches in remote locations across Indonesia's 17,500 islands. The small-scale, low impact, and remote nature of the handline tuna fishery means that it has not been a priority for government data collection systems. However, the handline tuna fishery is currently estimated to contribute at least 16% of the Indonesia catch (and likely more than that given the data gaps). Moreover, in order for Indonesia to be compliant with RFMO data requirements, it must improve its data on small-scale fisheries which may be small in terms of how they operate but catching a significant amount to the total catch.

System Attributes:

- **Primary drivers:** On-the-ground NGO support (MDPI); NGO or Industry Proof of Concept; Market Differentiations), Cross-jurisdiction needs (national), Trade Barrier (SIMP)
- **Enabling conditions:** Stakeholders Set and Maintain Commitments, Communication and Feedback Loops; Expertise, at least "borrowed"
- **Funding type:** Dedicated, Internal, International Aid
- **Leadership:** Amplified Voice; Patient Execution; Task-Master
- **Timeframe:** 4 years (stage 1) 3 years (Stage 2), 3 years (Stage 3), 2 years + (Stage 4) = 12 years +

Stakeholder Engagement & Technology Deployment: Several programs have been put in place since 2012 to improve the data for small-scale tuna fisheries including.

USAID IMACS (2012-2014) developed the **I-fish database**, an online database created to collect fisheries data in small-scale fisheries (Snapper/Grouper and Yellowfin tuna). Anova and MDPI supported its development by setting up data collection programs in tuna landing sites in Indonesia.

MDPI (since 2013) is a grass root Indonesian NGO which runs data collection and traceability programs funded through various projects and partnerships.

The IFITT project (2013-2016) and the NWO project ("Technology innovations towards sustainability in Indonesia's tuna supply chains" (2014-2016)) were supported by Wageningen University and implemented by MDPI in the handline and pole-and-line tuna fisheries. The project supported the expansion of MDPI's data collection

program, the development of the I-fish database and the development, piloting, and integration of electronic data capture and traceability technologies including Spot Trace (VMS/GPS device for small-scale vessels, **DOCK app** (a digital port sampling app), **OurFish app** (a broker/middleman app to record fish transactions), **Tally-O** (a traceability system for small-scale Indonesian tuna processors) and **ThisFish** (a consumer facing platform displaying fish traceability information).

Since 2014, the government of Indonesia launched several fisheries data modernisation initiatives including **Satu Data**, designed to centralize data systems for all sectors of the economy, including fisheries; **STELINA**, a government led traceability system for seafood export product; and **e-logbooks** for vessels >10GT (not applicable for small-scale vessels which are mostly <5GT).

The Oceans and Fisheries Partnership (USAID Oceans) (2015-2020) took many of the lessons learned from the previous projects and develops, pilots and integrates new and improved data capture and traceability technologies including: **PointTrek** (VMS system with e-logbook optional feature), **Trafiz** (improved version of OurFish) and **Trace Tales** (improved version of Tally-O). USAID Oceans also works to integrate those technologies with existing and developing government data systems (e.g. STELINA, e-logbooks, SatuData).

In addition, the WCPFC supported Indonesia data improvement efforts since 2010 through the **West Pacific East Asia Oceanic Fisheries Management Project** (WPEA-OFM).

MADAGASCAR

Stage: Pilot (2)

Background: Madagascar underwent a three-year process to win the bid to serve as host for the Regional Maritime Information Fusion Center (MIFC), a data center that will serve to collect and disseminate information related to maritime crimes, blue economy, and marine environmental protection. At the same time as launching the regional center, the national government launched a parallel National MIFC to coordinate information sharing across Madagascar's own maritime divisions. Both centers were modeled off Singapore's Maritime Information Fusion Center (MIFC) and have brought significant technical and analytical capacity to Madagascar's maritime management. While application to improved fisheries is still nascent, engagement with fisheries division officials and discussions for expansion into that sectors are underway. Importantly, the focus of the National MIFC is on "maritime intelligence" and the center is housed directly under the Prime Minister's office and not within any specific cabinet; this was done to reinforce the idea for information to be collected and shared cross-departments to support better intelligence and analyses to benefit multiple divisions.

In addition, multiple NGOs have been active in Madagascar in support of dozens of Locally Managed Marine Areas (LMMA), including bringing data collection and analysis capacity. Several initiatives led by the NGOs involve digital data collection and now, a newly launched MIHARI national database promises to help collect, store, and share information about these projects and potentially, data generated by the various NGO and communities.

System Attributes:

- **Primary Drivers:** Cross-Jurisdiction Needs (regional MIFC), On-the-ground NGO Support
- **Enabling Conditions:**
 - RMIFC: Existing Willingness and Comfort with Tech (RMIFC); Government Assumes Responsibility; Appropriate Tech Identified Through Pilot (this case, an existing model)
 - NGO Initiatives: Recognition of Broader Benefits Informs Strategy; Communication and Feedback Loops; Recognition of Problem Rooted in Data Gaps
- **Leadership:** Amplified Voice; Task Master
- **Funding:** Dedicated
- **Timeframe:**
 - RMIFC: Initiate (3 years); Pilot into Establish (3 years)
 - NGO Initiatives: Initiate (1-2 years)

Stakeholder Engagement & Technology Deployment: Regional MIFC and National MIFC: Madagascar's government approved resources to send officials to Singapore to study their IFC system and bring back information to inform the development of a system that would be appropriate for the West African context. This investment resulted in a technologically strong proposal that won the bid on an EU RFP to host the Regional MIFC. Continued investment in sending representatives and demonstrating commitment of resources to the project helped them convince other countries during regional meetings that covered a three-year negotiation process. For the regional center, all data is collected in one main server (hub) and countries can access and take back analyses derived from this metadata.

For the National MIFC, placement of the center directly under the Prime Minister's office has helped to reinforce that this center is focused on intelligence—not on serving any one department but is an information sharing and analysis platform to serve the needs of multiple divisions. This governance structure has helped engage officials across divisions as no one department is benefiting from the additional resources the center provides.

NGO Initiatives: NGOs have focused on giving back to community and ministries valuable information as quickly as possible. Some of the technology in use includes Tableau software for visualizations, and Open Data Kit for standardizing and collecting fisheries information. Training fishers to be able to use technology requires extensive in-person time and they have made sure to support these efforts. Workshops have also been used to bring together NGOs, technologists, and government to identify the key data gaps, set up MOUs and identify ways to move forward as a collective. Database is now built and NGOs are starting to populate it with their information about their projects. This is less sensitive information than the fisheries data itself, which hopefully will be hosted in the database in phase 2 (1-2 yrs from now).

PacFIN

Stage: Scale (4)

Background: The Pacific Fisheries Information Network (PacFIN) is a state-federal collaboration to collect and manage accurate data for the purpose of effective fisheries management. PacFIN is the oldest of the five Fishery Information Networks in the US and is a program of the Pacific States Marine Fisheries Commission (PSMFC, also known as Pac States). PSMFC is an Interstate Compact formed in 1947 among California, Oregon, Washington, Idaho, and Alaska to collectively support the protection and management of Pacific Ocean fishery resources. PacFIN has been operational since 1981 and is responsible for data standards, data collection, data integration and storage, data quality assurance and control (QA/QC), data processing, and disseminating data to stakeholders and the public through user-friendly web-interfaces.

PSMFC is a unique type of entity, in that it is composed of government representatives and serves fisheries management efforts, but has neither regulatory nor management authority. Thus, as a neutral party, PSMFC tends to be trusted by industry, regulators, and scientists alike. PacFIN, with its focus on collecting and disseminating timely, accurate data is also perceived to be neutral and unbiased, which is one of the keys to its success.

System Attributes:

- **Primary Drivers:** Cross-Jurisdiction Needs (national); National Policy
- **Enabling Conditions:** Government Assumes Responsibility; Existing Willingness and Comfort with Tech; Existing Data Sharing Protocols and Relationships
- **Funding Type:** Dedicated; Internal
- **Leadership:** Patient Execution; Task-Master
- **Timeframe:** The timeline for phases 1-4 of this initiatives spanned decades and is ongoing

Stakeholder Engagement & Technology Deployment: Four main objectives guided the design of the PacFIN program and database, and consensus was always the goal in terms of engaging stakeholders and ensuring that all voices were heard. These four objectives included:

- Implementing and managing a Pacific Fisheries Information Network (PacFIN) to aggregate detailed and summarized state and federal fisheries data;
- Providing data-management consultation and technical advice to the Council's Management Teams and participating agencies upon request;
- Establishing priorities and coordinating plans to improve the efficiency and timeliness of data acquisition and delivery with a minimum of unnecessary duplication; and
- Promoting the development and implementation of coastwide data-collection standards to facilitate aggregation of fisheries data within the PacFIN system.

Retrospective analyses of the early years of PacFIN have identified key decisions that contributed to its overall effectiveness and success. First, early on PacFIN created a set of standard codes for species, area fished, gear, port, and so on that could be applied to every data source across all regions and all time periods. However,

as opposed to requiring that the data sources convert their coding schemes to the PacFIN codes, PacFIN did (and still does) the work of translating those source data codes into its own standard codes. Second, the PacFIN database was built to easily create summary reports based on any variable or combination of variables that could be of interest to data analysts. Relatively quickly, PacFIN's agency-specific reports (e.g., state reports) became preferred over the source-agencies' own generated reports. Finally, the database was designed to be easily modified and expanded as new needs arose. In fact, most of the enhancements made to the system in the first few years were recommended by users. For example, the Quota Species Monitoring module was created because industry requested more timely data on total catch relative to quotas in order to plan production and marketing.

PERU

Stage: Pilot (2)

Background: Enormous variance among fisheries data collection and sharing systems exist within Peru, from sophisticated systems in the industrial anchoveta fishery to rudimentary (if any) systems for the multitude of benthic artisanal fisheries. In 2017, Peru made a public commitment to make Peru's Vessel Monitoring System (VMS) data publicly available through Global Fishing Watch; in 2018, Ministry of Production (PRODUCE) passed supreme decree DS-003-2018-PRODUCE, calling for strengthened formalization policies and the sustainable development of the artisanal fisheries through improved control and surveillance. The Ocean's Institute of Peru (IMARPE) is currently in charge of the most comprehensive in-country data collection, housed in the IMARSIS system and analyzed by a separate statistics program. A push for formalization, including boat registration and fisher licensing, is also underway, utilizing online registration systems and electronic databases to store information.

System Attributes:

- Primary Drivers: Sanctions/Trade Barriers (SIMP, EU IUU); NGO or Industry Proof of Concept; On-the Ground NGO Support
- Enabling Conditions: N/A - we were unable to find any significant enabling conditions for data modernization in Peru
- Funding Type: Discretionary; Dedicated
- Leadership: Amplified Voice
- Timeframe: 3 years (Stage 1), 2 years + (Stage 2) = 5 years +

Stakeholder Engagement & Technology Deployment:

- **Global Fishing Watch (GFW):** As of October 2018, at least 1,300 of Peru's industrial fishing vessels, most of which were previously undetected by GFW's Automatic Identification System (AIS) data, are now visible on the public map. The goal is to aid in national monitoring and control efforts, including combating Illegal, Unreported and Unregulated (IUU) fishing.
- **WWF TrazApp:** WWF Peru is piloting a program to engage fishers to register capture and transport data through TrazApp, an initiative which is taking place in partnership with PRODUCE as well as DICAPI.

- **Government of Peru:**
 - **Sistema de seguimiento satelital de embarcaciones (SISEAT):** Peru's Ship Satellite Tracking System, SISEAT, is run by the Pesca Responsable (Responsible Fishing) office, and is used to monitor the spatial distribution of industrial fishing fleets including anchoveta, hake, and squid. The system was implemented in Peru at the beginning of 2001 for the purpose of analyzing fleet distribution dynamics and resource variability. SISEAT use will soon be expanded to mahi mahi, which is an exclusively artisanal fleet.
 - **Sistema de Trazabilidad Satelital (TRASAT):** Created by PRODUCE, TRASAT allows users to visualize the positioning of fishing vessels monitored by satellite. The general service is available to all users, and is published by PRODUCE on a public web portal.
 - **Monitoreo con señal satelital (SIMTRAC):** The Aquatic Traffic Information and Monitoring System (SIMTRAC) uses an AIS system to determine the position, course, and speed of foreign ships. Information is regulated by IMO.
 - **Imágenes de Píxeles de Luminosidad del Satélite SUOMI:** Nocturnal images provided by the Japanese satellite Suomi NPP show the location of the foreign squid fleet operating in international waters adjacent to the Exclusive Economic Zone (EEZ) of Peru.
 - **SITRAPESCA:** Project to automate data produced through disembarkation, processing, transport, and commercialization, including certificates of origin. Created by the General Direction of Supervision, Fines, and Sanctions (DGSFSPA), who is coordinating with other government offices and industry actors.
 - **IMARSIS:** The internal information database of IMARPE, holding the sampled capture and environmental data from along the peruvian coast. Landing samples are collected on paper, then transferred to an excel format, which is then shared with the internal IT office to be uploaded into the central database.
 - **RAPIPEZ:** electronic sales platform created by PRODUCE to help artisanal fishers sell their products locally, designed in part to help fishers adjust to international supply chain disruptions caused by COVID19

PARTIES TO THE NARU AGREEMENT (PNA)

Stage: Scale (4)

Background: The Parties to the Naru Agreement (PNA) include 8 island nations: the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu. Innovative and cooperative management measures of PNA's high-value tuna stock has allowed PNA countries to take ownership of the market through collaboratively managing stock sustainability. The countries jointly utilize Fisheries Information Management System (FIMS) and the integrated Fisheries Information Management System (iFIMS) technology underpinning the Vessel Day Scheme (VDS) in the largest and most complex tuna fisheries management system that currently exists. The PNA FIMS/iFIMS was established specifically to support the implementation of the VDS. iFIMS is a separate and distinct system only for industry,

customised at industry request, with ongoing management and development now funded by industry.

System Attributes:

- **Project Drivers:** Market Differentiations, On-the-Ground NGO support, Cross-Jurisdiction Needs (international)
- **Enabling Conditions:** Government Assumes Responsibility, Stakeholders Set and Maintain Commitments, Recognition of Broader Benefits Informs Strategy, Minimum Viable Participant Group, Communication and Feedback Loops
- **Funding Type:** Dedicated, Internal
- **Leadership:** Amplified voice, Patient Execution, Task-Master, visionary
- **Timeframe:** Ongoing (Stage 4. Initial stages 1-3 took over a decade)

Stakeholder Engagement & Technology Deployment:

- The **PNA Vessel Day Scheme (VDS)** sets a Total Allowable Effort (TAE) limit on the number of days fishing vessels are licensed to fish in PNA Exclusive Economic Zones (EEZs) on an annual basis. Each country is allocated an annual share of the TAE for use in its zone, and VDS days can be traded between countries.
- **iFIMS** is not considered extraordinarily high tech, but it is well developed to fit the needs of the PNA countries. The PNA benefits from their commitment in taking on one system (iFIMS), implementing it, and further making adjustments upon it (i.e. integrating with other platforms, interoperability with other regional systems). The unique requirements and processes for data sharing/reporting that support a harmonized and interoperable system in the PNA region include the following:
 - Purse seine and longline vessels that want to fish in the PNA countries' EEZs or FZs must register on the Online Vessel Register (OVR) on the PNA website.
 - PNA register is linked to other registers of the region (i.e. FFA Regional Register and WCPFC Record of Fishing Vessels)
 - Data is transmitted from tablet via satellite to each country's Fisheries agency and reported through the PNA data center to the FFA and the SPC

Table 4 Summary of Case Study Drivers, Enabling Conditions, Funding Type, Leadership Type, and Timeframe.

Case Study	Attributes				
	Primary driver	Enabling condition	Funding type	Leadership	Stages & timeframes
ACCSP	National Policy; Cross-jurisdiction needs (national)	Existing Data Sharing Protocols and Initiatives; Government Assumes Responsibility	Dedicated; Internal	Patient Execution; Task-Master	Ongoing (Initial Stages 1-3 took over 20 years)
Chile	Market Differentiations; Sanctions/Trade Barriers (SIMP and EU IUU), On-the Ground NGO Support	Government Assumes Responsibility; Minimum Viable Participant Group	Dedicated; Internal	Amplified Voice; Patient Execution	4 years (Stage 1), 1 year + ongoing (Stage 2) = 5+ years

Case Study	Attributes				
	Primary driver	Enabling condition	Funding type	Leadership	Stages & timeframes
Ghana	Sanctions/ Trade Barrier (EU yellow card)	Minimum Viable Participants; Existing Willingness and Comfort with Tech; Recognition of Benefits Informs Strategy	International Aid	Patient Execution	2 years (Stage 1), 3 years (Stage 2) = 5 years
Indonesia	On-the-ground NGO support (MDPI); NGO or Industry Proof of Concept; Market Differentiations), Cross-jurisdiction needs (national), Trade Barrier (SIMP)	Stakeholders Set and Maintain Commitments, Communication and Feedback Loops; Expertise, at least "borrowed"	Dedicated, Internal, International Aid	Amplified Voice; Patient Execution; Task-Master	4 years (stage 1) 3 years (Stage 2), 3 years (Stage 3), 2 years + (Stage 4) = 12 years +
Madagascar	Cross-Jurisdiction Needs (regional RMIFC), On-the-ground NGO Support	-RMIFC: Existing Willingness and Comfort with Tech (RMIFC); Government Assumes Responsibility; Appropriate Tech Identified Through Pilot (this case, an existing model) -NGO Initiatives: Recognition of Broader Benefits Informs Strategy; Communication and Feedback Loops; Recognition of Problem Rooted in Data Gaps	Dedicated	Amplified Voice; Task Master	-RMIFC: 3 years); Pilot into Establish (3 years) -NGO Initiatives: Initiate (1-2 years)
PacFIN	Cross-Jurisdiction Needs (national); National Policy	Government Assumes Responsibility; Existing Willingness and Comfort with Tech; Existing Data Sharing Protocols and Relationships	Dedicated; Internal	Patient Execution; Task-Master	The timeline for phases 1-4 of this initiatives spanned decades and is ongoing
Peru	Sanctions/Trade Barriers (SIMP, EU IUU); NGO or Industry Proof of Concept; On-the Ground NGO Support		Discretionary; Dedicated	Amplified Voice	3 years (Stage 1), 2 years + (Stage 2) = 5 years +
Parties to the Naru Agreement PNA)	Market Differentiations, On-the-Ground NGO support, Cross-Jurisdiction Needs (international)	Government Assumes Responsibility, Stakeholders Set and Maintain Commitments, Recognition of Broader Benefits Informs Strategy, Minimum Viable Participant Group, Communication and Feedback Loops	Dedicated, Internal	Amplified voice, Patient Execution, Task-Master, visionary	Ongoing (Stage 4. Initial stages 1-3 took over a decade)

APPENDIX III:

Resources

RESOURCE ACCESSIBILITY

There are dozens of available reports, guides, toolkits, presentations, case study write-ups, technology platforms, initiatives, awards, and events that could be used to support data modernization efforts. However, these resources generally remain scattered and difficult to find, in part due to a lack of common terminology or language. While one resource may focus on “full supply chain electronic traceability”, the next focuses only on “electronic monitoring and recording programs”, while others promote “tools and technologies to prevent IUU.”

Another challenge with the current tools landscape is that the majority of these documents are data rich but communications poor—the information and knowledge they contain is valuable but not accessible, often buried in longer white papers, reports, or presentations. This creates an additional barrier for potential users—after struggling to find the tool in the first place, they then must weed out relevant pieces of information on their own from work that may be highly technical, or cross geographies and species in a way that makes it difficult to translate important lessons learned from one project to another. Finally, many of these resources fail to provide clear indicators of when and how exactly they should be applied.

In addition to structural barriers, the majority of resources available to support data modernization are written primarily in English, and are most applicable to the Initiate and Pilot stages of the data modernization process. Meanwhile, many English-speaking countries have already passed these stages at least to some extent; non-English speaking countries represent a far larger opportunity for growth and impact in the space. Limiting all of the entry-level tools to one language severely limits both their reach and efficacy and creates an additional hurdle for those who might otherwise champion data modernization efforts.

EXISTING RESOURCES

While this list is not exhaustive, it does provide over 90 resources screened for content value and accessibility. Resources fall into 1 of 8 categories: Awards, Events, Guides, Information Platform, Initiatives, Reports, Technologies, & Toolkits. A number of resources may cover more than one category—however, in this instance, they were only listed once in order to prevent user confusion and maintain a streamlined list. In the future, we recommend the creation of a user interface with a searchability function allowing for tools to be sorted into and searched by more than one category at a time.

Resource	Description	Category
<u>Electronic Monitoring and Reporting Grant Program</u>	The Electronic Monitoring and Reporting Grant Program helps to integrate technology into U.S. fisheries data collection to improve fisheries management.	Award
<u>Fish 2.0</u>	Fish 2.0 builds connections to spur growth, investment, and innovation in the sustainable seafood sector globally. Competitors engage in a challenging but fun and interactive process to improve their business models and learn how to successfully approach investors; in turn, investors who participate gain early access to new deals, co-investors, and insights into sustainable seafood trends and opportunities.	Award
<u>Fisheries Innovation Fund</u>	The program seeks to advance NOAA's sustainable fisheries goals to partner with fishermen, stakeholders, state agencies and Fishery Information Networks to systematically integrate technology into fisheries data collection and observations, and streamline data management and use for fisheries management. The program aims to improve the quality, quantity, and timeliness of fisheries-dependent data, catalyzing the implementation of electronic technologies for catch and compliance monitoring, and improvements to fishery information systems.	Award
<u>Fishtech Awards</u>	The aim of the Fishtech Awards is to champion innovation in the rapidly expanding seafood industry. The Fishtech Awards creates a global platform to support innovation in the seafood sector by bringing together industry innovators, professionals and investors in China, the world's fastest growing seafood market	Award
<u>The Marine Protection Prize</u>	The Marine Protection Prize competition seeks to identify a range of solutions that offer low-cost and easy-to-maintain technologies that address the needs of local communities. The competition will source the best uses of technology and data collection to help combat illegal, unreported and unregulated (IUU) fishing affecting island nations and coastal communities.	Award
<u>The Techstars Sustainability Accelerator</u>	Techstars and The Nature Conservancy are seeking for-profit entrepreneurs with commercially viable technologies that can rapidly scale to help sustainably provide food and water and address global issues like climate change.	Award
<u>Fishackathon</u>	Fishackathon inspires the creation of digital solutions to address sustainable fisheries challenges. Fishackathon brings together thousands of concerned designers, developers, and subject matter experts for a weekend to build practical tech solutions to endemic problems defined by the world's most respected fisheries experts.	Event
<u>IFOMC</u>	This conference and international forum for work on issues surrounding fisheries observer programs, emerging monitoring technologies, and other approaches to fishery-dependent data collection and analyses.	Event
<u>Seafood and Fisheries Emerging Technologies (SAFET) Conference</u>	A conference to explore and discover the potential of emerging, and potentially disruptive, technologies that could be applied to improve the conservation and management of our world's fisheries.	Event
<u>A Human Rights Based Approach to Data</u>	In step with the 2030 Agenda for Sustainable Development (2030 Agenda) and its Sustainable Developments Goals (SDGs), this note aims to provide general guidance and elements of a common understanding on a Human Rights-Based Approach to Data (HRBAD), with a focus on issues of data collection and disaggregation	Guide
<u>A Roadmap for IT Modernization in Government</u>	This report examines the status of IT modernization in the public sector and draws on key lessons from private industry, state government, and exemplary federal government agencies	Guide
<u>An Inventory of New Technologies in Fisheries</u>	This paper examines some of these technologies used in maritime fisheries management, both current and emerging, so as to better understand how policies can influence their development and use and vice-versa. It was designed to help governments to consider how they can adapt and improve their policies, regulations, their enforcement and compliances.	Guide
<u>Building a Fisherman-First Data Ecosystem</u>	This report presents opportunities and possible models for the New England groundfish community to own, control, manage, and use fisheries data, with a particular focus on governing electronic monitoring data	Guide
<u>Catalyzing the Growth of Electronic Monitoring in Fisheries: Building Greater Transparency and Accountability at Sea</u>	This paper presents a brief overview of the current state of EM, the benefits of the technology, and the main barriers to broader adoption, as well as a set of recommendations to help catalyze the growth of EM in fisheries.	Guide

Resource	Description	Category
<u>Challenges, Opportunities, and Costs of Electronic Fisheries Monitoring</u>	An evaluation of the importance of EM and the associated challenges, opportunities, and costs; as well as an easy to use but comprehensive financial spreadsheet.	Guide
<u>Cost Recovery Guidelines for Monitoring Services</u>	This report examines options, and proposes guidelines, for the recovery of costs for electronic monitoring (EM) services in FFA island member country tuna longline fisheries. Includes presentation as well as model spreadsheets	Guide
<u>Design Options for the Development of Tuna Catch Documentation Schemes</u>	Catch documentation schemes (CDS) have been a topic of debate for more than 16 years, and continue to mean different things to different people. This paper clarifies the nature of CDS and what they can achieve, and identifies the factors to be considered in the design of such schemes as a management and MCS tool in tuna fisheries.	Guide
<u>Designing and Implementing Electronic Monitoring Systems for Fisheries</u>	This guidebook is aimed at helping fishermen, fishery managers, NGOs, seafood buyers and others interested in monitoring fisheries to understand how EM works, what EM systems can do and how to design and implement an EM program that overcomes barriers to full implementation.	Guide
<u>Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally-Managed Fisheries, Discussion Draft</u>	Advice and best practices is provided in a discussion document format for NMFS and Councils to evaluate, add to, and apply where applicable in developing regionally-appropriate fishery dependent data collection programs utilizing electronic monitoring and electronic reporting.	Guide
<u>Electronic Monitoring Program Toolkit: A Guide for Designing and Implementing Electronic Monitoring Programs</u>	This toolkit presents an overview of key questions and issues that may arise when governmental bodies in general, and fishery managers in particular, are considering the development and implementation of EM programs.	Guide
<u>Electronic Monitoring White Papers</u>	The term electronic monitoring (EM) is used broadly, indicating all means of collecting, recording, or reporting data both on shore and at sea. However, EM and electronic reporting (ER) technologies are significantly different in terms of design, purpose, and application. To the extent possible, this paper will provide distinctions between ER and EM while maintaining a cohesive summary of existing technologies.	Guide
<u>Evaluating Electronic Methods of Fisheries Monitoring, Control, and Surveillance</u>	Comparison of various EM technologies and case studies at a global scale	Guide
<u>The Field Guide to Human Centered Design</u>	The Field Guide has everything you need to understand the people you're designing for, to have more effective brainstorms, to prototype your ideas, and to ultimately arrive at more creative solutions	Guide
<u>Fisherieigital Data Collection Guide</u>	For managers, scientists, fishers, and anyone involved in ocean conservation, increasing accessible data collection tools presents opportunities to bring faster, more accurate data into management. This guide is to help users think through which tools might make sense for their fishery, and what questions to ask before adopting them.	Guide
<u>Fisheries Monitoring Roadmap</u>	A guide to evaluate, design and implement an effective fishery monitoring program that incorporates electronic monitoring and electronic reporting tools	Guide
<u>FishPath</u>	A comprehensive decision support tool for fisheries management, FishPath guides fisheries managers through the otherwise overwhelming array of choices before them, highlighting the best management options for their unique circumstances	Guide
<u>Getting There from Here: A Guide for Companies Implementing Seafood Supply-Chain Traceability Technology</u>	This report aims to highlight the compelling market incentives of traceability, while raising awareness of the very real human and technological barriers that hamper broader adoption.	Guide
<u>Good Practice Guidelines (GPG) on National Seafood Traceability Systems</u>	This document aims to guide the relevant national authorities on the uniform and proactive application of good practices so as to ensure that fish and fishery products entering the global supply chain do not come from IUU fishing. Ultimately, these good practices will provide and/or facilitate capacity building and institutional strengthening opportunities for those responsible for developing, integrating, implementing and/or evaluating traceability systems.	Guide

Resource	Description	Category
<u>Guiding Principles for Development of Effective Monitoring Programs</u>	The Monitoring Guiding Principles provide guidance for fishery managers and other stakeholders on planning, developing, and implementing monitoring programs. By outlining key components to consider and providing concise recommendations, the Guiding Principles can expedite and improve the design of monitoring programs.	Guide
<u>Improving Net Gains: Data Driven Innovation for America's Fishing Future</u>	The modernization and streamlining of fishery information systems is a critical fisheries challenge--this report reviews progress to date, assesses the experiences of fisheries stakeholders, considers best practices from elsewhere, and makes recommendations for how the National Marine Fisheries Service can work with partners to successfully move forward.	Guide
<u>Minimum Standards for the Implementation of Electronic Monitoring Systems for the Tropical Tuna Purse Seine Fleet</u>	This document presents a series of proposed standards for the use of EMS to monitor purse seine fisheries.	Guide
<u>OECD Issue on Inventory of new technologies in fisheries (2017)</u>	This issue address the theme, "Inventory of new technologies in fisheries: challenges and opportunities in using new technologies to monitor sustainable fisheries	Guide
<u>Offshore Fish Identification Cards for Small Scale Fisherman</u>	Identification cards to help improve the catch data and statistics from small scale fisherman that target pelagic species. Small scale fishers who are fishing on the pelagic stock and fisheries officers who are monitoring these fishes are most likely users of these cards.	Guide
<u>Open Water Guidance on Vessel Transparency</u>	This paper provides recommendations for how companies can improve vessel monitoring and transparency both within their operations as well as globally. Recommendations for increasing the global ratification and enforcement of key international agreements are also included to support the ultimate goal of strengthening vessel safety and labor protections for crew.	Guide
<u>Principles for Digital Development</u>	The Principles are not meant to be stagnant, nor compulsory. They are a set of living guidance intended to help practitioners succeed in applying digital technologies to development programs.	Guide
<u>Seafood Traceability for Fisheries Compliance</u>	This document explores ways in which individual countries in seafood supply chains can, in their capacities as coastal, flag, port, processing or end-market states, contribute to maximizing the effectiveness of catch documentation schemes.	Guide
<u>Smart Boats and Networked Fisheries</u>	New pathways to sustainable fishing in the digital age	Guide
<u>Technologies for Improving Fisheries Monitoring</u>	The purpose of this report is to describe other kinds of monitoring technologies that can be especially useful in fisheries that do not have sufficient infrastructure, revenue or capacity for conventional EM systems, and to show how monitoring programs using technologies can be designed for any fishery	Guide
<u>Technology for Fisheries Monitoring and Surveillance</u>	Pew Charitable Trusts visualizes the various technologies in fisheries monitoring and surveillance on this infographic leaflet. It seeks to clearly identify some significant emerging technologies and their differing uses for improving global fisheries against illegal fishing activity.	Guide
<u>The Business Wins of Seafood Traceability Technology</u>	This set of case studies highlights vendor-specific examples that lay foundational evidence for the tangible business wins of traceability technology.	Guide
<u>The Field Guide to Human Centered Design</u>	The Field Guide has everything you need to understand the people you're designing for, to have more effective brainstorming, to prototype your ideas, and to ultimately arrive at more creative solutions	Guide
<u>The Ideal Purse Seine Vessel: A Guide To Demonstrating Best Practices & Meeting ISSF Conservation Measures</u>	In an infographic and supporting paper, ISSF presents a suite of conservation measures for tuna purse seine fisheries – many of which are also tracked on ISSF's ProActive Vessel Register – and other best practices encouraged by ISSF and some tuna RFMOs as a guide to tuna sustainability best practices for purse seine vessels.	Guide
<u>Tools and Technologies for the Monitoring, Control and Surveillance of Unwanted Catches</u>	Review of the currently available and emerging options for the MCS of discarding of unwanted catches, including well-established pros and cons. Includes a review and analysis of the main EM technologies currently available in European fisheries	Guide

Resource	Description	Category
<u>TDWI Big Data Maturity Model and Assessment Tool</u>	Complete the assessment and receive a set of scores indicating your big data maturity across five dimensions that are key to deriving value from big data analytics: organization, infrastructure, data management, analytics, and governance.	Guide
<u>CountrySTAT</u>	CountrySTAT is a collection of software tools, methods, and standards to facilitate the acquisition, management, and analysis of large, diversified and distributed sets of data. It supports multiple-sourced data integration and harmonization according to international standards and contributes to improving data quality and reliability.	Information Platform
<u>EM4fish</u>	Virtual collaborative community for fishery electronic monitoring experts. Includes tools and resources as well as a list of EM vendors, services, and events.	Information Platform
<u>FishCom Ghana</u>	The Fisheries and Coastal Management database of Ghana serves as a data hub seeks to acquire and archive data on Ghana's coastal resources and their management. It embraces managed data access for researchers and fisheries managers, policy makers as well as promotes exchange of information between universities, government agencies and non-governmental organisations both local and international.	Information Platform
<u>ICT4Fisheries</u>	This information and networking portal is intended to promote broader, international cross-learning and collaboration among stakeholders developing open source apps for small-scale fisheries across the globe	Information Platform
<u>ISSF</u>	The International Seafood Sustainability Foundation (ISSF) is a global coalition of scientists, the tuna industry and World Wildlife Fund (WWF) — the world's leading conservation organization — promoting science-based initiatives for the long-term conservation and sustainable use of tuna stocks, reducing bycatch and promoting ecosystem health. (MSC Certification focused)	Information Platform
<u>OCTO: Open Communications for the Oceans</u>	OCTO accelerates ocean conservation by connecting ocean professionals to the knowledge and networks they need. Through a broad suite of tools and communities, this platform seeks to break down barriers to knowledge — empowering ocean professionals to apply best practices and science worldwide.	Information Platform
<u>Satu Data website</u>	A website describing all aspects related to Satu Data (e.g. regulations, history, analytics), a database system currently under development by the Indonesian Ministry of Marine Affairs and Fisheries (MMAF), that aims to streamline data from all sectors of the economy (including fisheries) into one single system.	Information Platform
<u>WHOFISHESFAR</u>	This website aims to demonstrate the need for institutional transparency and accountability of the activities of the EU fleet's activities in waters outside the EU. The website discloses information about EU fishing vessels operating in third-country waters.	Information Platform
<u>Atlantic Coastal Cooperative Staistics Program (ACCSP)</u>	ACCSP's goal is to be the principal source of fisheries-dependent information on the Atlantic coast through cooperation of all program partners, producing dependable and timely marine fishery statistics for Atlantic coast fisheries that are collected, processed and disseminated according to common standards agreed upon by all program partners.	Initiative
<u>Caught Red-Handed</u>	Works with navies, coast guards, and law enforcement to systematically increase the value and sophistication of human intelligence in vessel monitoring datasets used to combat illegal fishing in the Western Indian Ocean	Initiative
<u>CRISP</u>	CRISP is a centre for research-based innovation established to develop smarter technologies to meet future challenges for a sustainable and economically viable fishing industry	Initiative
<u>Fish-i Africa</u>	In FISH-i Africa, country representatives (Task Force) and international technical experts (Technical Team) use advanced analytical tools, systems and investigative techniques to identify and track vessels to gather and share intelligence about illegal fishing operations and responsible actors. Through the systematic compilation, and exchange of information and involvement in illegal fishing cases, the FISH-i partners get a better understanding of the nature and patterns of illegal fishing operations in the Western Indian Ocean and how to improve controls.	Initiative

Resource	Description	Category
<u>Fisheries Information System Program</u>	This collaboration works to improve access to comprehensive, high-quality, timely fisheries information by investing in data gaps and data quality, efficient technology and data integration, and the effective coordination and communication in the design, collection, and uses of data	Initiative
<u>Fishing Data Innovation Taskforce</u>	The Fishing Data Innovation Taskforce is a coalition of experts from the commercial and recreational fishing sectors, seafood industry, conservation community and technology industry; established with the goal of promoting efforts to modernize and streamline fishery information systems.	Initiative
<u>Global Fishing Watch</u>	A technology platform that uses satellite Automated Information Systems (AIS) data to monitor fishing activity around the world in near real-time. Provides an online map available for free to the public that tracks the movements of commercial fishing vessels all over the world, including downloadable data about past and present activities	Initiative
<u>Open Data Kit</u>	Open Data Kit is an open community of people whose mission is to help millions around the world collect, manage, and use their data. They value open communities and open source, and the work is user-focused and deployment-centric.	Initiative
<u>Safe Ocean Network</u>	The Safe Ocean Network was launched by the U.S. Department of State in 2015 to build a global community to better detect, enforce against, and prosecute those engaged in illegal fishing and other associated criminal activities. The goal of the Safe Ocean Network is to enhance coordination, information sharing, and capacity building worldwide.	Initiative
<u>Seafood Alliance for Legality and Traceability (SALT)</u>	The partnership will initially convene meetings of interested parties to identify and agree on the problems it will seek to address, within three larger topics: expanding electronic catch documentation traceability programs, bolstering the ability of countries that export fish to implement those traceability systems, and increasing incentives for industry to adopt such systems.	Initiative
<u>Smart Boat Initiative</u>	EDF's Smart Boat Initiative is working with our partners to test sensor, network, data analysis and other technologies to open new frontiers for fishing fleets of all sizes	Initiative
<u>SMARTFISH H2020</u>	To create new technologies, tools, and systems to revolutionize the sector in terms of monitoring, analyzing and improving processes in all facets of the European fishing sector	Initiative
<u>Southeast Asian Fisheries Development Center</u>	The Southeast Asian Fisheries Development Center (SEAFDEC) is an autonomous inter-governmental body established in 1967. SEAFDEC's mission is to promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia.	Initiative
<u>The Ocean Data Alliance</u>	The Ocean Data Alliance will seek to design and build this open-source integration platform for all ocean data and to ensure that it is geared from the outset to serve the global public interest. The key will be to encourage collaboration among all the key sensor enterprises to catalyse the process of integrating their data from a range of sources. With a design concept a blueprint in place for the integration exchange or platform, app designers and large data processors such as IBM Watson can then engage in public-private design labs to work with various oceans and fisheries stakeholders from across industry, research and government to find out exactly how best they may want to use the data streams on offer	Initiative
<u>The Sustainability Incubator</u>	The Sustainability Incubator is a network organization focused on project design and methodology, as well as raising the right team of experts to solve existing problems with fresh perspective and in new ways.	Initiative
<u>Too Big To Ignore: Global Partnership for Small-Scale Fisheries</u>	A global research network and knowledge mobilization partnership that focuses on addressing issues and concerns addressing viability and sustainability of small-scale fisheries	Initiative
<u>A Roadmap for IT Modernization in Government</u>	This report examines the status of IT modernization in the public sector and draws on key lessons from private industry, state government, and exemplary federal government agencies.	Report

Resource	Description	Category
<u>The Case for A Digital Ecosystem for the Environment</u>	This discussion paper outlines the status quo of the most salient challenges related to the collection, management and use of environmental data, algorithms and insights according to a comprehensive group of international stakeholders	Report
<u>eCatch: Enabling Collaborative Fisheries Management with Technology</u>	eCatch enables avoidance of sensitive species and habitats and quantitative reporting on performance metrics related to those activities. What started as a technology solution to a problem of timely scientific monitoring revealed collateral benefits of collaboration with the fishing industry and markets that support sustainable activities.	Report
<u>Improving the Collection, Management, and use of marine Fisheries Data</u>	This study reflects NMFS' desire to have the National Research Council assess methods for improving data for stock assessments and fisheries management, and a more specific interest by Congress to have the summer flounder stock assessments reviewed.	Report
<u>Project to Develop an Interoperable Seafood Traceability Technology Architecture: Issues Brief</u>	The issues brief describes factors associated with enterprise level traceability systems that will impact the design of technology architecture suited to enabling whole chain interoperable traceability. The brief details why a technology architecture is required, what it means for industry in terms of benefits and opportunities, and how the architecture will translate into practical results.	Report
<u>The Business Wins of Seafood Traceability Technology</u>	This set of case studies highlights vendor-specific examples that lay foundational evidence for the tangible business wins of traceability technology.	Report
<u>Opportunities to improve fisheries management through innovative technology and advanced data systems</u>	By reviewing the application of fishery dependent data technology in multiple fisheries sectors globally, we show that innovation is stagnating as a result of lack of trust and cooperation between fishers and managers. We propose a solution based on a transdisciplinary approach to fishery management that emphasizes the need for collaborative problem solving among stakeholders.	Report
<u>Abalobi</u>	A mobile app suite and programme aimed at social justice and poverty alleviation in the small-scale fisheries chain, transformation in the way knowledge is produced, stewardship of our marine resources, and resilience building in the face of climate change.	Technology
<u>Earth Twine Stratis Platform (SPARKL)</u>	The first dedicated blockchain system for origin data and tracking for the international seafood industry. This platform combines collaborative technologies (Earth Twine, SPARKL, Stratis), and will provide the means for tracking mandatory data for IUU compliance.	Technology
<u>FACTS</u>	Electric Edge's platform provides electronic data collection and reporting, harvest verification, and data management for the state's commercial, charter, and wholesale needs to the Michigan Department of Natural Resources	Technology
<u>FLUX</u>	The Fisheries Language for Universal Exchange (FLUX), provides a harmonized message standard allowing Fishery Management Organizations (FMOs) to automatically access the electronic data needed for fish stock management. Such data include vessel and trip identification, fishing operations (daily catch or haul by haul), fishing data (catch area, species and quantity, date and time, and gear used), landing and sales information, license information and inspection data.	Technology
<u>FOCUS (Fisheries Open Source Community Software)</u>	The Fisheries Open Source solution community is an open source community that aims to oversee and maintain free software dedicated to the management and preservation of the fishery resource. Serves as platform for FLUX and Union VMS	Technology
<u>I-Fish Database</u>	I-Fish is an Indonesian fisheries information system for fishing boat captains, boat owners, and managers	Technology
<u>Integrated Fisheries Management System (IFIMS)</u>	iFIMS is currently only used by the PNA for purse seiners and FADs, but is aimed to expand to longline. The iFIMS platform integrates vessel position and activity generated from Vessel Monitoring System (VMS), reports of catch from fishing industry, and reports from fisheries observers. Companies can see their own boat and catch information through the industry database as well as apply for licenses electronically through the portal. Individual PNA parties can access data related to catch and vessel activity in particular EEZs. Overall, it holds industry, government and flag state information and is currently utilizing Electronic Reporting apps as iFIMS data entry tools for observers and vessel operators.	Technology

Resource	Description	Category
<u><i>POSEIDON</i></u>	A joint project using advanced computer modeling to better understand the ecosystem, including the human dimension, to help identify simpler and better approaches to fisheries management. The program uses an agent-based computer modeling approach that can better capture how individuals interact with the system, often in unintuitive ways	Technology
<u><i>Project Eyes on the Seas</i></u>	Unites satellite monitoring and imagery data with fishing vessel databases and oceanographic data to help authorities detect suspect fishing activity. Designed to be a cost-effective global fisheries monitoring and enforcement tool for governments around the world, including the most resource-poor enforcement agencies.	Technology
<u><i>TUFMAN2</i></u>	A data entry & data checking tool for observers and vessel operators fishing in the WCFPC region, who can enter and secure access to their log sheets, unloadings, port sampling, and position reports (access to other nations data is also possible with data-sharing rules applied). Also features data quality checks and data-sharing.	Technology
<u><i>Union Vessel Monitoring System (Union VMS)</i></u>	An EU project with the goal of producing a free, open-source implementation of a vessel monitoring system (VMS). Requirements for the project have been set by a board consisting of representatives from participating member states.	Technology
<u><i>Data Limited Methods Toolkit</i></u>	The Data-Limited Methods Toolkit (DLMtool) is a freely-available, open-source software package that uses computer simulations of real-world fisheries to help scientists and managers with three common objectives: 1) identifying the most effective management methods given the uncertainties associated with data-limited fisheries, 2) computing explicit management guidance based on the best-available data, and 3) prioritizing future data collection programs.	Toolkit
<u><i>Digital Impact Toolkit</i></u>	The Digital Impact Toolkit can help you learn to manage and govern your digital data safely, equitably and effectively with the same care you commit to financial and human resources	Toolkit
<u><i>Digital Investment Toolkit</i></u>	Use of this resource will support robust development of digital systems that are effective, sustainable, and support the self-reliance of local partners that own and operate these systems.	Toolkit
<u><i>FishPath</i></u>	The goal of the FishPath tool is to guide the selection of context-appropriate management strategies by identifying options for data collection, stock assessment, and management measures. Once registered, you may access the FishPath tool, including the FishPath questionnaire, interactive results tailored to your fishery, and supporting resources.	Toolkit
<u><i>LMMA Toolkit</i></u>	This toolkit, available in both English and French, provides practical guidance in setting up and maintaining Locally Managed Marine Areas (LMMAs). The Resource Kit is aimed primarily at technical partners that assist communities with implementation, but is also designed to be accessible by community members trained in LMMA implementation. With a focus on Madagascar, practical experience and case studies from the field are used to present user-friendly 'How to' guidance at each stage of LMMA creation.	Toolkit
<u><i>Open Artfish</i></u>	Toolkit for routine small-scale fisheries data collection, comprising a generic database and a mobile phone application.	Toolkit
<u><i>Open Data Kit (ODK) Guide</i></u>	Open source software for collecting data in our field sites without much prior technical knowledge. Much of this is available on the ODK website but here, non-developers have spent time working through some of the technical language, testing out different data collection methods and compiling our lessons and advice for using this in a remote, community based data collection setting, to produce a simple easy to follow step-by-step guide to setting up ODK monitoring.	Toolkit

Resource	Description	Category
<u><i>Standards, Specifications, and Procedures for Electronic Reporting in the WCPFC - operational catch and effort data + observer data</i></u>	<p>These SSPs are a set of data standards that:</p> <ul style="list-style-type: none"> a. provide a basis for those CCMs who are considering the implementation of electronic reporting technologies in their fisheries; b. provides a mechanism, for those CCMs who have commenced implementation of electronic reporting technologies in their fisheries, to have the option of using these technologies to facilitate their implementation of certain reporting requirements to the Commission; c. provides a basis for the Secretariats preparations to be ready to receive a standardized set of electronically reported fisheries data from CCMs and as appropriate from vessels; 	Toolkit
<u><i>Sustainable Fisheries Toolkit</i></u>	The Sustainable Fisheries Toolkit is a comprehensive set of resources for improving fisheries management practices and outcomes for people and the environment.	Toolkit
<u><i>The Fishers Factsheet: E-reporting and E-monitoring</i></u>	This factsheet is designed to be printed and taken aboard fishing boats, so fishing captains and crew understand how e-reporting and e-monitoring affect them and what they need to know about it as the equipment is installed on their fishing vessels.	Toolkit



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