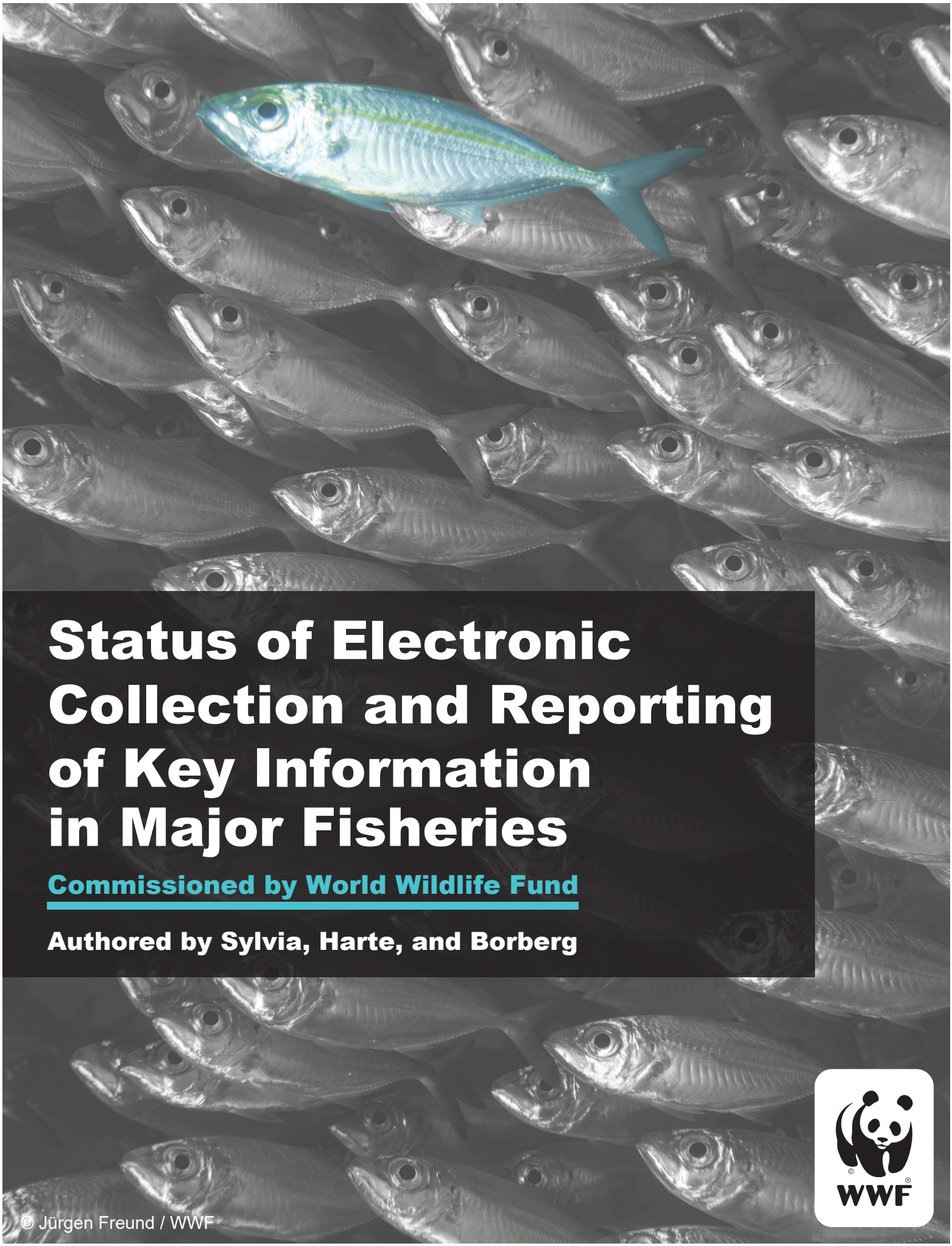

Status of Electronic Collection and Reporting of Key Information in Major Fisheries

Commissioned by World Wildlife Fund

Authored by Sylvia, Harte, and Borberg

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Citation
This publication should be cited as: Sylvia G, Harte M, Borberg J. 2019. Status of electronic collection and reporting of key information in major fisheries.

Acknowledgements
This publication was made possible by the support of the World Wildlife Fund. Additionally, the authors would like to thank Bran Black for the work on the maps included in this report.

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Acronyms and Definitions of Terms

Frequently-used Acronyms

- CDS – Catch documentation schemes
- COFI – FAO Committee on Fisheries
- EEZ – Exclusive Economic Zone
- EFIS – Electronic fisheries information system
- EM – Electronic monitoring
- ER – Electronic reporting
- ERP - Enterprise Resource Planning
- ET - Electronic tracking
- ETr – Electronic traceability
- EU – European Union
- FAO – Food and Agriculture Organization of the United Nations
- FFA – Forum Fisheries Agency (*or Agreement)*
- FIP – Fishery Improvement Plan
- iFIMS – Integrated Fisheries Information Management System
- IPOA IUU – International Plan of Action to Prevent, Deter, and Eliminate IUU Fishing
- ISSF – International Seafood Sustainability Foundation
- ITDS – US International Trade Data System
- IUU – Illegal, unreported, and unregulated
- KDE – Key data elements
- MCS – Monitoring, control and surveillance
- MSC – Marine Stewardship Council
- NGO – Non-governmental organization
- NOAA – US National Oceanic and Atmospheric Administration
- PSMA - Agreement Port State Measures to Prevent, Deter and Eliminate IUU Fishing
- RFMO – Regional fishery management organization
- SIMP - US Seafood Import Monitoring Program
- Tr - Traceability
- UNCLOS – United Nations Convention on the Law of the Sea
- US – United States of America

Regional Bodies:
UNCLOS-designated tuna RFMOs

- CCSBT - Commission for the Conservation of Southern Bluefin Tuna
- IATTC - Inter-American Tropical Tuna Commission
- ICCAT -International Commission for the Conservation of Atlantic Tunas
- IOTC - Indian Ocean Tuna Commission
- WCPFC - Western and Central Pacific Fisheries Commission

UNCLOS-designated non-tuna RFMOs

- GFCM - General Fisheries Commission of the Mediterranean
- NAFO - Northwest Atlantic Fisheries Organization
- NEAFC - Northeast Atlantic Fisheries Commission
- SEAFO - Southeast Atlantic Fisheries Organization
- SIOFA - South Indian Ocean Fisheries Agreement

- SPRFMO - South Pacific Regional Fisheries Management Organization
- WECAFC - Western Central Atlantic Fisheries Commission

Other regional groups
- CCAMLR - Convention on Conservation of Antarctic Marine Living Resources
- PNA – Parties of the Nauru Agreement

Definitions of Terms
- EM – Electronic monitoring: An integrated system of cameras and sensors on fishing vessels (Michelin et al, 2018); largely consists of a closed video or photographic system integrated with a sensor system that can be used to view changes in fishing activity and to trigger or coordinate photographic viewing (closed system)
- ER – Electronic reporting: Systems used as monitoring and database systems, satisfying data-reporting requirements for regionally coordinated work such as regional stock assessments, regional fisheries management, and compliance (open system because it requires manual input of data)
- ET - Electronic tracking: Tracking vessel movement including position, course, and speed (closed system)
- Interoperable: "The extent to which systems can exchange data, and interpret shared data" (Bhatt et al, 2016)
- CTEs - "Points where product is moved between premises or is transformed, or is determined to be a point where data capture is necessary to maintain traceability" (McEntire et al, 2010)
- KDEs - "the data elements required to successfully trace a product and/or its ingredients through all relevant CTEs" (McEntire et al, 2010)
- Tr - Traceability: "The ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications" (Olsen and Borit, 2013); "The ability to follow the movement of a food through specified stage(s) of production, processing, and distribution" (McEntire et al, 2010)

Executive Summary

This report provides an evaluation of the status of electronic collection and reporting of key fisheries and product information in major fishing nations and regions. Electronic fisheries information systems (EFIS) that allow for the accurate and verifiable collection of fisheries data -- and the sharing and tracing of that data from harvest through the value chain to final point of sale -- are slowly developing in regional, national, and global systems, in both developed and developing countries, and national and international fisheries.

A major component of this report is an assessment of the status of the different components of EFIS including: electronic vessel tracking systems (ET), electronic monitoring (EM), electronic reporting (ER), and electronic traceability (ETr) for twenty-plus countries and Regional Fisheries Management Organizations (RFMOs) whose fish and fish products are imported by the European Union and the United States (US).

While electronic vessel tracking systems have shown rapid global growth, development of electronic monitoring, electronic reporting, and electronic traceability have been slower to develop and as a consequence, fully integrated EFIS remains rare in the fishery and seafood sector. Although efficiency is often cited as reason to adopt these systems, upfront and fixed costs for these systems can be high and the benefits may accrue slowly over time. There are also other reasons for their relatively slow adoption including:

- Many propriety systems: A proliferation of proprietary EFIS constrains development of global interoperability and development of common standards, protocols, specifications, and guidelines.
- Different purposes: EFIS evolved from different starting places. Some sub-systems were targeted at seafood traceability along seafood supply chains, some at fishery compliance, some for fisheries regulations, and others for gathering data for management and scientific research. Often, there has been little consideration for all possible uses of the electronic data, how it should be collected, and the way it should be formatted and disseminated to promote wide scale use.
- Different dates of development: EFIS subsystems developed at different times using different hardware and software and associated standards. Limitations in data storage and processing capability often constrained developers of earlier systems. Many earlier systems eventually become dated and cannot take advantage of new software and integration with other programs, modules, and systems.
- Different scales: EFIS are usually developed for specific fisheries or corporate supply chains, less often as comprehensive national systems, and rarely as international systems. This often translates to higher user costs.
- Diversity of fisheries: EFIS, regardless of the purpose and scale, often have to deal with an extraordinary diversity of species, fleets, gear, participants, and markets with varying degrees of market integration, technological expertise and resources.
- Complexity and secrecy in seafood industry supply chains: Complexity and secrecy hinder the design of a data architecture suited to enabling global interoperable EFIS. Trust is often lacking and secrecy is often high in a globally competitive market place where almost every seafood product has a substitute – whether wild or farmed.

The report makes the following recommendations to advance EFIS development:

1. Promote the concept of integrated “EFSIS” (Electronic Fishery and Seafood Information Systems) to help drive integration and interoperability across fishery management organizations and seafood supply chains to improve fishery and market benefits;
2. Support global dialogues, forums, and trainings on EFSIS including governance, policies and procedures, alignment of principles, incentives, funding, interoperability, and benefits/costs;

3. Develop creative financing and market support strategies to drive down the costs and risks of implementing EFSIS; and
4. Enable, support, and highlight/promote EFSIS collaborative value chain projects through: 1) research that reveals how collaborative supply chains form and use key data elements to increase benefits; and, 2) by sponsoring and supporting EFSIS collaborative value chain projects including pre workshops and follow up educational programs.

1 Introduction

1.1 Study Context

Three interrelated global drivers are placing greater pressure on seafood supply chains -- from harvester to consumer -- to become more productive, sustainable, and transparent. The first driver is the rapid expansion of seafood trade, from USD $8 billion in 1976 to USD $143 billion in 2016. It is estimated that up to 78% of fish by volume and fish products are now exposed to international trade competition (Tveterås et al, 2012). Seafood trade from developing countries now makes up approximately 59% of global trade (FAO, 2018). This increase in trade is characterized by longer and more complex supply chains, new logistical technologies, and adoption of scale economies. Driven by forces of supply and demand including the increase of the world's population, national and international seafood producers are growing and consolidating. The rapid growth in trade is also reflected in greater sharing and integration of cultural preferences for seafood and the rise of information technology, which is increasing the speed and ease with which consumer tastes and trends are spread around the globe.

Second, seafood markets and consumers want to know that domestic and global fisheries are acting responsibly and sustainably to address issues such as illegal, unreported, and unregulated fisheries (IUU), seafood safety, and seafood fraud. Seafood companies and supply chains are under greater pressure to demonstrate social and environmental responsibility. These pressures are leading to demands by major seafood importing countries including the United States and the European Union to require that importers provide key information to demonstrate that seafood is authentic, transparent, and accountable.

A third driver and a key focus of this report is the rapid advancement of electronic information technologies to help provide information that management organizations, governments, and seafood supply chains need to manage responsibly and meet the needs of markets and consumers for high quality, responsible, and sustainable seafood products.

Responding to these drivers requires information that is conveniently and securely available to regulators, supply chain participants, and consumers in near-real time. Electronic monitoring and reporting systems that allow for accurate collection of fisheries data, and sharing and tracing that data from harvest through the supply chain (i.e., the "life cycle" of the product), is a rapidly evolving field that has the potential to meet these increased regulatory and market demands.

Electronic vessel tracking (ET), electronic monitoring (EM) and electronic reporting (ER) were initially developed as regulatory tools to assist monitoring, control and surveillance, with benefits including improved compliance and reporting, improved fisheries sustainability, and improved quality in stock assessment (Banks et al, 2016). Electronic fisheries information systems (EFIS) are systems that utilize ET, EM, and ER with additional benefits including system-wide electronic traceability (ETr) that can improve product value, catch quality, and fleet and company profitability (Banks et al, 2016). Traceability has a number of working definitions, for example: "the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications" (Olsen and Borit, 2013); or, "the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution" (McEntire et al, 2010). Traceability will most effectively be accomplished in the global seafood supply chain through integrated and interoperable EFIS

1.2 Project Goals and Framework

This paper sets out to document and evaluate the state of electronic fisheries information systems in major fishing countries and regions and to determine key strategies for transitioning to integrated EFIS. The study focuses on supply chains of internationally traded seafood products from capture fisheries. The study

evaluates EFIS and its electronic system components (ET, EM, ER, ETr) from fishing operations through supply chains and considers key factors influencing the development and implementation of EFIS. The analysis is used to develop recommendations for advancing EFIS globally.

1.3 Report Structure

The report is structured to provide baseline information, analysis, and recommendations. Section 2 summarizes major influences on data requirements in global seafood supply chains. Section 3 documents the Status of EFIS in major fisheries (by exporting country and regional fisheries management organization), and presents both summaries and findings with particular focus on issues and barriers preventing EFIS development. Section 4 presents case studies of selected countries, fisheries, and management organizations that highlight core issues, barriers, and strategies. Section 5 describes trends and issues identified from our review of the global status of EFIS. Section 6 concludes the report with a summary of key issues in developing and implementing EFIS and recommendations.

2 Key Influences on Fisheries Data Requirements

Over the past several years, increased public and regulatory attention has been drawn to illegal, unreported and unregulated (IUU) fishing and slave labor on fishing vessels, elevating the call for traceability in the seafood supply chain (Michelin et al, 2018; FishWise, 2018). NGOs have been playing a key role in bringing attention to IUU issues, demanding transparency throughout the fish supply chain, and directly supporting EM and ER trials to improve sustainable fisheries management and traceability (FishWise, 2018; Banks et al, 2016). Efforts to address IUU put focus on using EM to prevent IUU at its source (i.e., harvest), however, international markets also play a critical role in preventing and reducing IUU (Hosch and Blaha, 2017). With 59% of exports of fish and fish products originating in developing countries (FAO, 2018) and oversight and enforcement often weak, tracking and monitoring of harvest alone is not enough to deter IUU fishing. As a result, major efforts are underway to use trade-related measures to prevent IUU products from entering global supply chains, especially in Western countries (Hosch and Blaha, 2017).

There are many influences on trade-related fisheries data requirements. However, globally there are three major influences: The European Union Catch Certificate Scheme; United States Seafood Import Monitoring Program; and codification of critical tracking events and key data elements.

European Union Catch Certificate Scheme

The European Union (EU), the largest global importer of fish and fish products (FAO, 2018), adopted a regulation in 2008 establishing a system to prevent, deter, and eliminate IUU fishing. Detailed rules were adopted by the European Commission, the sole negotiating partner on behalf of all EU member states for seafood and fishery product imports. Since 2010, the EU has required all imports to be accompanied by a Health Certificate to prove that the shipment meets strict rules on sanitary conditions and a Catch Certificate certified by the exporting nation assuring the fish were legally harvested. The EU also maintains a list of countries and territories from which it will accept fisheries imports that meet EU standards and they have developed a process for listing IUU vessels (European Commission, 2015).

For all fishery product imports, countries of origin must meet the EU Specific Key Elements, and imports from non-EU countries must enter via an approved Border Inspection Post (European Commission, “EU import conditions for seafood”). Information required to obtain these certificates include: name and contact information for all responsible parties; country, region, and dispatcher of origin and destination; date of departure; description of commodity (scientific name, weight, commodity code, wild or aquaculture, catch date); temperature; shipment details (port of departure, vessel name and flag); and, a health attestation from an authorized inspector. At the first point of entry, shipments have the following veterinary inspections: (1)

health certificate is examined, (2) shipment is inspected for consistency between product and documents, and (3) physical examination of products and lab testing are done as determined necessary. Since December 2014, additional label requirements include: commercial name of species, production method, fishing gear, and catch area.

After five years of implementation, the EU's Catch Certificate Scheme was updated to TRACES in 2014, moving from a paper-based system to a central electronic registry to record catch certificates for fishery imports to improve system efficiency and reduce costs (Hosch and Blaha, 2017; European Commission, "EU import conditions for seafood").

United States Seafood Import Monitoring Program

The US Seafood Import Monitoring Program (SIMP) was established by NOAA Fisheries in December 2016 and implemented in 2018, defining requirements for permitting, reporting and recordkeeping to prevent products from IUU fisheries from being imported into the US. SIMP requires importers to maintain records on chain of custody and to provide and report the following key data through the International Trade Data System (ITDS) electronic portal —from the point of harvest to the point of entry into US commerce: 1) harvest data (name and flag of vessel, permit or license, vessel identifier, name of farm if applicable, gear type used); 2) landing data (species by ASFIS three alpha code, date, location, product form, weight, catch area, name of entity responsible); and, 3) data on the chain of custody including transshipment and processing of product (US Federal Register 81 FR 88975[1] and 50 CFR 300.324[2]). Random audits will be conducted to verify information, and information collected through the ITDS is confidential. SIMP initial species include: Atlantic cod, blue crab, mahi mahi, grouper, king crab, Pacific cod, red snapper, sea cucumber, sharks, swordfish, tuna (albacore, bigeye, skipjack, yellowfin, and bluefin), abalone, and shrimp.

Critical tracking events and key data elements

Critical tracking events (CTEs) and key data elements (KDEs) were defined as key components of traceability by the Institute of Food Technologists (IFT, 2009), and KDEs are now broadly accepted as the foundation of product traceability across industries (Bhatt et al, 2016; FishWise, 2017). CTEs are the points in a value chain where data capture is necessary for traceability (e.g., at harvest, processing, trade) and KDEs are the data required for traceability at each CTE (McEntire et al, 2010). More simply put, KDEs are the who, what, when, and where from point of harvest onwards (Fishcoin, 2018).

Significant efforts have been undertaken by government, conservation groups, certification bodies, and industry experts to help identify a common set of CTEs and KDEs and other critical standards for the seafood sector. In 2014, the Global Food Traceability Center (GFTC), a public-private partnership program within IFT, identified CTEs and KDEs for nine global seafood value chains based on the traceability practices of 48 seafood businesses (Sterling et al, 2015). In related work, CTE and KDE best practices were reviewed along the seafood supply chains for the purposes of food safety, quality, sustainability, and fraud; and among other findings, the authors determined that the point of harvest is the most important CTE (Bhatt et al, 2016).

[1] https://www.federalregister.gov/documents/2016/12/09/2016-29324/magnuson-stevens-fishery-conservation-and-management-act-seafood-import-monitoring-program

[2] https://www.govinfo.gov/content/pkg/CFR-2018-title50-vol11/xml/CFR-2018-title50-vol11-sec300-324.xml

3 EFIS Status in Key Fisheries

3.1 EFIS Status for Countries and Regions

The status of ET, EM, ER, and ETr technology requirements and usage for major exporting countries of fish and fish products to the EU and US are summarized in Appendix 1, and for regional fisheries management groups in Appendix 2. These brief summaries provide examples of voluntary, proposed, required, and implemented electronic fishing efforts; thereby showing country and RFMO progress towards EFIS and traceability. Appendix 1 summaries for country EFIS status were done from the perspective of the coastal/flag states, and an important qualification is that coastal/flag states must comply with electronic vessel tracking and reporting requirements of other countries and regional fisheries management organizations when fishing in their waters, and with traceability requirements of importing states. Another qualification is that the summaries are based on available information, with EFIS information limited for some countries and regions.

Information from these summaries were used to numerically and visually evaluate country and regional progress towards EFIS, with Table 1 showing trends of EFIS status by country and Table 2 showing trends of EFIS status by region. Each EFIS component - ET, EM, ER, and ETr - was coded on a scale of 0 to 5 with 0 representing no electronics proposed or required and 5 representing electronics are operational in most or all fisheries for that country or region. Table cells were color-coded from white to dark green with darker colors showing more progress towards integration of electronic fishery systems. As very few fully interoperable electronic traceability systems have been implemented, it is noted in the narrative when countries and regions have demonstrated a commitment to traceability and detection and prevention of IUU, even if evidence of electronic technologies were not found. The results from Tables 1 and 2 are also shown in Figures 1a, 1b, 1c, and 1d illustrating on a global map the locations and scoring of ET, EM, ER, and ETr (respectively) for each country; and Figures 2a, 2b, 2c, and 2d for RFMOs.

Table 1. Current status of EFIS for the major countries from which the EU and US import fish and fish products, in alphabetic order by country. The EFIS components, ET, EM, ER, and ETr are ranked on a scale of 0 to 5 with a higher number indicating greater adoption and implementation of electronics (see key below). The supporting narrative can be found in Appendix 1.

Country	ET	EM	ER	ETr
Argentina	3	4	1	0
Australia	4	3	3	2
Canada	4	3	4	1
Chile	4	4	3	2
China	3	0	2	0
Ecuador	4	2	3	2
Iceland	5	3	4	3
India	3	0	1	1
Indonesia	3	2	3	2
Japan	3	0	1	2
Mexico	3	2	2	2
Morocco	3	0	3	2
New Zealand	5	4	4	5
Norway	5	2	5	3
Peru	4	2	3	2
Philippines	4	2	3	2
Russia	5	3	3	0
South Korea	4	2	3	0
Taiwan	3	0	3	2
Thailand	4	3	3	1
Vietnam	3	0	0	0

Key:
0 = No electronics proposed or required (by government or an RFMO) for any export fisheries, and no evidence found.
1 = Mostly paper-based, but electronic data collection permitted
2 = Under trial in some export fisheries but not widely used or planned for wide-scale use
3 = Operational in some export fisheries but not proposed for wider-scale use
4 = Operational in some export fisheries and proposed for wide-scale use
5 = Operational in most/all export fisheries

Table 2. Current status of EFIS for the major regional fisheries management organizations, in alphabetic order by region. The EFIS components, ET, EM, ER, and ETr are ranked on a scale of 0 to 5 with a higher number indicating greater adoption and implementation of electronics (see key below). The supporting narrative can be found in Appendix 2.

Regional Organization		Organization type	EVT	EM	ER	ETr
ASEAN	Association of Southeast Asian Nations	Regional Group	2	2	2	2
CCAMLR	Convention on Conservation of Antarctic Marine Living Resources	International Convention and Treaty	5	2	4	5
CCSBT	Commission for the Conservation of Southern Bluefin tuna	RFMO, tuna	4	0	3	3
GFCM	General Fisheries Commission of the Mediterranean	RFMO, non-tuna	5	0	0	2
IATTC	Inter-Amer tropical tuna Commission	RFMO, tuna	4	1	1	1
ICCAT	International Commission for the Conservation of Atlantic Tunas	RFMO, tuna	4	2	3	3
IOTC	Indian Ocean Tuna Commission	RFMO, tuna	4	2	2	1
NAFO	Northeast Atlantic Fisheries Organization	RFMO, non-tuna	5	0	5	0
NEAFC	Northeast Atlantic Fisheries Commission	RFMO, non-tuna	5	1	3	0
PNA	Parties of the Nauru Agreement	Oceania Subregional Agreement	5	3	4	4
SEAFO	Southeast Atlantic Fisheries Organization	RFMO, non-tuna	5	1	5	1
SIOFA	South Indian Ocean Fisheries Agreement	RFMO, non-tuna	5	0	1	0
SPRFMO	South Pacific Regional Fisheries Management Organization	RFMO, non-tuna	4	0	1	0
WCPFC	Western and Central Pacific Fisheries Commission	RFMO, tuna	5	2	3	3
WECAFC	Western and Central Pacific Fisheries Commission	RFMO, non-tuna	2	0	1	0

Key:
0 = No electronics proposed or required (by government or an RFMO) for any export fisheries, and no evidence found.
1 = Mostly paper-based, but electronic data collection permitted
2 = Under trial in some export fisheries but not widely used or planned for wide-scale use
3 = Operational in some export fisheries but not proposed for wider-scale use
4 = Operational in some export fisheries and proposed for wide-scale use
5 = Operational in most/all export fisheries

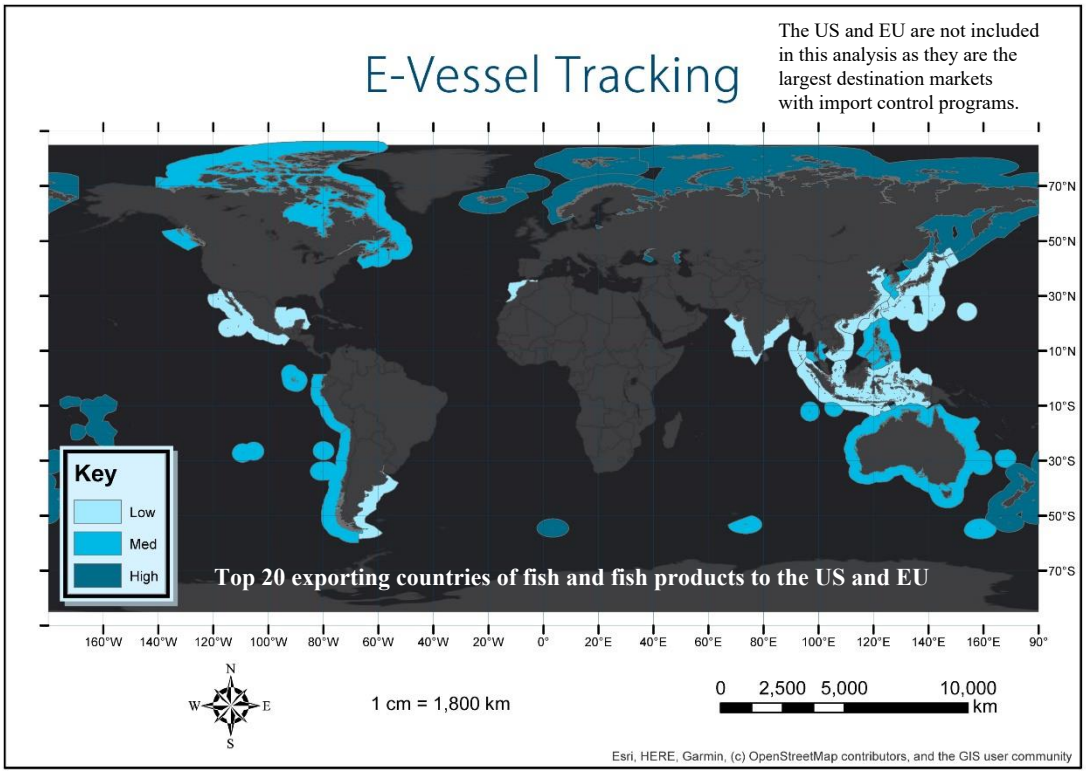

Figure 1a. Map of ET for country EEZs, ranked from low to high with low indicating that ET is operational in some export fisheries and high indicating that ET is operational in most or all export fisheries.

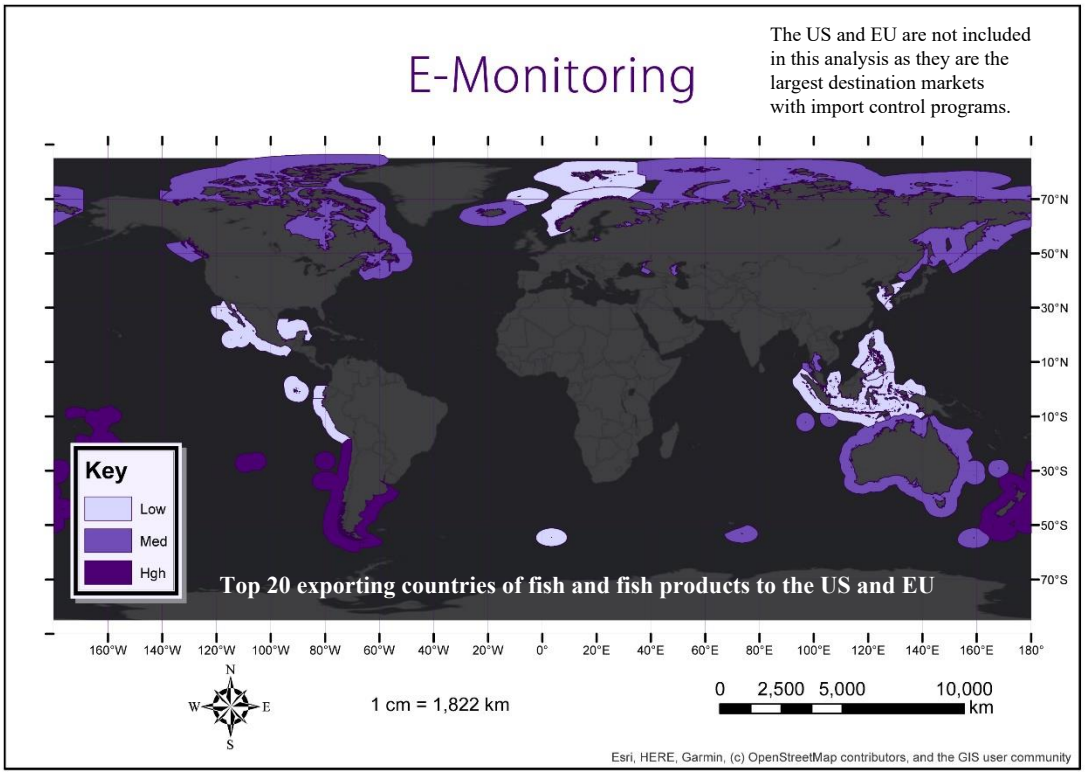

Figure 1b. Map of EM for country EEZs, ranked from low to high with low indicating no EM requirements and high indicating that EM is operational in some export fisheries and has been proposed for wide-scale use.

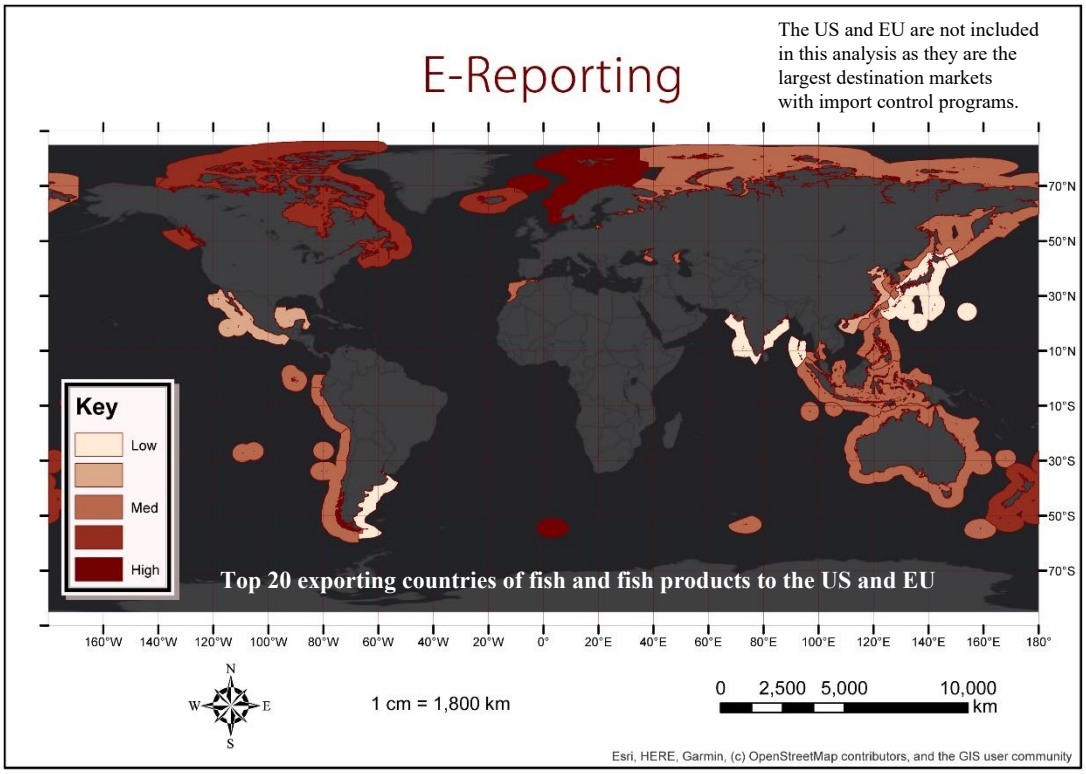

Figure 1c. Map of ER for country EEZs, ranked from low to high with low indicating that no ER is required and high indicating that ER is operational in most or all export fisheries.

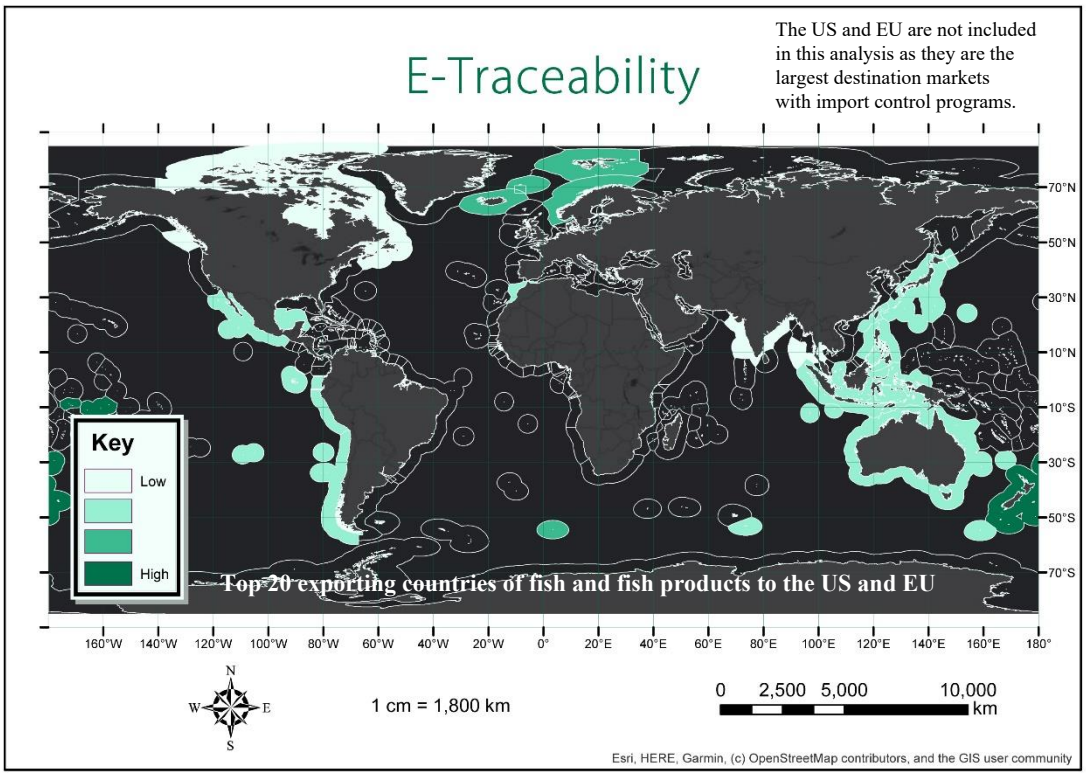

Figure 1d. Map of ETr for country EEZs, ranked from low to high with low indicating that ETr is not required and high indicating that ETr is operational in most or all export fisheries.

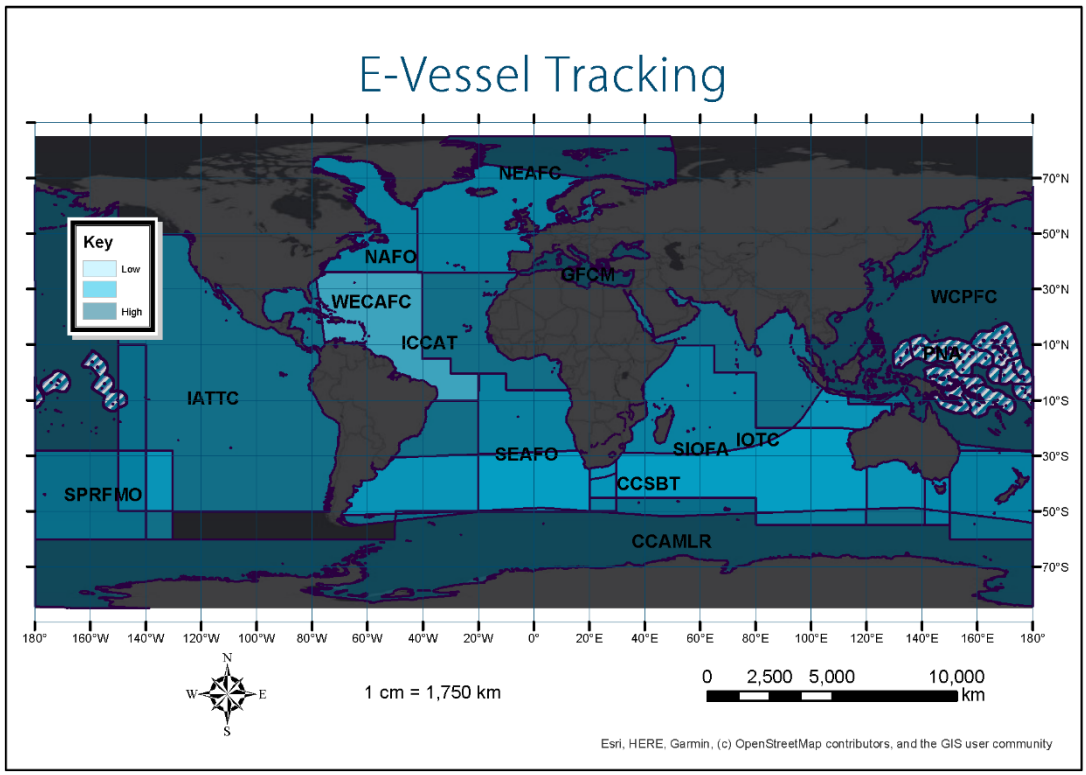

Figure 2a. Map of ET for RFMOs, ranked from low to high with low indicating that ET is under trial in some export fisheries but not otherwise operational and high indicating that ET is operational in most or all export fisheries.

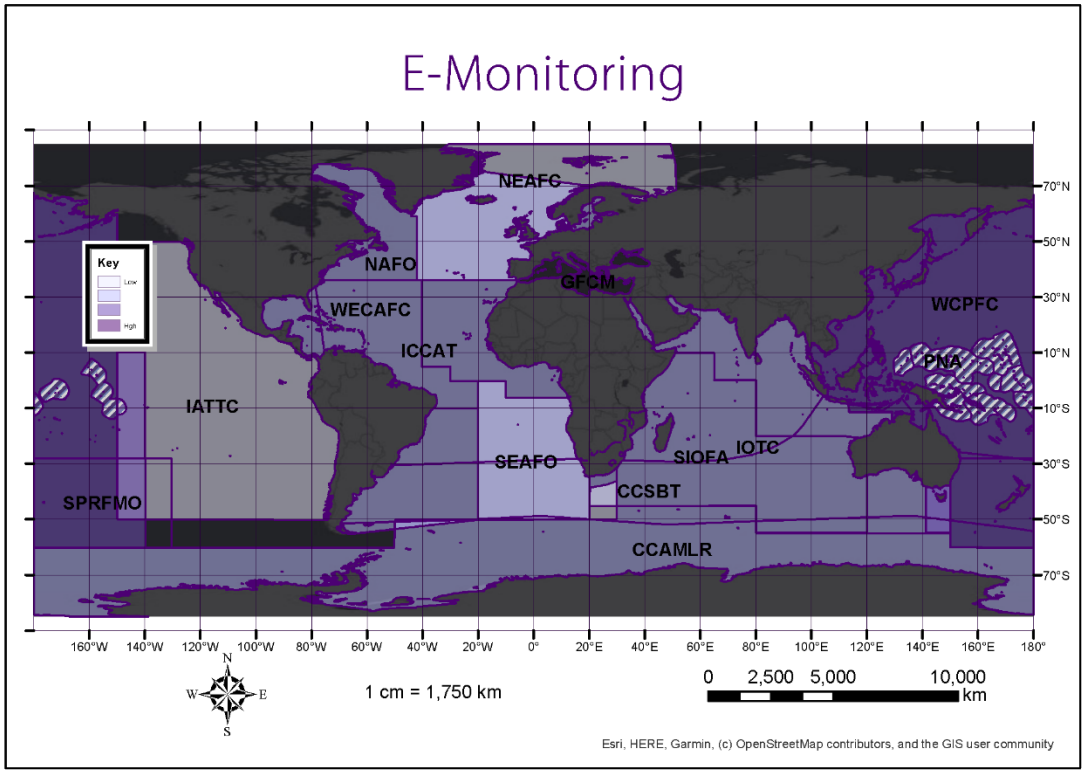

Figure 2b. Map of EM for RFMOs, ranked from low to high with low indicating no EM requirements and high indicating that EM is under trial in some export fisheries but not otherwise operational.

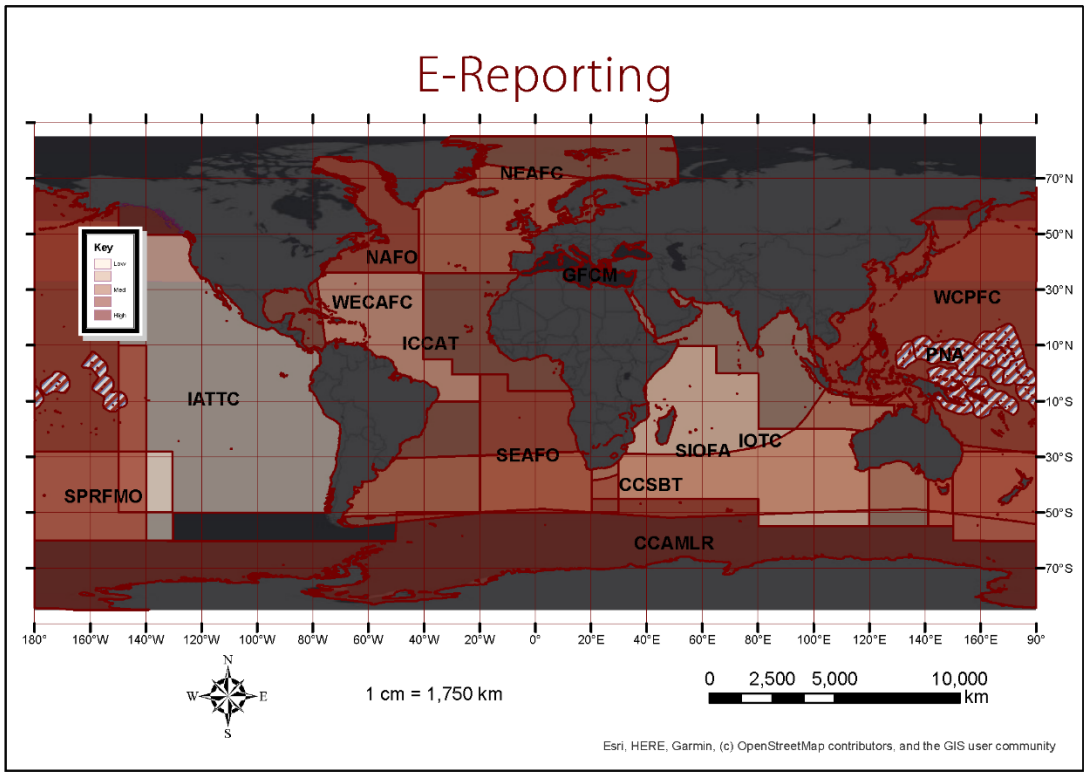

Figure 2c. Map of ER for RFMOs, ranked from low to high with low indicating that no ER is required and high indicating that ER is operational in most or all export fisheries.

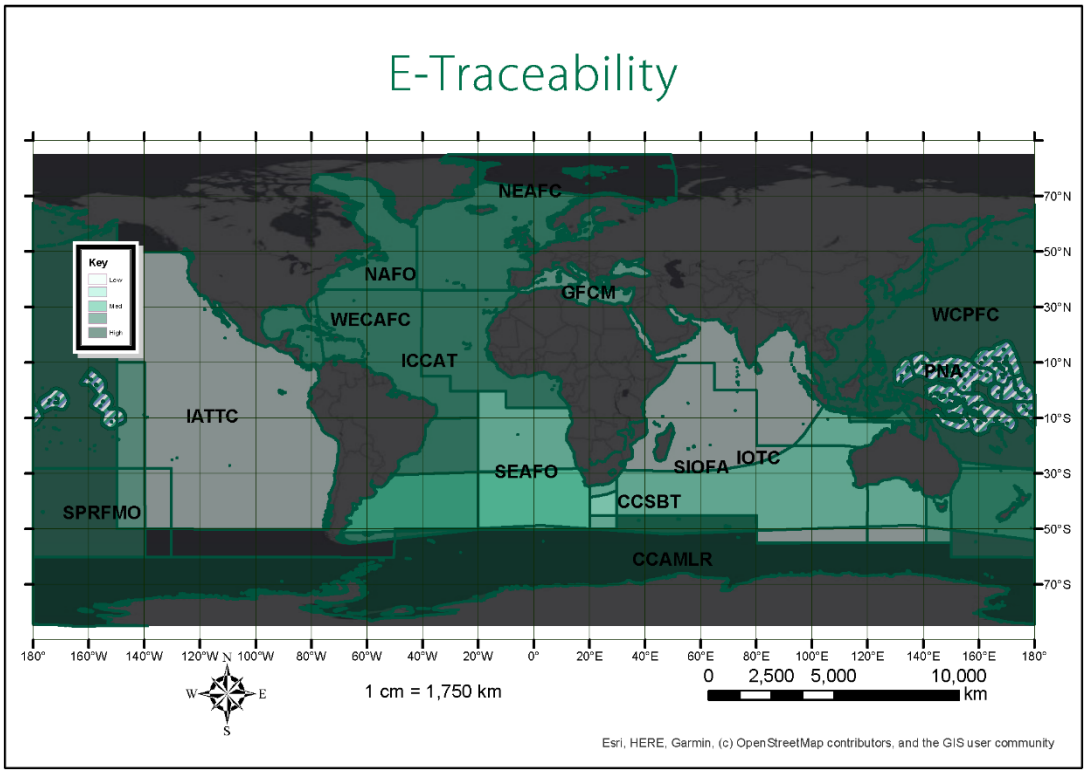

Figure 2d. Map of ETr for RFMOs, ranked from low to high with low indicating that ETr is not required and high indicating that ETr is operational in some export fisheries but not proposed for wide-scale use.

3.2 Key Enabling Conditions

There are many challenges associated with establishing a framework and conditions under which EFIS can be successfully implemented. Key conditions that can help facilitate successful implementation of EFIS were identified and defined (Table 3), and for each country these seven enabling conditions were categorized as weak, moderate, or strong (Appendix 1 and Table 4). Conditions categorized as "weak" indicate that they are a barrier to EFIS implementation and those categorized as "strong" indicate an enabling condition.

Conditions that enable or create barriers to comprehensive EFIS implementation vary greatly within any given region, thus an equivalent evaluation was not undertaken for RFMOs. In many RFMOs, the market incentive for EFIS is strong but legislation, governance, political support, financial resources, and expertise are highly dependent on state and fishery.

Table 3. Seven key enabling conditions for EFIS implementation and their definitions.

Key Enabling Condition	**Definition**
Comprehensive Legislation	Laws are in place to implement and enforce EFIS.
Governance	The state or RFMO has a fisheries governance framework that will support the voluntary and/or legislated development and implementation of EFIS.
Market Orientation	There is a market driver for electronic traceability via EFIS. In countries or regions where differences exist in EFIS incentives between domestic and export markets, scores are provided for each.
NGO Support	NGO funding and/or technical support has been provided and/or NGOs are successfully advocating for the development of EFIS.
Political Support	The national or local government responsible for fisheries management is supportive of EFIS, indicated by actual or pending policies and/or legislation, funding, and other mechanisms. This is important during development and implementation of EFIS.
Financial Resources	The government and/or fishing industry has the ongoing financial (actual or potential) means to support vessel operators in transitioning and then operating EFIS.
Expertise	EFIS technical expertise is available within the state at sufficient levels to support the developmental and operation of EFIS systems. For RFMOs and other regions, it is noted where available expertise is dependent on the states and the fisheries.

Table 4. Evaluation of conditions that can enable implementation of EFIS for the major countries importing fish and fish products into the EU and US, in alphabetic order by country.

Country	Legislation	Governance	Market Orientation	NGO Support	Political Support	Financial Resources	Expertise
Argentina	Weak	Weak	Weak (domestic) Moderate (export)	Moderate	Moderate	Weak	Weak
Australia	Strong (Commonwealth) Moderate (State)	Strong (Commonwealth) Moderate (State)	Strong	Strong	Strong	Strong	Strong
Canada	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Chile	Weak (artisanal) Moderate (industrial)	Moderate	Weak (artisanal); Moderate (industrial)	Moderate	Moderate	Moderate	Moderate
China	Weak	Weak	Weak (domestic) Moderate (export)	Moderate	Moderate	Weak	Weak
Ecuador	Moderate	Moderate	Weak (artisanal) Moderate (industrial)	Moderate	Moderate	Weak	Weak
Iceland	Strong	Strong	Strong	Strong	Strong	Strong	Strong
India	Weak	Weak	Weak (domestic) Moderate (export)	Moderate	Weak to Moderate	Weak	Weak
Indonesia	Weak	Moderate	Weak (domestic) Strong (export)	Strong	Strong	Weak (domestic) Moderate (export)	Weak
Japan	Weak	Moderate	Weak (domestic) Strong (export)	Moderate	Moderate	Strong	Moderate
Mexico	Weak (artisanal) Moderate (industrial)	Weak	Weak (artisanal) Moderate (industrial)	Moderate	Weak	Weak	Moderate
Morocco	Moderate (domestic); Strong (export)	Moderate	Moderate (domestic) Strong (export)	Moderate	Moderate	Weak	Moderate
New Zealand	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Norway	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Peru	Weak (artisanal) Moderate (industrial)	Weak	Weak (artisanal) Moderate (industrial)	Moderate	Weak	Weak	Moderate
Philippines	Weak (domestic) Strong (export)	Weak (domestic) Strong (export)	Weak (domestic) Strong (export)	Strong	Moderate	Moderate	Weak
Russia	Moderate	Moderate	Weak (domestic) Strong (export)	Moderate	Moderate	Moderate	Moderate
South Korea	Weak (domestic) Moderate (export)	Weak (domestic) Moderate (export)	Weak (domestic) Strong (export)	Moderate	Moderate	Moderate	Moderate
Taiwan	Weak	Moderate	Weak (domestic) Moderate (export)	Moderate	Moderate	Strong	Moderate
Thailand	Weak (domestic) Moderate (export)	Weak (domestic) Moderate (export)	Weak (domestic) Strong (export)	Moderate	Moderate	Moderate	Weak
Vietnam	Weak	Weak	Weak (domestic) Moderate (export)	Moderate	Weak	Moderate	Weak

4 Case Studies-International Trade

4.1 Moving to EFIS interoperability with speed bumps: New Zealand

Across the globe, there has been a profusion of different electronic fisheries information systems with different data collection, transmission and transparency standards. Earlier adopters may find themselves operating legacy systems that are challenging and expensive to retrofit to utilize emerging technologies and meet new data standards. New Zealand found itself in this situation after operating an electronic reporting system for some 15 years. In New Zealand's case, the fisheries sector was large enough and sufficiently integrated to afford the cost of a completely new cloud-based digital interoperable architecture. This architecture allows different providers of electronic services to develop and market compatible applications on a commercial basis. As a cloud-based service based around Application Program Interface (APIs), multiple technology providers can compete to supply electronic services to the seafood sector.

The initiative is called the *Digital Monitoring Project*. This interoperable digital system for tracking, reporting, and monitoring commercial fishing activity is being implemented to provide more accurate and up-to-date information to better inform decision-making by government and the fishing industry. The aims include:

- Maximizing the recreational, customary, commercial, and environmental value of New Zealand's fisheries.
- Giving consumers in New Zealand and from around the world, confidence that fish from their waters are being managed and caught sustainably.
- Allowing Fisheries New Zealand to verify information being reported and to encourage compliance.

Digital monitoring in New Zealand consists of three components:

1. Electronic catch reporting via an e-log book – to give better and more timely information on commercial catch effort.
2. Electronic position reporting – to verify, when used with electronic catch reporting, where and when fishing happened.
3. Electronic monitoring using on-board cameras to verify what is being reported.

Digital catch reporting is required by all holders of commercial fishing permits (or will be by the end of 2019). It has several components:

- Fish catch report: An estimate of the top eight species caught. For trawl, fishers report the top five quota management system (QMS) species and top three non-QMS species. All other methods report the top eight species whether QMS or not. This must be completed within eight hours after fishing.
- Capture of non-fish or protected fish species report: Reports any non-fish and protected species caught for that fishing event and must be provided with the corresponding fish catch report.
- Processing report: For vessels that process their catch on board this must be completed and provided before the close of the day:
    - following the day covered by the report, or
    - on when the processing is finished, if processing catch is done over more than one day.
- Disposal report: Information on all fish not landed. A disposal report is required for each fishing event where fish are disposed unless the vessel is submitting processing reports. In this case they submit a disposal report covering the same period as the processing report.
- Landing report: A detailed inventory of catch when landed. This is updated when confirmed green weights are received from the licensed fish receiver.

Geospatial position reporting is required by any fishing permit holder required to file a digital catch report. Effectively, this means that every commercial fishing vessel operating in New Zealand will be required to have geospatial tracking system on-board.

The implementation of comprehensive electronic monitoring using cameras, although provided for in fishing regulations passed in 2017 and initially due to commence in October 2018. The New Zealand Government, after pushback from the fishing industry, is now postponing rollout until there is confirmation that the "regulations are practical to implement, the technology is operationally ready to go, the systems are in place, and the fisheries management framework is clearly understood" (Hon. Stuart Nash, New Zealand Minister for Fisheries 2018). The debate and contention around electronic monitoring demonstrates that achieving the "trifecta" of electronic technologies is challenging and is as much a political issue as it is an economic or ecological issue. NGOs in New Zealand are actively campaigning for electronic monitoring regulations to be implemented according to the original schedule. New Zealand now has regulations in place for EM to be implemented for all commercial fishing vessels from late 2019; and the Minister of Fisheries has committed to consulting on options for how and when cameras might be introduced across the commercial fishing fleet.

The New Zealand Animal Products Electronic-certificate (E-cert) platform has been in place since 2001. E-cert is the web application the Ministry of Primary Industry uses to issue official export certificates for food products that are exported from New Zealand. It is mandatory to use E-cert for some countries, and strongly recommended for all others. E-cert tracks products from the time they're produced until they're exported. The information on an export certificate varies, depending on the product or commodity and the destination country, but it may include (https://www.mpi.govt.nz/exporting/food/seafood/steps-to-exporting/):

- The country of origin of the product and origin of any additional ingredients.
- Treatment or other processes the product has undergone, prior to export.
- The microbiological status of the product.
- The product's health status – for example, whether or not a certain animal or plant disease is present in New Zealand.
- Meet labelling requirements (including approved names) for export fish.

E-Cert has enabled New Zealand expertise to efficiently meet the import requirements of multiple countries, although there do not appear to be any systematic reviews of its performance. E-cert is not formally part of the fisheries Digital Monitoring project, however digital information from the project is able to be used in the E-cert program. This is a consistent pattern in EFIS around the world. Electronic vessel tracking, catch reporting and catch monitoring are managed separately from electronic traceability systems and interoperability plays a crucial role in whether the electronic data can be transferred between systems.

4.2 Fijian longline caught tuna and blockchain: Charting a course in a sea of opportunity[3]

Blockchain is an emerging technology being trialed in fisheries supply chains to improve traceability as it is a digital ledger that is distributed, decentralized, verifiable and irreversible and can be used to record transactions of value. One example blockchain trial is a WWF-led pilot to demonstrate a blockchain supply chain traceability system for tuna caught in a Fijian longline fishery. The goal of the project was to create a transparent and traceable supply chain, utilizing blockchain technology for the fresh and frozen tuna supply chain.

The blockchain trial faced several key challenges including:

- Paper-based traceability still dominates. Much of the longline fishery in the Pacific remains heavily reliant on paper-based processes in both Government agencies, like Fiji's Ministry of Fisheries, and in

[3] Adapted with permission from Cook, A. 2018 Blockchain: Transforming the Seafood Supply Chain. https://dj8xp7a0ejkvv.cloudfront.net/downloads/draft_blockchain_report_1_4_1.pdf

fishing companies. Digital traceability platforms must be developed in order to capture the KDEs necessary for traceability.

- Limited availability of local technology suppliers and technicians. The trial began with FRID technology that was not locally available and when imported there was no local knowledge available to install and operate the system. Alternatives such as QRF codes were later used due to the inability to use RFID technology effectively.
- Limited knowledge of the value. Many fishing companies do not know what happens to their product after it is purchased by an international buyer. This makes mapping the value chain, a necessary part of creating a blockchain, challenging. Vertically integrated companies that have control of their entire supply chain are likely able to implement block technology more effectively than others.
- Non-cooperation of supply chain participants. Without agreement among all supply chain participants to maintain traceability, and without incentives to engage in the process, it is difficult to have full traceability and a complete boat-to-plate blockchain.
- Data authenticity. A blockchain can only record the data provided to it. In the absence of electronic catch reporting and vessel tracking, and interoperability with these data systems, WWF New Zealand is challenged to verify the authenticity of data being recorded at each stage of the supply chain. Mass balance and DNA-based verification methods can be used to trace fish after landing. The permanence of the blockchain allows real-time auditing of a historic record that could help identify patterns of ongoing fraud.

Phase II of the project is underway expanding into a tuna export market (Phase I did not involve export markets) to further prove the viability of the technology. New project partners include a large regional bank, an additional seafood processor, a regional distributor, and a major retail outlet. Phase II will include automatic payments into the tuna supply chain using smart contracts.

The Fijian Tuna trial helps demonstrate the potential for blockchain in fisheries in developing countries. Yet challenges common to all EFIS exist and these will be an impediment to blockchain-like traceability specifically, and EFIS generally, in many fisheries around the world. Progress is likely to be rapid in fisheries vertically integrated with global supply chains .

4.3 iFIMS: An interoperable electronic highway for PNA tuna data

The Parties to the Narau Agreement (PNA) is a sub-regional partnership between eight Pacific Island Countries[4] creating a management system capable of conserving tuna resources and securing the flow of net economic benefits from the purse seine, and potentially the longline fishery, on a sustainable basis. It creates a common rights-based management system by setting and allocating allowable effort in both the purse seine and longline fisheries. PNA members agree on a limited number of fishing days for the year, based on scientific advice. Fishing days are then allocated to PNA countries and sold to distant water fishing fleets.

The PNA Office has managed its purse seine fishery using the Integrated Fisheries Information Management System (iFIMS) since 2013. IFIMS provides near real time cloud-based recording and transmission of fisheries information. IFIMs consists of 16 digital modules including:

- Electronic vessel tracking and position reporting.
- Electronic reporting and electronic logbooks.
- Fishery observer management and reporting. This manages both information about observers and also allows observers to feed catch data into iFIMS from electronic tablets
- Electronic catch documentation and electronic port monitoring & reporting. This provides automated cross verification of catch and landings data, allowing a flag state to authorize Catch Certificates, and coastal states to monitor vessel compliance.

[4] The Parties to the Nauru Agreement (PNA) are the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu. Tokelau also participates in the VDS

- Audit and traceability modules support compliance in meeting chain of custody and traceability requirements for international markets. This includes the Marine Stewardship Council (MSC) traceability requirements for MSC certified purse seine skipjack tuna.

In December 2018, the Government of Papua New Guinea purchased iFIMS from the developer for use by the PNA. IFIMs is very likely the first EFIS platform that integrates fisheries management, compliance and marketing across multiple EEZs. It provides interoperable support for coastal state, flag State and port state responsibilities associated with monitoring control and surveillance, fisheries science, and traceability requirements of importing countries. Currently the PNA implements iFIMS only for purse seiners and tracking fish aggregating devices. The PNA intends to expand iFIMS to include longline, carrier and bunker (refueling) vessels in the future. PNA success with iFIMS has promoted the expansion of interoperable EFIS to other regions managed by the Forum Fisheries Agency, and the Western and Central Pacific Fisheries Commission is exploring ways of introducing an RFMO-wide EFIS that draws on key elements of iFIMS.

4.4 Indonesia's increasing embrace of EFIS

Indonesia is the world's fourth most populous country and is home to the second highest number of people dependent on aquatic resources to support their livelihoods. In 2016, Indonesia was the world's second highest producer of wild-capture fish, shellfish, and aquatic plants by volume and approximately 95% of this production comes from artisanal fishermen based in communities spread throughout the vast archipelago. Over 2.6 million people are engaged in capture fishing and there are over 800,000 vessels in operation of which around 560,000 are motorized. Illegal, Unreported, and Unregulated (IUU) fishing has been a significant problem in Indonesia with many vessels, both foreign and domestic, contributing to the problem.

Since 2015, the USAID Oceans program has worked in partnership with the Indonesia Ministry of Marine Affairs and a network of Indonesian local government, private sector, and non-governmental partners to develop and implement an electronic catch documentation and traceability system in Indonesia (SEAFDEC, "The Ocean and Fisheries Partnership"). The electronic traceability system is designed to provide for full traceability, with the aim to improve fisheries management, human welfare, and support international fisheries trade. One innovative aspect of the program is the recognition that at-sea data entry may not be suitable or cost effective for small scale fisheries. As an alternative, the project supported development of an android-based application to be used by small scale fish buyers and brokers at first point of sale. Pilots have been undertaken in Bitung, targeting small to large-scale vessels at various points in the supply chain including harvest, landing, processing, and sale. In 2016 a six month blockchain trial was undertaken for tracing yellowfin and skipjack in Indonesia via digitized mobile data collection at harvest through mobile access of information for consumers. Internally the Ministry of Marine Affairs is working to promote interoperability between 12 different fisheries and seafood related data bases and systems.

In other EFIS-related initiatives, the Indonesian Government has undertaken to implement electronic fishing logbooks to domestic fishing vessels authorized to operate in the country`s 11 fisheries management areas and on the high Seas. The International Pole & Line Foundation, in partnership with a UK company Provenance, piloted a blockchain project for tracing Indonesian yellowfin and skipjack tuna from harvest to final point of sale, though this does not appear to be intended as a commercially viable initiative at this time (Provenance, 2016).

In Indonesia there are a number of factors and players driving EFIS development. As the world's second largest producer of wild caught seafood, international markets and their demand for traceability, sustainability, and transparency are a key influence. A number of independent EFIS initiatives are responding to this demand. Interoperability between independently developed systems will be a major future challenge. The relationship between fishery-driven initiatives and Indonesian government initiatives is unclear and there does not appear to be any overarching roadmap to provide guidance. Given the large number of fishers and fisheries, it also clear that economic benefits must flow from international markets to

the fishers and coastal communities if the benefits of EFIS are realized at the local level and not just by exporters and importers in value chains.

5 Global Lessons from the Review of Electronic Fishery Information Systems

This review has demonstrated that fisheries are only slowly developing EFIS systems and rarely in an integrated and comprehensive way that promotes interoperability. Although efficiency is often cited as a reason to adopt these systems, upfront and fixed costs for these systems can be high and the benefits may accrue slowly over time. There are also other reasons for their relatively slow adoption including:

- Many propriety systems: A proliferation of proprietary EFIS constrains development of global interoperability and development of common standards, protocols, specifications, and guidelines.
- Different purposes: EFIS evolved from different starting places. Some sub-systems were targeted at seafood traceability along seafood supply chains, some at fishery compliance, and others for fisheries regulations, and others for gathering data for management and scientific research. Often, there has been little consideration for all possible uses of the electronic data, how it should be collected, and the way it should be formatted and disseminated to promote wide scale use.
- Different dates of development: EFIS subsystems developed at different times using different hardware and software and associated standards. Limitations in data storage and processing capability often constrained developers of earlier systems. Many earlier systems eventually become dated and cannot take advantage of new software and integration with other programs, modules, and systems.
- Different scales: EFIS are usually developed for specific fisheries or corporate supply chains and less often as comprehensive national systems and rarely as international systems. This often translates to higher user costs.
- Fit for purpose: Developing and implementing comprehensive EFIS is not a goal of most fisheries management agencies. Many countries are challenged to implement basic paper-based observer, logbook and traceability systems, let alone electronic ones. In some cases, especially for RFMOs, current non-electronic systems are seen as adequate for meeting the reporting obligations of RFMO members and cooperating states to RFMO secretariats.
- Diversity of fisheries: EFIS, regardless of the purpose and scale, often have to deal with an extraordinary diversity of species, fleets, gear, participants, and markets with varying degrees of market integration, technological expertise and resources.
- Complexity and secrecy in seafood industry supply chains: Complexity and secrecy hinder the design of a data architecture suited to enabling global interoperable EFIS. Trust is often lacking and secrecy is often high in a globally competitive market place where almost every seafood product has a substitute – whether wild or farmed.

Many of these issues are particular true for ETr technology. Interoperability with other EFIS systems as well as resource enterprise planning systems of private companies (ERPs) has proven to be a major constraint in the voluntary adoption of traceability. This is due in part to technical challenges in developing coordinated, efficient, and interoperable systems, as well as the challenges of establishing an enabling environment, transparent incentives, and the ability to quantify benefits to managers and businesses (Bhatt et al, 2017; Sterling et al, 2015; FishWise, 2018). The need for interoperable e-systems for traceability is not unique to the seafood sector and it is valuable to look to sectors with experience in developing successful traceability systems. Bhatt and co-authors (2017) evaluated industry sectors that have made major investments in traceability including automotive, banking, pharmaceutical and food produce. They found that in order to enable more effective interoperable traceability there is a need for strong governance, standardized policies and procedures, alignment of principles, and creation of foundational agreements between supply chain

partners, industry, and regulatory agencies. Many of these lessons are applicable to the seafood sector; however, seafood faces unique challenges due to the inherent diversity, scale, and complexity of the industry (Hardt et al, 2017; Bhatt et al 2017).

5.1 Barriers, Costs, Incentives and Enabling Conditions

To improve the development and adoption of EFIS there needs to be a fundamental understanding of barriers, benefits, costs, and incentives associated with EFIS development and implementation around the globe.

Barriers

There are many challenges associated with establishing a framework and conditions under which EFIS can be successfully implemented in the global fishery market. While technology limitations exist, the barriers that are harder to overcome include:

- Market relationships that are built on short term contracts and handshakes and resistant to transition to an e-system that raises major questions regarding transparency, confidentiality, and data privacy;
- A lack of international consistency in policies and regulations, and enforcement of already existing policies (Sterling et al, 2015; Michelin et al, 2018);
- An absence of data recording and reporting standards, mechanisms for widely sharing data, and interoperability of data systems (Banks et al, 2016; Hosch and Blaha, 2017);
- A lack of funds and human capacity to collect, track, transmit, and manage data, as well as disagreement on who should be responsible for costs (Michelin et al, 2018; Banks et al, 2016).

The barriers are even more severe in developing countries where fundamental "enabling" conditions are rudimentary or non-existent including efficient communication and transportation systems, responsible governance and management systems, enforceable property rights, and quality education systems. An underlying issue that has held back the development and adoption of EFIS is that incentives to overcome the many barriers and drive investment in EFIS are not obvious – this is particularly true from an industry perspective (Sterling et al, 2016; Banks et al, 2016). To establish an environment that is truly enabling for wide adoption of EFIS requires creating, spurring, and aligning incentives for managers, industry, and value chains alike. It requires each player in the seafood system to ask and answer the following question: "what is the value proposition?"

Benefits

The need and demand for "fast, reliable, and innovative systems for collecting, storing, communicating, and sharing fisheries data" has increased (Banks et al, 2016). Comprehensive ET, EM, ER, and ETr technologies have been developed and employed in many fisheries, and e-systems are moving towards integrated EFIS. Benefits of integrated EFIS include improved compliance and reporting, improved fisheries sustainability, improved quality in stock assessment, improved traceability and catch quality, and improved industry profitability. In many fisheries, it is logistically more feasible, cost effective, and safer to use electronic monitoring and reporting to collect catch and bycatch data; while in others it is more challenging (NOAA Fisheries, "Electronic Monitoring"; Sylvia et al, 2017).

Many companies that have traditionally used internal computerized ERP systems (Enterprise Resource Planning) to track purchases, production, inventory, and sales are willing to integrate third-party traceability software when it improves profitability or efficiencies (Lewis et al, 2017). A major challenge, however, is determining how to efficiently integrate the firm's internal tracking systems with traceability systems acting across different supply chains (Gooch et al, 2017).

Costs

There are a variety of costs in establishing and managing EFIS systems. These costs need to be thoroughly understood in order to develop cost-effective, profitable, and successful systems. For example, research by Sylvia and co-authors (2017), compared electronic monitoring with human observers to develop financial scenarios describing when electronic monitoring costs are lower (or higher) than using human observers. For example, because of the high fixed costs associated with electronic monitoring, they found that when observing is frequently required on fishing trips, electronic monitor is less expensive than using human observers.

Another form of cost is associated with supply chain relationships. Without agreement among all supply chain participants to maintain traceability and without incentives to engage in the process it is difficult to have full traceability and a complete boat-to-plate traceability system. Many fishing companies do not know what happens to their product after it is purchased by an international buyer. This makes mapping the value chain and working with all value chain members difficult. Vertically integrated companies that have control of their entire supply chain are likely able to implement traceability more effectively than other companies.

And sometimes there are political costs. For example, as the case study illustrated, The New Zealand Government, after pushback from the fishing industry, is now postponing the redesigned EFIS rollout until there is conformation that the "regulations are practical to implement, the technology is operationally ready to go, the systems are in place, and the fisheries management framework is clearly understood" (Hon. Stuart Nash, New Zealand Minister for Fisheries 2018). The debate and contention around electronic monitoring demonstrates that achieving the "trifecta" of electronic technologies is challenging and is as much a political issue as it is an economic or ecological issue.

Incentives

Incentives can operate at both the public sector level and private sector level. At the public sector level, the most powerful incentive is through law and regulation. For example, prohibiting vessels and seafood companies from fishing, selling, or exporting if they do not use electronic means to support EFIS subsystems. Some of those examples are illustrated in Appendix 1 and the Case Studies. For example, with the newly introduced SIMPs regulation in the U.S, seafood companies will not be allowed to export certain species if they do not provide selected KDE traceability information. In most cases, however, governments and RFMO's do not require electronic systems for FIS subsystems but sometimes will accommodate electronic systems and information generated from these systems (especially EM and ER). Governments can also incentivize adoption of EFIS through subsidy, additional fishing privileges such as experimental fishing permits, adoption of common standards across fisheries, regions and nations, education and training, and support for interoperability if they manage key parts of the EFIS subsystems (e.g., electronic logbooks or fish tickets).

In the private sector, incentives work if they improve business success – this often translates into improving profitability (or at least maintaining it) and reducing risk or achieving other core values – what is called "the value proposition." Depending on the firm and seafood industry sector, profitability may be in the immediate term or long term. Because costs to transition to EFIS systems are often upfront but benefits and profits may be longer term, there may be great reluctance to transition to EFIS unless the benefits are transparent and outweigh the costs including finance costs. This means that costs and benefits must be understood and quantified, even though they may be diverse and multidimensional. For example, could electronic logbooks help a fishing firm with financial analysis and planning? Could logbooks data be valuable in research, management, and stock assessment? Could analyzing logbook data help improve harvest strategies including for example, avoiding bycatch or choke species? Are there ways to reduce costs of financing? While this is true for ER it is also true for ETr. The research by the GFTC has demonstrated that the potential benefits of electronic traceability may be significant and multidimensional for all players in the value chain if they understand what information they need, how to use the information (and databases), and quantify its benefits.

6 Summary of Key Issues, Findings, and Recommendations

The following section summarizes and concludes by highlighting key issues and findings and developing recommendation consistent with the project goals of understanding the state of EFIS in world fisheries.

6.1 Key Issues and Findings

Drivers of Electronic Fisheries Information Systems
Seafood including wild capture fisheries and aquaculture are facing an increase in regulatory and market demands for authenticity, transparency and accountability. They are also facing greater demand for seafood information that is conveniently and securely available to regulators, supply chain participants and consumers in real time. Key drivers include:

- Combating IUU fishing: Increased public attention has been drawn to IUU fishing and slave labor on fishing vessels, in part spurred by outreach and education campaigns by NGOs, elevating the call for traceability in the seafood supply chain (Michelin et al, 2018; FishWise, 2018). This is being addressed through a number of avenues including FAO Port State Measures Agreement, US Seafood Import Monitoring Program and EU Catch Certificate Scheme.
- Food safety: Human health and food safety have driven traceability for food commodities for decades. The need for traceable systems in the seafood sector has been highlighted by foodborne illness concerns including the US CDC finding that fish are the most commonly implicated food category for foodborne illness in the US, led by scombroid poisoning and followed by ciguatoxin (Dewey-Mattia, 2018).
- Seafood fraud and mislabeling: Multiple studies (with varying degrees of scientific rigor) suggest that there is significant mislabeling of seafood (by species) somewhere between 15% to over 80% depending on species and markets.
- Monitoring control and surveillance: Regulatory authorities are turning to electronic fisheries information systems to provide fisheries managers and regulators with an increasing range of biological and compliance information that is more comprehensive, cost effective, secure, and timely.
- Corporate social and environmental responsibility: Companies including major food retailers, have made commitments to source responsibly and legally caught seafood and rely on electronic fisheries information systems to verify the provenance of the product.

These drivers are putting increasing pressure on fisheries and seafood supply chains to develop EFIS that allow for the accurate and verifiable collection of fisheries data and the sharing of subsets of that data with managers, fishermen, processors, markets, and consumers.

The Status of Global Electronic Fisheries Information Systems
Fully interoperable and integrated EFIS systems have been slow to develop in the seafood sector. Electronic system components have been developed for many different purposes and with little coordination across fisheries or along seafood supply chain. This has resulted in different data collection, transmission, and transparency methods and standards. This situation has many contributing causes, and barriers must be addressed to advance interoperable EFIS systems and encourage wide-scale adoption. These include: 1) interoperability challenges due to the proliferation of proprietary EFIS that were developed at different points in time, for different purposes, and for different sectors of the fishery supply chain; 2) varying data needs to account for the diversity of species, gear, participants, and markets; 3) major disparities in the use of systems, even within a given supply chain, and misaligned or missing data and inconsistent regulatory standards; and, 4) a resistance by industry to voluntarily adopt EFIS due to concerns about confidentiality, intellectual property, and costs – this is particularly true when need, incentives, costs, and benefits have not been clearly analyzed and communicated.

A major consequence of these influences is an abundance of EFIS with different data collection, transmission and transparency standards. Existing EFIS are often operating legacy systems that are challenging and expensive to retrofit to utilize emerging technologies and meet new data standards. Limited and expensive expertise in data management systems is another constraint facing the upgrade of older systems even if they seek integration with new cloud-based big data-oriented EFIS.

Emerging Trends and Opportunities

- Critical Tracking Events and Key Data Elements: The use of CTEs and KDEs can help structure electronic fisheries information systems and are increasingly accepted as the foundation of product traceability in seafood supply chains. More broadly, CTEs and KDEs can be used to harmonize approaches to electronic fisheries information systems globally. For example, the South Pacific Regional Fisheries Management Organization lists comprehensive standards for the collection, reporting, verification and exchange of data for trawling, purse seining, longlining, potting and squid jigging that would form the foundation for an integrated, interoperable EFIS if the RFMO wished to move beyond paper-based systems. The US SIMP requires a simple set of key data elements, including what, when, and where, for each harvesting event. Though neither system requires electronic submission at the moment, the lists of key data elements have much in common and are a start for a shared vocabulary for use in electronic information systems.
- Software Platforms and Interoperability: The principle of interoperability is key to the future of electronic fisheries information systems. To be fully interoperable, electronic fisheries information systems must be able share data formats and must interpret information based on common definitions. Interoperable systems have been slow to be developed and adopted in the seafood sector, resulting from a lack of understanding of what interoperability is, poorly demonstrated incentives, costs, and resource requirements, and technical challenges. Established standards are critical for interoperability and while electronic data standards exist, they have yet to be broadly adopted by the seafood sector. Interoperable data systems tailored for the seafood sector are evolving and improving as a result of the many initiatives underway through efforts led by industry, retailers, civil society organizations, public-private partnerships and precompetitive collaborations.
- Blockchain Type Digital Ledgers: As a digital platform, blockchain and related technologies do not replace electronic fisheries information systems. It is an example of a data technology that electronic fisheries information systems can use to create authenticity, transparency and accountability and for this information to be conveniently and securely available to regulators, supply chain participants and consumers in real time. As noted in the report and the case studies, there are many examples of blockchain being trialed in fisheries supply chains and in the next few years we should see the first operational commercial blockchain systems in use in fisheries.
- Continuing Dialogue on Seafood Traceability: The Global Dialogue on Seafood Traceability is a significant business to business (B2B) effort to clarify traceability roles and responsibilities and develop standards and definitions that advance ETr systems. B2B and other efforts should be supported for the advancement of efficient, interoperable, and standardized traceability systems.

These drivers are putting increasing pressure on fisheries and seafood supply chains to develop EFIS that allow for the accurate and verifiable collection of fisheries data and the sharing of subsets of that data between managers, fishermen, processors, markets, and consumers.

6.2 Recommendations

Recommendation 1: Adopt and promote the concept of integrated "EFSIS" (Electronic Fishery and Seafood Information Systems)

EFIS (Electronic Fishery Information System) describes systems currently used by most fisheries management organizations and bodies using ET, EM, and ER. The focus is primarily on coordinating and

managing the fishery (including eliminating IUU fishing) as compared to supporting the broader seafood system.

Recommendation 2: Support a Global Dialogue, Forums, and Trainings on EFSISs
The Global Dialogue on Seafood Traceability and companion projects are major international effort to clarify traceability roles and responsibilities and develop standards, definitions, and trainings that advance ETr systems. The concept of a "global dialogue" could also be a strategy for advancing EFSIS and addressing the types of fundamental challenges described in this report.

Recommendation 3: Develop Creative Financing and Cost Reduction Strategies
As emphasized in this report, investment, financing, and support and management costs are critical for advancing EFSIS. Smaller companies are particularly disadvantaged given high fixed costs and larger marginal costs in purchasing hardware and software and managing electronic systems. Interoperability is one contributing factor since some companies are forced to run parallel information systems including paper and electronic. Economies and geographies of scale are also critical given the enormous disparity in size, operations, and enabling conditions of fishing and seafood firms around the globe.

Recommendation 4: Enabling, Supporting, and Spotlighting EFSIS Collaborative Value Chain Projects
Work by the Global Food Traceability Center demonstrated that firms participating in collaborative chains place a much higher value on the quantity and diversity of benefits derived from traceability information compared to supply chains that have weak relationships and limited cooperation.

Appendix 1 – EFIS Status by Country

Appendix 1 provides supporting information for Table 1, summarizing the status of electronic vessel tracking, monitoring, reporting, and traceability for the major countries exporting fish and fish products to the EU and US. For each country, key conditions that help facilitate successful implementation of EFIS are categorized as weak, moderate, or strong (see Table 3 for definitions of key enabling conditions). Additionally, the outlook for comprehensive EFIS implementation over the next five to ten years is provided for each country using the following scale: poor, moderate, good, or very good. Where differences in outlook exist between domestic and import (or artisanal and industrial) fisheries and markets, ranks are provided for each.

All country summaries were sent for external review, with the majority reviewed by WWF personnel who have EFIS expertise for the country reviewed.

Oceania

Australia
The Australian Fisheries Management Authority (AFMA), the statutory authority responsible for the management of Commonwealth fishery resources within the Australian Fishing zone, manages Australian vessels fishing on the high seas and in some cases fisheries by agreement with states and territories. States and territories are responsible for management of Coastal and Inland waters (water between the limits of the Australian States and the Northern Territory and a line three miles seaward of the territorial sea baseline). Strong fisheries legislation is in place to support AFMA with compliance for domestic fishery programs, including ET and EM requirements for Commonwealth fisheries and an ER requirement that was recently initiated. A fully integrated and interoperable EFIS system is not yet in place.

EFIS Status
ET: AFMA has been utilizing VMS technology since 1993, with VMS now required for all Commonwealth vessels prescribed under legislated Fisheries Management Plans. Approximately 500 Commonwealth vessels licensed in various fisheries (eg, Eastern Tuna and Billfish - ETBF, Western Tuna and Billfish - WTBF, Western Deepwater Trawl) are monitored by VMS, and over the next five years it is anticipated to increase to a total of 800 vessels monitored.[5]

Additionally, several Australian state agencies maintain their own VMS programs, including South Australia, Queensland, Tasmania, and Western Australia. For example, VMS is currently a requirement for trawl, net, line and crab pot boats in Queensland, with commercial fishing vessels required to have VMS from 2020.[6]

EM: EM was first trialed in Australia in 2005, and in 2015 EM systems were adopted and are now required for most commercial vessels in the ETBF, WTBF, and the Gillnet Hook and Trap fishery, with 75 vessels having EM systems installed. [7] Adoption was primarily driven by compliance concerns, such as sea lion interactions in the gillnet fishery. EM is now being trailed on trawlers in the Southern and Eastern Scalefish and Shark fishery and the Small Pelagic fishery.[8] Additionally, Queensland fisheries are undertaking proof

[5] FAO, "VMS Worldwide programmes", http://www.fao.org/fishery/topic/18072/en
[6] Pers comm, Simon Miller, May 2019
[7] Michelin et al, 2018; AFMA, "Electronic monitoring program", https://www.afma.gov.au/monitoring-enforcement/electronic-monitoring-program
[8] Pers comm, Erik Raudzens, May 2019

of concept trials for integrated EM and ER, scheduled to be complete by December 2019. The current proposal is for a gradual rollout of EM from 2020, with a priority for use in high risk fisheries.[9]

ER: Some Australian vessels have used electronic logbooks to report catch and effort data to AFMA since 2011[10], and in 2017 AFMA initiated a program to increase the use of digital reporting. The program, being rolled out in 2018 and 2019, requires reporting using an approved electronic logbook program for the Commonwealth Trawl Sector, Gillnet Hook and Trap Sector, ETBF, WTBF, and for other Commonwealth Fisheries.[11] This requirement will apply to all boats that have fished 50 days or more in the current or previous fishing season or those that have an electronic monitoring system installed; and 30 days or more for the ETBF and WTBF Fisheries.

In addition to the Queensland EM and ER trails noted above, New South Wales has implemented a staged rollout of ER via mobile app for all quota (catch or effort) managed fisheries, commencing in December 2017. The reporting includes a pre-fish notification, pre-land estimated weight report, landing location and post-land weight report, used for real time quota deduction and compliance.[12]

ETr: Australia has agricultural traceability systems that have been in place, and as part of their export certification process over 70% of agriculture and fishery exports are certified. Further, seafood traceability standards are in place and it is mandatory to maintain one up, one down traceability records[13]; however, there does not appear to be a requirement for full electronic traceability. The government has undertaken a National Traceability Project to evaluate if current agriculture traceability needs are being met and they determined that they need to invest in more advanced IT systems to meet increasing information requirements by trade partners and that there is room for improvement in seafood traceability.[14]

Key Enablers

Comprehensive Legislation	Strong (Commonwealth); Moderate (State)
Governance	Strong (Commonwealth); Moderate (State)
Market Orientation	Strong
NGO Support	Strong
Political Support	Strong
Financial Resources	Strong
Expertise	Strong

Five- to Ten-Year Outlook for Comprehensive EFIS: Very good for commonwealth fisheries; moderate for state fisheries

New Zealand

New Zealand initiated the Digital Monitoring Project that includes electronic tracking, monitoring, and reporting of commercial fishing efforts to be implemented in a phased approach.[15] The Minister of

[9] Pers comm, Simon Miller, May 2019
[10] OECD, 2017
[11] AFMA, "Logbooks", https://www.afma.gov.au/fisheries-services/logbooks
[12] NSW Government, "FisherMobile", https://www.dpi.nsw.gov.au/fishing/commercial/fishonline/fishermobile
[13] FishWise, 2018
[14] Australian Government Department of Agriculture, 2018, "National Traceability Project", http://www.agriculture.gov.au/market-access-trade/traceability-project/report
[15] Fisheries New Zealand, "Digital monitoring resources", https://www.fisheries.govt.nz/protection-and-response/sustainable-fisheries/strengthening-fisheries-management/fisheries-change-programme/digital-monitoring-resources/#regulations

Fisheries has committed to consulting on options for how and when cameras might be introduced across the commercial fishing fleet. This interoperable digital system is being implemented to provide accurate and up-to-date information to better inform decision-making by government and the fishing industry.

EFIS Status
ET: New Zealand is requiring electronic position reporting for all commercial vessels in a phased approach that began January 2019 and is to be completed in December 2019. Vessels over 28 meters in length have been reporting electronically since October 2017.

EM: New Zealand has regulations in place for EM to be implemented for all commercial fishing vessels from late 2019. The Minister of Fisheries has committed to consulting on options for how and when cameras might be introduced across the commercial fishing fleet.

ER: New Zealand is requiring electronic catch reporting for all vessels by December 2019, with vessels over 28 meters in length already reporting electronically. Vessels can apply for a short-term exemption if reporting technologies are not available for their fishing operations.

ETr: The New Zealand Animal Products E-cert (AP E-cert) platform has been in place since 2001; and the new Digital Monitoring Project currently being implemented for all commercial vessels is an integrated and interoperable ET, EM, and ER system that enables electronic traceability beginning at harvest.

Key Enablers

Comprehensive Legislation	Strong
Governance	Strong
Market Orientation	Strong
NGO Support	Strong
Political Support	Strong
Financial Resources	Strong
Expertise	Strong

Five- to Ten-Year Outlook for Comprehensive EFIS: Very good

North America

Canada
Canada exported $6.9 billion in fish and seafood products to 139 countries in 2018.[16] Fisheries and Oceans Canada (DFO), the federal lead responsible for managing Canada's fisheries, strictly regulates products to ensure safety and sustainability. Although Canada was an early developer and adopter of EM and has more recently initiated ER requirements, it lacks fully integrated and interoperable EFIS.

EFIS Status
ET: DFO has a national VMS requiring many Canadian fishing vessels to be equipped with VMS including various scallop, pelagic, crab, groundfish, and shrimp fleets.[17] The data are received in near real time and stored in a centralized database.

[16] Fisheries and Oceans Canada, "Fisheries Programs and Initiatives", http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/index-eng.htm
[17] Fisheries and Oceans Canada, "National Vessel Monitoring System", http://www.nfl.dfo-mpo.gc.ca/e0010178

EM: The first EM programs were piloted and implemented in Canada, with the British Columbia hook-and-line and crab fisheries implemented about twenty years ago.[18] One-hundred percent of the BC hook-and-line and trap groundfish fisheries are monitored using EM technology, with about 200 vessels fully monitored in 2013.[19] EM was more recently explored for the New Brunswick snow crab fishery to address issues with right whale entanglements.[20]

ER: DFO is rolling out an electronic logbook system (ELOG) with a goal of mandating its use by most commercial fisheries. Phase 1 of the plan began in 2018 where they made ELOG available to fish harvesters, and Phase 2 was set to begin in 2019 where ELOG will be available to harvesters and service providers.[21]

ETr: Canada created a Catch Certification Program in response to EU IUU regulations in 2010, implemented by the Canadian Catch Certification Audit Office.[22] The Canadian Food and Inspection Agency verifies industry compliance with food inspection requirements and it released a new Safe Foods for Canadian Regulations (SFCR) in June 2018; however it lacks full traceability.[23]

Key Enablers

Comprehensive Legislation	Strong
Governance	Strong
Market Orientation	Strong
NGO Support	Strong
Political Support	Strong
Financial Resources	Strong
Expertise	Strong

Five- to Ten-Year Outlook for Comprehensive EFIS: Good

Europe

Iceland

The Iceland Directorate of Fisheries (DOF) is responsible for fisheries management and monitoring in Iceland, and works closely with the Ministry of Fisheries towards sustainable and efficient fish harvest. In this role, the DOF collects and processes large volumes of data on vessels and catch, and ensures data access to the Icelandic public, authorities, and interested parties through the Directorate database.[24] To this end, DOF maintains a highly dynamic and interactive website where interested parties can monitor the precise quota status of each species, and examine the performance of individual vessels, their catches, quota status, transfer of allocated catches and other information regarding fishing vessels, their owners and related fishery companies. This information is posted on the DOF website and updated every six hours.

[18] Michelin et al, 2018
[19] Blondin, 2018; Course, 2015
[20] Michelin et al, 2018
[21] Fisheries and Oceans Canada, 2017; Nova, "What you need to know about electronic logging…", https://solutions.novacommunications.com/2018/07/25/what-you-need-to-know-about-electronic-logging-for-commercial-fisheries/
[22] Fisheries and Oceans Canada, 2016, "Catch Certification Program", http://www.dfo-mpo.gc.ca/fm-gp/ccp-pcc/export/catch-program-captures-eng.html
[23] Oceana, 2018, "CFIA's new food regulations miss the boat…", https://oceana.ca/en/press-center/press-releases/cfias-new-food-regulations-miss-boat-seafood-traceability-oceana-canada
[24] Iceland Directorate of Fisheries, http://www.fiskistofa.is/media/utgefid_efni/DOF.pdf

EFIS Status

ET: All Icelandic vessels are required to have ET, with about 1,608 vessels equipped with VMS.[25] Iceland has two tracking systems – one for safety that is mandatory for all vessels and one for fisheries control that is required for some fisheries and areas. VMS is operated by the Icelandic Coast Guard, with data housed in their communication center and accessible to the DOF. Equipment costs are the responsibility of the vessel owner, and communication costs are covered by authorities.

EM: The Iceland Ministry of Industries and Innovation proposed a bill that would increase fisheries monitoring through camera systems and drones, but this bill faced industry opposition.[26] The current status of the regulation is unknown.

ER: The Icelandic DOF mandated the use of an e-logbook system and a large proportion of the fishing fleet delivers its log book entries electronically; the aim is to extend this practice further in the near future.[27]

ETr: The Icelandic Government established Traceability and Fish Guidelines specifying a numbering system for tracking products, bar coding for traceability, and provides a unique identification and physical labelling of fish products using Global Trade Item Number (GTIN) as well as other key standards.[28] Some industry traceability initiatives have been undertaken, offering consumers in the US fully traceable Icelandic seafood.[29]

Key Enablers

Comprehensive Legislation	Strong
Governance	Strong
Market Orientation	Strong
NGO Support	Strong
Political Support	Strong
Financial Resources	Strong
Expertise	Strong

Five- to Ten-Year Outlook for Comprehensive EFIS: Very good

Norway

Norway's Ministry of Trade, Industry, and Fisheries is responsible for the health and welfare of fish, and the Directorate of Fisheries (DOF) serves as its advisory and executive body for aquaculture and fisheries.[30] Electronic vessel tracking and catch reporting are required and enforced, with data centrally stored by the DOF Fisheries Monitoring Center (FMC), responsible for monitoring and surveillance, processing reporting schemes, and it serves as the hub for combatting IUU.[31]

ET: Vessels 15 meters or greater in length (12 meters or greater for the Skagerrak area) are required to be equipped with VMS.

[25] FAO, "Iceland – VMS programme", http://www.fao.org/fishery/topic/18085/en
[26] Iceland Monitor, 2018, "Fearing unprecedented surveillance…", https://icelandmonitor.mbl.is/news/politics_and_society/2018/08/15/fearing_unprecedented_surveillance_society/
[27] Iceland Directorate of Fisheries, http://www.fiskistofa.is/media/utgefid_efni/DOF.pdf
[28] Liu, 2002, "Investigation on traceability of fish products in Iceland…"
[29] CISION, 2018, , "Oliver Luckett's Niceland Seafood...", https://www.prnewswire.com/news-releases/oliver-lucketts-niceland-seafood-partners-with-king-soopers-and-city- market-300763576.html
[30] DOF, https://www.regjeringen.no/en/dep/nfd/organisation/etater-og-virksomheter-under-narings--og-fiskeridepartementet/Subordinate-agencies-and-institutions/The-Directorate-of-Fisheries/id1507/
[31] DOR, "Fisheries Monitoring Centre", https://www.fiskeridir.no/English/Fisheries/Fisheries-Monitoring-Centre

EM: Norwegian companies have developed a number of camera and sensor system technologies, with systems utilized particularly in the aquaculture sector.

ER: Vessels 15 meters and above (12 meters and above to the Skagerrak area) are required to report catches electronically.[32] Norway also has electronic reporting requirements for some vessels fishing in the waters of other countries or internationally, for example, all Norwegian vessels over 15 meters fishing in Icelandic waters were required to begin reporting catch and activity electronically; and in turn, Icelandic vessels fishing in Norwegian waters must report electronically.[33]

ETr: Norway's Ministry of Trade, Industry, and Fisheries and its Food Safety Authority ensure compliance with strict EU regulations, and Norway was one of the first countries to introduce a system for seafood traceability for herring.[34] Norway has a number of measures in place for seafood traceability, with 100% of the fish farming industry utilizing electronic systems for internal traceability and with systems available for full supply chain traceability such as TraceTracker AS and eSporing (a government-initiated project).[35]

Key Enablers

Comprehensive Legislation	Strong
Governance	Strong
Market Orientation	Strong
NGO Support	Strong
Political Support	Strong
Financial Resources	Strong
Expertise	Strong

Five- to Ten-Year Outlook for Comprehensive EFIS: Very good

Russia

Russia's Federal Agency for Fishery is responsible for fisheries management and oversight of inland waters.[36] Russia has been regularly cited with IUU issues, and in an effort to begin addressing this, a national plan was adopted in 2014 to deter and eliminate IUU fishing through improved legislation and enforcement, and by establishing a traceability system, starting with the use of electronic logbooks on fishing vessels.[37]

EFIS Status

ET: The Russian Federation requires all Russian vessels (fishing or transport, with an output of at least 55kW and a tonnage of at least 80) in its waters as well as on the high seas must have operational VMS and automatic identification system devices at all times, with a total of 3,800 vessels monitored by VMS.[38]

EM: Currently monitoring of catch is done via reverse calculation of final products to actual catch by using calculation ratios specified for each species harvested. In 2018, Russian authorities proposed to fit all vessels

[32] DOF, 2015, "Electronic Reporting Systems", https://www.fiskeridir.no/English/Fisheries/Electronic-Reporting-Systems
[33] The Fish Site, 2013, "Electronic reporting of fishing in Icelandic waters", https://thefishsite.com/articles/electronic-reporting-of-fishing-in-icelandic-waters
[34] Seafood from Norway, "Seafood Safety", https://herring.fromnorway.com/herring/seafood-safety/
[35] Foras and Storoy, 2012, "Seafood traceability solutions in Norway"
[36] The Russian Government, "Federal Agency for Fishery", http://government.ru/en/department/243/
[37] SeaFish, "Focus on ethical issues in seafood", https://www.seafish.org/media/publications/RussiaEthicsProfile_201509.pdf; WWF, 2014, "Russian government approves plan to counter illegal fishing", https://wwf.ru/en/resources/news/arkhiv/pravitelstvo-rf-utverdilo-plan-borby-s-nnn-promyslom/
[38] FAO, "Russia – VMS programme", http://www.fao.org/fishery/topic/18090/en

with 'Trawl', a system to gauge catch weight among other things; however due to the cumbersome system fishermen offered to install CCTV systems as an alternative.[39] In 2019 discussions of perspectives for "Trawl" system continued at the governance level. At the same time, some fishing companies have been introducing CCTV systems on their vessels voluntarily to control fishing operations.[40]

ER: Russia's 2014 national plan to combat IUU introduced e-logbooks for fishing vessel captains. The e-logbooks system implementation began in late 2018 and is now being integrated into fishing operations.[41]

ETr: Since 2014, when seafood traceability was introduced as part of the national plan, Russia has developed the "Mercury" system to achieve traceability targets. The system began to be tested on pilot vessels beginning July 2018, and national legislation requires Mercury to be operational at full scale on all fishing vessels by July 2019 to trace all seafood production and ensure verification and one-up, one-down reporting from producers to processors.[42]

Key Enablers

Comprehensive Legislation	Strong
Governance	Strong
Market Orientation	Weak (domestic), Strong (export)
NGO Support	Moderate
Political Support	Strong
Financial Resources	Moderate
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate

Latin America

Argentina

The Argentine Ministry of Agriculture, Livestock, and Fisheries is responsible for developing and executing national plans for fisheries management, conservation, and health; as well as plans to deter IUU fishing.[43] Argentina complies with electronic requirements for vessels operating in RFMO fishing areas and for major export fisheries, but the legislative framework, governance, and resources are lacking for broad scale development and implementation of EFIS.

EFIS Status

ET: The Argentine Department of Control and Surveillance enforces Federal Fisheries Law 24922 through satellite monitoring of the fleet; with about 400 Argentine vessels tracked in compliance with requirements of CCAMLR and CONVEMAR.[44]

EM: Argentina has approved an on-board camera system that will equip the majority of vessels with EM systems.[45] The status of this initiative is unclear.

[39] Hook and Net Magazine, "Russia to monitor catches from space", https://main-hookandnetmag-hookandnet.content.pugpig.com/2018/01/19/2018-01russtrawleng/pugpig_index.html
[40] Pers comm, Miron Borgulev, May 2019
[41] Pers comm, Miron Borgulev, May 2019
[42] Pers comm, Miron Borgulev, May 2019
[43] General Directorate for International Cooperation, "Argentina Cooperates", http://cooperacionarg.gob.ar/userfiles/catalogo-eng.pdf
[44] OECD, 2011; Blondin, 2018
[45] OECD, 2017

ER: The Argentine government proposed an electronic logbook with a haul by haul form, and fishing authorities approved a new regulation that sets an electronic logbook based on fishing areas (1º Latitude x 1º longitude).[46] This implies that it is necessary to add the catches, sets, and fishing effort made in each area; however, aggregate information is loaded without an adequate georeference and other important data for spatial management.[47]

ETr: The EU is the main market for Argentine seafood, and trade regulations have been expanded upon through national customs control requiring more detail for certain species and a catch documentation scheme to certify Argentine landings in alignment with international requirements.[48] Argentina also has two FIPs underway, for offshore and onshore red shrimp, with an objective of increasing transparency of scientific data.[49] However, there appears to be little impetus for comprehensive traceability in seafood products either paper based or electronic.

Key Enablers

Comprehensive Legislation	Weak
Governance	Weak
Market Orientation	Weak (domestic); Moderate (export)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Weak
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Poor

Chile

The Chilean Under secretariat for Fisheries and Aquaculture (SUBPESCA) is part of the Ministry of Economy, Development and Tourism, and is the agency responsible for regulating and managing fisheries and aquaculture activities.[50] The National Fisheries and Aquaculture Service (SERNAPESCA) is responsible for overseeing and auditing compliance with the regulations.[51] The government has taken initiative to transition to electronic monitoring and reporting, particularly for fisheries that extend beyond its EEZ and to prevent IUU fishing; however, an interoperable EFIS system is not in place.

EFIS Status

ET: All commercial fisheries in Chile have ET requirements with over 780 fishing vessels reported to be equipped with VMS.[52] Chile has also agreed to make its VMS data publicly available via agreement with Global Fishing Watch in 2019.[53]

[46] Ministry of Justice and Human Rights, "Resolution 48/2019", http://servicios.infoleg.gob.ar/infolegInternet/anexos/320000-324999/321195/norma.htm
[47] Pers comm, Guillermo Canete, 06/13/2019
[48] OECD, 2017
[49] FisheryProgress.org, "Argentina offshore red shrimp – bottom trawl", https://fisheryprogress.org/fip-profile/argentina-offshore-red-shrimp-bottom-trawl
[50] SUBPESCA, "The Undersecretariat", http://www.subpesca.cl/portal/616/w3-article-86158.html
[51] SERNAPESCA, "What is SERNAPESCA", http://www.sernapesca.cl/que-es-sernapesca
[52] FAO, "Chile VMS Programme", http://www.fao.org/fishery/topic/18080/en; SERNAPESCA, 2018, "Cuenta Publica", http://www.sernapesca.cl/sites/default/files/cuenta_publica_sernapesca_2018_mayo.pdf
[53] SeafoodSource, 2019, "Chile will provide vessel data…", https://www.seafoodsource.com/news/environment-sustainability/chile-will-provide-vessel-data-to-global-fishing-watch

EM: Chile has made a commitment to install EM systems on its fishing fleets, beginning implementation with its industrial fleet and the government has initiated inquiries with major EM providers.[54]

ER: Chile does not have ER requirements and while an electronic reporting system is available, reporting remains mainly paper logbook base. However, SERNAPESCA signed an agreement end of 2018 with WWF Chile to implement electronic logbook software, starting with the industrial fleet.[55] Chile's government, via an agreement with Peru and Ecuador, has committed to prevent IUU fishing vessels from using their port by using satellite tracking and electronic logbooks for foreign vessels in a collective effort; and the three governments are cooperating to establish monitoring protocols.[56]

ETr: No evidence of a concerted government effort to introduce electronic seafood traceability was found. Reference was found to aspirational traceability initiatives for example, representatives from five Chilean government groups met in 2018 to discuss an integrated EM/ER/ETr system.[57] This initiative would collect and manage datasets on landings, VMS tracks, electronic reporting and monitoring systems, health certificates, product traceability and other fisheries data sets. In addition, SERNAPESCA has launched a pilot program with a private Chilean company in nine artisanal fishing communities.[58]

Key Enablers

Comprehensive Legislation	Moderate (artisanal); Moderate (industrial)
Governance	Moderate
Market Orientation	Weak (artisanal); Strong (industrial)
NGO Support	Strong
Political Support	Moderate
Financial Resources	Moderate
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate

Ecuador

Ecuador's Ministry of Production, Foreign Trade, Investment and Fisheries is the agency responsible for fisheries management and regulation.[59] The government, fishing industry, and NGOs have initiated EM and ER systems for select export fisheries; however, there are no widespread EFIS requirements in place.

EFIS Status

ET: Ecuador requires all vessels above 20 GT to use VMS, with stiff penalties for non-compliance.[60]

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[54] Michelin et al, 2018

[55] WWF, 2018, "WWF Chile delivers to SERNAPESCA advanced electronic logbook…", http://www.wwf.cl/sala_redaccion/comunicados_de_prensa/noticias_feed.cfm?uNewsID=340170; USAID, 2017; JCOMM, 2011, "Olrac SPS", https://www.jcomm.info/index.php?option=com_oe&task=viewInstitutionRecord&institutionID=13714

[56] SeafoodNews.com, 2016, "Peru, Chile, Ecuador from anti-IUU pact…", https://www.seafoodnews.com/Story/1045125/Peru-Chile-and-Ecuador-Form-Anti-IUU-Pact-Requiring-Foreign-Vessels-to-Submit-Electronic-Logbooks

[57] Future of Fish, "Chilean fisheries government data modernization workshop", http://futureoffish.org/blog/chilean-fisheries-government-data-modernization-workshop-versi%C3%B3n-en-espa%C3%B1ol-abajo

[58] MundoAcuicola, 2019, "They launch a comercial traceability pilot program…", https://www.mundoacuicola.cl/new/2019/04/17/lanzan-programa-piloto-de-trazabilidad-comercial-que-beneficiara-a-pescadores-y-consumidores/

[59] Ministry of Production, Foreign Trade, Investment and Fisheries, "The Institution", http://www.produccion.gob.ec/la-institucion/

[60] WildAid and TNC, "Enforcement Guide: Nearshore Artisanal Fisheries", http://wildaid.org/wp-content/uploads/2017/09/Nearshore-Artisanal-Fisheries-Enforcement-Guide_0.pdf

EM: Ecuador does not have electronic monitoring requirements in place, however, there are examples of voluntary EM usage including video cameras for enforcement in the Galapagos National Park with three ports equipped with cameras.[61] At the moment, some boats of the Ecuadorian purse seine tuna fleet are participating in EM pilots in coordination with scientists from the IATTC.[62]

ER: Ecuador does not require electronic reporting nationally, but does have ER requirements for select fisheries. For example, the Undersecretariat of Fisheries requires mandatory ER for the titi shrimp fishery of Guayaquil Gulf to use electronic logbooks.[63] This resulted from the successful development and piloting of e-logbook technology, allowing fishermen to record fishing activity using mobile devices.[64]

ETr: Ecuador's government, via an agreement with Chile and Peru, committed to prevent IUU fishing vessels from using their ports by using satellite tracking and electronic logbooks for foreign vessels in a collective effort; and the three governments are cooperating to establish monitoring protocols.[65] Additionally, Ecuador, in coordination with the IATTC has a FIP for mahi mahi, the largest and most economically-important fishery for Ecuador.[66] The fishery entered full assessment in February 2019, with a goal of achieving MSC certification by December 2019.[67] The majority of mahi mahi catch is exported to the US, requiring Ecuador to comply with SIMP traceability regulations.

Key Enablers

Comprehensive Legislation	Moderate
Governance	Moderate
Market Orientation	Weak (artisanal); Moderate (industrial)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Weak
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate to good for some specific industrial fisheries such as mahi mahi and tuna; poor for artisanal fisheries.

Mexico

Mexico's Secretariat of Agriculture and Rural Development (SADER) is responsible for overseeing fisheries in Mexico.[68] Mexico complies with electronic requirements for vessels operating in RFMO fishing areas and for major export fisheries, but the legislative framework, governance, and resources do not provide for the

[61] Reef Resilience Network, 2015, "Ecuador – Fisheries Management", http://reefresilience.org/case-studies/ecuador-fisheries-management/
[62] IATTC, 2019, "Scientific Advisory Committee: Tenth Meeting", https://www.iattc.org/Meetings/Meetings2019/SAC-10/Docs/_English/SAC-10-12_Electronic%20monitoring%20of%20purse%20seine%20vessel%20activities%20and%20catches.pdf
[63] WWF, 2018, "Ecuador formally adopts an electronic fishing bitaker system…", http://wwf.panda.org/wwf_news/?338110/bitacorasdepesca
[64] WWF, "Smartphone app helps communities…", https://www.worldwildlife.org/projects/smartphone-app-helps-communities-improve-their-fisheries-management
[65] SeafoodNews.com, 2016, "Peru, Chile, and Ecuador form anti-IUU pact…", https://www.seafoodnews.com/Story/1045125/Peru-Chile-and-Ecuador-Form-Anti-IUU-Pact-Requiring-Foreign-Vessels-to-Submit-Electronic-Logbooks
[66] FisheryProgress.org, "Completed – Ecuador mahi-mahi longline", https://fisheryprogress.org/fip-profile/ecuador-mahi-mahi-longline
[67] WWF, 2019, "The mahi mahi fishery of Ecuador…", http://www.wwf.org.ec/?uNewsID=343990
[68] SAGARPA, "Introduction", http://www.sagarpa.mx/English/Pages/Introduction.aspx

development and implementation of a comprehensive EFIS. There are, however, growing efforts by NGOs to develop EFIS for both industrial and artisanal fisheries in Mexico.[69]

EFIS Status
ET: Mexico has some electronic vessel tracking requirements in place, with over 2,000 vessels equipped with VMS as part of the bilateral agreement with Cuba.[70] VMS is primarily required for large-scale vessels such as the Mexican tuna fleet.[71]

EM: Electronic monitoring systems are not required; however, low-cost EM systems have been trialed in Mexico.[72]

ER: Reporting via electronic logbook is not required by the government for any fishery.

ETr: The government has not demonstrated a commitment towards seafood traceability, however, there are examples of attention to the issue by the private sector and NGOs in Mexico. For example, traceability technology is being developed by the private sector for compliance with US and EU regulations[73]; and Mexico has 15 FIPs underway[74].

Key Enablers

Comprehensive Legislation	Weak (artisanal); Moderate (industrial)
Governance	Weak
Market Orientation	Weak (artisanal); Moderate (industrial)
NGO Support	Moderate
Political Support	Weak
Financial Resources	Weak
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate for industrial fisheries; poor for artisanal fisheries

Peru
Peru's Vice Ministry of Fisheries and Aquaculture of the Ministry of Production oversees the country's fishing sector.[75] The government, fishing fleet, and NGOs have taken steps towards transparency and electronic tracking and reporting for major export fisheries; however, there are not widespread EFIS requirements in place.

EFIS Status
ET: Peru has ET requirements in place with around 2,000 fishing vessels equipped with VMS (mostly industrial or small scale vessels), including for the anchovy, sardine, mackerel, and hake, among others.[76]

[69] Pers comm, Esteban Arenas, 05/30/2019
[70] Blondin, 2018
[71] Pers comm, Esteban Arenas, 05/30/2019
[72] Michelin et al, 2018
[73] Penumsoft, http://plenumsoftmarina.com/en/
[74] FisheryProgress.org, https://fisheryprogress.org
[75] Ministry of Production, https://www.gob.pe/produce
[76] Ministry of Production, "Fishery Vessels", https://www.produce.gob.pe/index.php/shortcode/servicios-pesca/embarcaciones-pesqueras; FAO, "Peru – VMS Programme", http://www.fao.org/fishery/topic/18089/en

Additionally, Peru's VMS data are published through a partnership with Global Fishing Watch.[77] Recently new regulations have been published and certain artisanal fishing vessels also have VMS requirements. Likewise, a VMS pilot was trialed with a couple of high seas artisanal fishing vessels which had high acceptance from fishers because they saw several benefits.

EM: EM systems are not required by the Peruvian government. Various EM trials have been undertaken, for example, a study on Peru's small-scale elasmobranch fishery that showed EM to be effective in detecting and quantifying catch as well as pinniped bycatch.[78]

ER: Peru does not have broad-scale ER requirements in place, however, electronic logbooks have been implemented and trialed for for the anchoveta fisheries. Electronic log systems were implemented for all Peruvian Anchoveta fleets to enforce controls.[79] As part of a mahi mahi FIP, a mobile electronic CDS system was piloted with fishers to record their catch.[80] Some anchoveta companies have started discussions about trialing a private electronic logbook to gather additional information that will be useful for internal processes. Additionally, a group of fishers undergoing a formalization process in which if they organized as a fishing cooperative they would receive fishing permits. To maintain these permits they have an obligation to have and use an electronic catch documentation system.

ETr: Peru's government demonstrated a commitment to prevent IUU through an agreement with Chile and Ecuador to prevent IUU fishing vessels from using their port through the use of satellite tracking and electronic logbooks for foreign vessels, [81]; through co-organizing an international workshop on traceability with the governments of Argentina, Brazil, Chile, Ecuador, and the US[82]; and via the formation of a Latin American Network to fight IUU under the framework of PSMA, and led by Peru.[83] Additionally, Peru's anchovy and mahi mahi fisheries have taken steps towards electronic traceability through publishing ET data, initiating electronic logbook systems, and implementing FIPs that have traceability components.[84]

Key Enablers

Comprehensive Legislation	Weak (artisanal); Moderate (industrial)
Governance	Weak (artisanal)
Market Orientation	Weak (artisanal); Moderate (industrial)
NGO Support	Moderate
Political Support	Weak
Financial Resources	Weak
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate for industrial fisheries such as anchoveta or hake. Poor for artisanal fisheries.

Asia

[77] Global Fishing Watch, "Indonesia VMS", https://globalfishingwatch.org/initiatives/indonesia-vms/
[78] Bartholomew et al, 2018; Michelin et al, 2018
[79] FishSource, 2018, "Anchoveta", https://www.fishsource.org/stock_page/1383
[80] WWF Seafood Sustainability, "Fishery Improvement Projects: Peru Mahi", http://seafoodsustainability.org/portfolio/peru-mahi/
[81] SeafoodNews.com, 2016, "Peru, Chile, Ecuador from anti-IUU pact…", https://www.seafoodnews.com/Story/1045125/Peru-Chile-and-Ecuador-Form-Anti-IUU-Pact-Requiring-Foreign-Vessels-to-Submit-Electronic-Logbooks
[82] WWF, 2019, "Experts meet in Lima…", http://www.wwf.org.pe/en/?uNewsID=342931
[83] Network for the exchange of information and shared experiences, http://www.redpescaindnr.gob.pe/?lang=en
[84] FisheryProgress.org, "FIPs", https://fisheryprogress.org/directory

China

China's Bureau of Fisheries is responsible for developing fisheries strategies and programs, and for recommending fishery policies, laws, and regulations to the Ministry of Agriculture and Rural Affairs.[85] China developed its 13th Five-Year Plan for marine fisheries in 2016, which included requirements for electronic reporting and greater transparency in marine fisheries; however, a review of this plan concluded that while it is impressive in scope, serious institutional reform and consistent policies across provinces are required in order for this plan to be implemented and enforced.[86]

EFIS Status

ET: Since 2007, China's Ministry of Agriculture has requested ship position monitoring for all offshore fishing vessels. By 2018, there were 2,654 ocean-going fishing vessels in China. Vessel trajectories are recorded by Relico's integrated offshore fishing management platform using GPS and CDMA networks. [87]

EM: China's Fisheries Administration of the Ministry of Agriculture has formulated the "Technical Specification for the Platform for Dynamic Monitoring and Management of Fishing Vessels and Fishing Ports". Relico's dynamic monitoring system monitors fishing vessels through satellite, mobile communication networks and radio communications, and provides information and services to the fishery management, fisheries, fishing companies, and the public.[88]

ER: The National Fisheries Big Data Sharing Platform is hosted by the Fisheries Administration of the Ministry of Agriculture and Rural Affairs, and is hosted by the National Aquatic Technology Extension Station and the China Fisheries Society.[89] It covers various industrial chains in the fishery sector and provides relevant information, reports and analysis. There are also fishery information platforms established by enterprises to provide fishery information construction and operation services for the government, enterprises, and the public.[90]

ETr: China has shown a commitment toward accountability, compliance, enforcement of regulations, monitoring, and public data reporting in its Five-Year Plan; however, no requirements are in place for electronic traceability in its fisheries.[91] China has five FIPs underway with those for the red swamp crayfish and Japanese flying squid including traceability objectives.[92]

Key Enablers

Comprehensive Legislation	Weak
Governance	Weak
Market Orientation	Weak (domestic); Moderate (export)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Weak
Expertise	Weak

[85] Ministry of Agriculture and Rural Development, "Main Function of Bureau of Fisheries", http://english.agri.gov.cn/aboutmoa/departments/201301/t20130115_9518.htm
[86] Cao et al, 2017, "Opportunity for marine fisheries reform in China", https://www.pnas.org/content/114/3/435
[87] LiMap, "Shipborne navigation equipment", http://www.qdlimap.com/jspWeb?jsp=web/ChuanBoShiBie-list&kind=equipment&ChuanBoShiBie
[88] LiMap, "Product System", http://www.qdlimap.com/jspWeb?jsp=web/YCJG-YCJG-sys&ZHYY-solution
[89] Fish Data, "National Scientific Big Data Sharing Platform for Fishery", http://www.fishdata.cn/web/moa/Default.aspx
[90] Pers comm, Patrick Yeung, 05/29/2019
[91] Cao et al, 2017
[92] FisheryProgress.org, "FIP Directory", https://fisheryprogress.org/directory

Five- to Ten-Year Outlook for Comprehensive EFIS: Poor

India

India's Department of Fisheries is responsible for fisheries development and management. Its Blue Revolution for integrated fisheries management, calling for improved database management as well as monitoring, control, and surveillance[93]; and the more recently revised National Policy on Marine Fisheries was released in 2017 with stronger MCS laws and requirements.[94] However, other than electronic tracking, there are no regulations in place for electronic monitoring and reporting and the food traceability mandate lacks enforcement.[95]

EFIS Status

ET: Indian tuna fishing vessels were monitored by an automatic tracking system, and in 2012 the Government finalized a program to install VMS technology on all fishing vessels, bringing them into compliance with requirements of RFMOs such as IOTC.[96] While this program did not progress, the 2017 National Policy has VMS requirements, with purse-seiners in the state of Maharashtra having VMS on board and all Kerala vessels will be legally required to be equipped with VMS by December 2019.

EM: EM systems using camera and sensor technology are not required by the Indian government.

ER: The Indian government does not have ER requirements, but mechanisms are in place to submit electronic logbook reports to the Fishery Survey of India.[97]

ETr: Food traceability is mandated by FSS (Food Recall Procedure) Regulation 2017, and CII Face and GS1 India undertook a study to evaluate the status of traceability in the Indian food industry, identify gaps, and provide recommendations.[98] Across food supply chains, they found that most businesses do not have effective traceability systems, at best they have tracking one-level down in the supply chain.

Key Enablers

Comprehensive Legislation	Weak
Governance	Weak
Market Orientation	Weak (domestic); Moderate (export)
NGO Support	Moderate
Political Support	Weak to Moderate
Financial Resources	Weak
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Poor

Indonesia

The Indonesia Ministry of Marine Affairs and Fisheries (MMAF), NGOs, and industry have undertaken initiatives towards fisheries transparency, combatting IUU, and improving seafood traceability in Indonesia through EFIS. Many of these initiatives are being undertaken with the support of the USAID Oceans program. While limitations exist, regulations are in place for ET and ER and trials have been undertaken for EM and ETr.

[93] Department of Animal Husbandry and Dairying, http://dahd.nic.in/about-us/divisions/fisheries
[94] Ministry of Agriculture and Farmers Welfare. 2017. National Policy on Marine Fisheries, released 28 April 2017.
[95] CII Face and GS1, 2018, "Food traceability in India"
[96] Vijayakumaran and Varghese, 2012, India's national report to the Scientific Committee of the Indian Ocean Tuna Commission.
[97] Vijayakumaran and Varghese, 2012, India's national report to the Scientific Committee of the Indian Ocean Tuna Commission.
[98] CII Face and GS1, 2018, "Food traceability in India"

EFIS Status

ET: All vessels above 30 GT are required to install VMS[99], and Indonesia is the first country to publicly release VMS data, done through a partnership with Global Fishing Watch.[100]

EM: While EM systems are not widely used, low-cost EM systems have been trialed in Indonesia.[101]

ER: In October 2018, Indonesia announced its commitment to implement electronic fishing logbooks for domestic fishing vessels authorized to operate in the country`s 11 Fisheries Management Areas and High Seas.[102] The e-Logbook will be utilized aboard large-scale fishing vessels and will capture data at the point-of catch, to be fed into STELINA to enable traceability throughout the value chain. The e-logbook can be provided to the captain in the form of a tablet. MMAF expects to distribute the e-logbook tablets to at least 150 Bitung-based fishing vessels.[103]

ETr: Since 2015, MMAF local government, private sector, and NGOs have been working in partnership with USAID Oceans to develop and implement an electronic catch documentation and traceability (eCDT) system.[104] Pilots have been undertaken in Bitung, Indonesia, targeting small to large-scale vessels fishing for different species at various points in the supply chain including harvest, landing, processing, and sale. In 2016, a six month blockchain trial was undertaken for tracing pole and line caught yellowfin and skipjack in Indonesia via digitized mobile data collection at harvest through mobile access of information for consumers.[105]

In 2018 MMAF launched the National Fish Traceability and Stock System (STELINA) to accommodate and comply with international market requirements, including the United States Seafood Import Monitoring Program (SIMP) and the European Union (EU) regulations which aim to combat IUU fishing and ensure food safety. STELINA is a downstream, government-hosted traceability system that will synthesize data from Indonesia's more than ten existing systems that currently and disparately host fisheries information. STELINA also operates with high interoperability, allowing data exchange between the MMAF and private sector traceability systems sector.[106]

Additionally, Indonesia has 13 FIPs, several with traceability objectives including one for yellowfin tuna in the Banda Sea.[107]

Key Enablers

Comprehensive Legislation	Weak
Governance	Moderate
Market Orientation	Weak (domestic), Strong (export)
NGO Support	Strong

[99] OECD, 2017

[100] Global Fishing Watch, "Indonesia VMS", https://globalfishingwatch.org/initiatives/indonesia-vms/

[101] Michelin et al, 2018

[102] AntartaNews.com, 2018, "Indonesia announces commitment to implement e-fishing logbook", https://en.antaranews.com/news/120023/indonesia-announces-commitment-to-implement-e-fishing-logbook

[103] SEAFDEC, "Indonesia continues progress in pursuit of end-to-end seafood traceability", https://www.seafdec-oceanspartnership.org/news/indonesia-continues-progress-in-pursuit-of-end-to-end-seafood-traceability/

[104] SEAFDEC, "Connecting the seafood supply chain…", https://www.seafdec-oceanspartnership.org/news/connecting-the-seafood-supply-chain-traceability-solutions-in-indonesia/

[105] Provenance, 2016, "From shore to plate: Tracking tuna on the blockchain", https://www.provenance.org/tracking-tuna-on-the-blockchain

[106] SEAFDEC, "Indonesia continues progress…", https://www.seafdec-oceanspartnership.org/news/indonesia-continues-progress-in-pursuit-of-end-to-end-seafood-traceability/

[107] FisheryProgress.org, "FIPs", https://fisheryprogress.org

Political Support	Strong
Financial Resources	Weak (domestic), Moderate (export)
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Good for major export fisheries (e.g. tuna blue swimmer crab); poor to moderate for domestic fisheries depending on size and scale of the fishery

Japan

Japan's Ministry of Agriculture, Forestry, and Fisheries (MAFF) oversees fisheries development and management, and set a target to increase the export value of fisheries products to 350 billion yen in 2020 (from 170 billion yen in 2012).[108] As a major importer and exporter of seafood and a member of all tuna RFMOs, Japan has the market incentive and financial resources to develop and implement EFIS systems; however, comprehensive legislation is not in place for broadscale electronic tracking, monitoring, and reporting for Japan's domestic and international fishing fleets.

EFIS Status

ET: Japan complies with VMS requirements of RFMOs; and participates in the groundfish fisheries monitoring agreement with Japan, Russia, South Korea, and the US which includes VMS requirements.[109]

EM: The government of Japan does not have requirements for EM, however, some fishermen voluntarily utilize EM systems with camera technology to improve transparency and marketability of products.[110]

ER: Japan does not require electronic reporting, but does have mechanisms in place for voluntarily reporting via electronic logbook.

ETr: Japan has measures in place that provide the framework for seafood traceability including labeling requirements under the Quality Labeling Standard for perishable Foods (2000) and traceability guidelines in the Japanese Handbook for Introduction of Food Traceability Systems.[111] Further, the government has shown a commitment to combatting IUU through its engagement in all tuna RFMOs[112]; and bilateral fishery agreements including the EU and Japan agreement to fight IUU[113]. They have taken recent steps towards building traceability into Japanese fisheries through their first traceability pilot as part of the Tokyo Bay Sea Perch FIP[114], and through a government supported blockchain pilot for sea cucumber traceability[115].

Key Enablers

Comprehensive Legislation	Weak
Governance	Moderate
Market Orientation	Weak (domestic); Strong (export)
NGO Support	Moderate

[108] MAFF, 2016, "Close to Your Daily Life", http://www.maff.go.jp/e/data/publish/attach/pdf/maff_2016-4.pdf
[109] Blondin, 2018; Japan Fisheries Association, 2007, "Tangible progress achieved…", http://www.suisankai.or.jp/topics_e/isaribi/isaribi_53.pdf
[110] The Japan Times, 2019, "Buoys, fisheries and aquaculture join the internet of things", https://www.japantimes.co.jp/life/2019/01/05/food/buoys-fisheries-aquaculture-join-internet-things/
[111] Charlebois et al, 2014; FishWise, 2018
[112] OECD, 2011
[113] FishWise, 2018
[114] Ocean Outcomes, http://www.oceanoutcomes.org/news/traceability-solutions-seafood-japan; https://fisheryprogress.org
[115] Seafood Source, 2019, "Blockchain trials for sea cucumber traceability in Japan", https://www.seafoodsource.com/news/environment-sustainability/blockchain-trialed-for-sea-cucumber-traceability-in-japan

Political Support	Moderate
Financial Resources	Strong
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Good for export markets; poor for domestic fisheries

Philippines

The Philippines reformed its fisheries governance in response to receiving a yellow card for illegal fishing activity from the European Commission in June 2014, threatening to ban their seafood from entering the EU market.[116] In response, the Philippines Bureau of Fisheries and Aquatic Resources (BFAR) amended its Republic Act 8550 in 2014, with the revised Act 10654 aimed to prevent and deter IUU.[117] This brought the Philippines legal system in alignment with international law, and they were delisted in April 2015. Later in 2015, BFAR approved PHILO Project Phase II to better monitor and protect marine resources, calling for increased electronic tracking, monitoring, and reporting with the aim of moving towards integrated EFIS.[118]

EFIS Status

ET: VMS is required on Philippines vessels in compliance with RFMOs including ICCAT, IOTC, CCSBT, and WCPFC.[119] Additionally, PHILO includes an objective of implementing VMS on commercial fishing vessels 30 GT and above operating in the Philippines EEZ and beyond by providing 5,000 VMS transmitters.[120]

EM: The PHILO Project specifies that Fisheries Monitoring Centers will provide operators with the ability to remotely control CCTV port surveillance cameras – pan, tilt and zoom and vessel snap shot and image capture with upload to vessel electronic file.

ER: The Philippines has mechanisms in place for vessels to report activity by paper or electronically[121], and PHILO included a proposal to provide five-hundred electronic workbooks as part of their fisheries observer program. As of 2017, 20 purse seine vessels had voluntarily adopted electronic reporting.[122]

ETr: The development and implementation of an electronic traceability system for seafood is underway in the Philippines. In partnership with USAID Oceans, non-profit organizations, and the fishing industry, BFAR developed a new electronic catch documentation and traceability system for seafood products, focused on tuna.[123] This was completed in September 2017, and after addressing a power supply issue on the vessel monitoring device, was tested in the port of General Santos City. BFAR is developing an additional module for processing and storage, as well as a mobile application for electronic traceability.[124]

Key Enablers

[116] European Commission, 2015, "EU acts on illegal fishing…", http://europa.eu/rapid/press-release_IP-15-4806_en.htm
[117] BFAR, "Fisheries Legislations", https://www.bfar.da.gov.ph/lawAndRegulation.jsp
[118] BFAR, "PHILO Phase 2", https://www.bfar.da.gov.ph/files/img/photos/PHILOPHASE2TORFINAL.pdf
[119] BFAR, "Fisheries Administrative Order", https://www.bfar.da.gov.ph/LAW?fi=404
[120] BusinessWorld, 2016, "Fishing boat surveillance to expand…", http://www.bworldonline.com/content.php?section=Economy&title=fishing-boat-surveillance-to-expand-by-mid-2016&id=123124
[121] Department of Agriculture, "Fisheries Administrative Order", http://ph.oceana.org/sites/default/files/7_13_fao_vmm_draft_rules.pdf
[122] USAID, 2017, "Output 3: Customer requirements for Philippine tuna products"
[123] USAID, 2017, "USAID partners with Philippine seafood industry…", https://www.usaid.gov/asia-regional/press-releases/oct-30-2017-usaid-partners-philippine-seafood-industry-roll-out
[124] Pers comm, David David, 05/31/2019

Comprehensive Legislation	Weak (domestic); Strong (export)
Governance	Weak (domestic); Strong (export)
Market Orientation	Weak (domestic); Strong (export)
NGO Support	Strong
Political Support	Moderate
Financial Resources	Moderate
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Moderate for export markets; poor for domestic fisheries

South Korea

The South Korean Ministry of Oceans and Fisheries is responsible for fisheries policy and management.[125] South Korea reformed its fisheries governance to align with international law in response to receiving a yellow card for illegal fishing activity from the European Commission in November 2013.[126] They were delisted in April 2015 as a result of this reform which included improved electronic tracking, monitoring, and reporting. This removed the threat of being banned from exporting seafood into the EU. South Korea has the market motivation to implement EFIS for major export fisheries; but challenges exist for implementation, particularly for domestic fisheries.

EFIS Status

ET: The Korean government implemented regulations in April 2015 requiring its fishing vessels to be equipped with VMS and monitored by Korean officials from a 24-hour Fisheries Monitoring Center.[127] There is a clause in the law that limits the use of VMS to safety purposes and there are no penalty measures in place for domestic fishery vessels that do not maintain VMS equipment.[128]

EM: The government proposed a video monitoring system using Korea's advanced information technology[129]; and Korea undertook an EM pilot project where video footage and sensor data were transmitted to the Korean Fisheries Monitoring Center[130].

ER: The government proposed equipping all vessels with an electronic logbook system, beginning September 2015.[131]

ETr: South Korea has shown a commitment to reducing IUU through their fisheries governance reform and agreement with the EU to fight IUU[132] and through signing an MOU with the Environmental Justice Foundation committing to share information to address IUU[133]. They have also demonstrated a commitment

[125] Ministry of Oceans and Fisheries, http://www.mof.go.kr/eng/index.do
[126] European Commission, 2015, "EU acts on illegal fishing…", http://europa.eu/rapid/press-release_IP-15-4806_en.htm
[127] EJF, 2015, "EU removes south Korea from list…", https://ejfoundation.org/news-media/2015/eu-removes-south-korea-from-list-of-those-failing-to-combat-pirate-fishing
[128] Government of Korea, "Notification on installation standards…", http://www.law.go.kr/admRulLsInfoP.do?admRulSeq=2200000032761
[129] European Commission Maritime Affairs and Fisheries, 2015, "Interview with Kim Young-Suk…", https://ec.europa.eu/dgs/maritimeaffairs_fisheries/magazine/en/people/interview-kim-young-suk-south-korean-vice-minister-oceans-and-fisheries
[130] WCPFC, 2016, "Summary Report: Second e-reporting and e-monitoring intersessional working group meeting"
[131] European Commission Maritime Affairs and Fisheries, 2015; EJF, 2015
[132] FishWise, 2018
[133] EJF, 2015

to expanding their requirements for ET, EM, and ER; however, they do not have interoperable electronic traceability systems in place.

Key Enablers

Comprehensive Legislation	Weak (domestic); Moderate (export)
Governance	Weak (domestic); Moderate (export)
Market Orientation	Weak (domestic); Strong (export)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Moderate
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Good for export markets; poor for domestic fisheries

Taiwan

The Taiwan Fisheries Agency develops policies and manages fisheries in its waters and for its vessels on the high seas.[134] The government has policies in place to implement and enforce components of EFIS, particularly for major export fisheries and in compliance with RFMO requirements. However, comprehensive EFIS are not in place for domestic or export fisheries. Further, concerns have been raised about IUU activities on the high seas and the need for improved electronic traceability, and accusations are being investigated by the Fisheries Agency.

EFIS Status

ET: All vessels operating on the high seas or in the EEZs of foreign countries, as well as specific fishing vessels operating in the waters of Taiwan, are required to report their position via VMS to national authorities and to respective RFMOs.[135]

EM: Taiwan does not have EM requirements in place. Reports of shark finning among other illegal activities on Taiwanese vessels prompted the recommendation for Taiwan to introduce EM to its high seas fleet including the use of CCTV cameras.[136].

ER: The Fisheries Agency of Taiwan has ER regulations in place for select fisheries, including the requirement for bigeye tuna vessels fishing in the Atlantic Ocean, squid jiggers, and Pacific saury to report catch data via electronic logbooks.[137]

ETr: The Taiwanese government has measures in place for traceability and inspection of fish, however, the focus has been primarily on the aquaculture sector. Several examples of use in the aquaculture sector exist, with traceability initially utilized to monitor pesticides in farmed fish.[138] There are also individuals who have voluntarily implemented ETr as a marketing tool, for example, tagging grouper with RFID tags to provide the fish's providence to customers.[139]

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[134] Fisheries Agency, Council of Agriculture (FA COA), https://www.fa.gov.tw/en/

[135] FA COA, 2013, "National Plan of Action of the Republic of China (Taiwan) to Prevent, Deter and Eliminate IUU Fishing", https://www.fa.gov.tw/upload/456/20160407145246366661.pdf

[136] The News Lens, 2018, "Taiwan's Tuna Vessels Caught…", https://international.thenewslens.com/feature/highseas/109562

[137] Association of Foreign Trade and Development of the Republic of China, http://www.ofdc.org.tw/websEn/List.aspx?main=19

[138] Seafood Watch, 2016, "Tilapia: Taiwan Ponds", https://www.seafoodwatch.org/-/m/sfw/pdf/reports/t/mba_seafoodwatch_tilapiataiwanreport.pdf; Chen et al, 2008, "The Harmonization of Food Safety…"

[139] RFID, 2008, "Taiwanese Seafoof Producer Tracks Fish…", https://www.rfidjournal.com/articles/view?3964

Key Enablers

Comprehensive Legislation	Weak
Governance	Moderate
Market Orientation	Weak (domestic); Moderate (export)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Strong
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Strong for export markets; moderate for domestic fisheries

Thailand

The Thailand Department of Fisheries is responsible for fisheries policy and management. Upon receiving a yellow card for illegal fishing activity from the European Commission in April 2015, Thailand initiated requirements for increased electronic tracking, monitoring, and reporting.[140] They were delisted in January 2019 as a result of these reforms; removing the threat of being banned from exporting seafood into the EU market.[141] With this, Thailand has the legal framework in place and the market motivation to implement EFIS for major export fisheries; but challenges exist in terms of governance, resources, and expertise, particularly for domestic fisheries.

EFIS Status

ET: Thailand has ET requirements in place, with vessels 30 GT and greater equipped with VMS; and all overseas fishing vessels required to have VMS installed by 2016.[142] These requirements would comprise roughly 7,000 vessels equipped with VMS.[143]

EM: Under Thailand Royal Ordinance on Fisheries B.E.2558, the Director General of the Department of Fisheries established a requirement for Thai fishing and transshipment vessels operating overseas to be equipped with an EM system using VMS, CCTV, and RFID technologies.[144]

ER: The Director General established a requirement for Thai fishing and transshipment vessels operating overseas to be equipped with an Electronic Reporting System (ERS) to directly report transshipment activities, logbook data, and seaman transfers.[145]

ETr: Thailand proposed a management measure to strengthen traceability through electronic systems and to increase the number of traceability inspectors; and also recommended amending laws as needed for traceability.[146] Industry-led initiatives have also been undertaken, such as to implement traceability in the Thai shrimp supply chain through stakeholder engagement.[147]

Key Enablers

[140] European Commission, 2015, "EU acts on illegal fishing…", http://europa.eu/rapid/press-release_IP-15-4806_en.htm
[141] European Commission, 2019, "Commission lefts 'yellow card' from Thailand…", http://europa.eu/rapid/press-release_IP-19-61_en.htm
[142] Thailand Department of Fisheries, 2015, "Marine Fisheries Management Plan of Thailand"
[143] Pramond, 2017, "Global Evaluation of Fisheries Monitoring Control and Surveillance in 84 Countries"
[144] Wongkeaw et al, 2017, "Installation of ERS and EM in the Thai fleets…"
[145] Wongkeaw et al, 2017
[146] Thailand Department of Fisheries, 2015
[147] FishWise, 2018

Comprehensive Legislation	Weak (domestic); Moderate (export)
Governance	Weak (domestic); Moderate (export)
Market Orientation	Weak (domestic); Strong (export)
NGO Support	Moderate
Political Support	Moderate
Financial Resources	Moderate
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Good for export markets; poor for domestic fisheries

Vietnam

Vietnam's Ministry of Agriculture and Rural Development's Directorate of Fisheries is responsible for fisheries management.[148] Vietnam replaced its 2003 Fisheries Law with the 2017 Fisheries and Aquaculture Law and adopted NPOA to fight IUU. Despite this change it has not further demonstrated a commitment to traceability and combatting IUU.[149] Vietnam has not ratified the PSMA, it was reported to CITES by CCAMLR for failure to participate in the CDS to regulate illegal trade of toothfish[150], and it was issued a yellow card from the European Commission for IUU infringement in October 2017. The Commission subsequently initiated a process of administrative cooperation with the authorities of Vietnam to evaluate the verification of catch certificates and the implementation, control and enforcement of laws, regulations and conservation and management measures; and concluded that the legal framework is lacking for fisheries monitoring and enforcement.[151] Vietnam thus has many barriers to developing and implementing EFIS.

EFIS Status

ET: Through financial support from France, around 100 Vietnamese vessels have been equipped with VMS, and the Ministry of Agriculture and Rural Development plans to equip 157 vessels with VMS through this project.[152]

EM: Vietnam's catch monitoring is limited with less than 1% of observer coverage and no requirements for EM through camera and sensor systems.[153]

ER: Logbook and other reporting requirements have been limited in Vietnam, having roughly 25-50% coverage for catch documentation and all systems are paper-based.[154] A yellowfin tuna FIP was initiated in 2013, and as part of this they are working to address concerns about logbook reporting consistency, data entry, and to ensure Vietnam meets data submission requirements of the WCPFC.[155]

ETr: The government of Vietnam does not have policies or regulations in place for electronic traceability of seafood, and moreover very little of the data required for traceability are recorded along the value chain.[156] Efforts towards traceability have been undertaken by NGOs and industry, such as the yellowfin tuna FIP which requires FIP partners to have a traceability system in place within one year of signing the agreement.[157]

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[148] Directorate of Fisheries, "Vietnam Fisheries", https://tongcucthuysan.gov.vn/en-us/VietNam-Fisheries
[149] Pramod, 2017, "Global Evaluation of FMC…"
[150] Pramod, 2017
[151] EUR-lex, 2017, "Commission Decision", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2017.364.01.0003.01.ENG&toc=OJ:C:2017:364:FULL
[152] Pramod, 2017
[153] Pramod, 2017
[154] Tuong et al, 2016, "Fit for FIP Traceability for Vietnam Yellowfin…"
[155] Tuong et al, 2016
[156] Blaha, Borit, and Thompson, 2015, "Traceability of Fisheries Products…'
[157] Tuong et al, 2016

Key Enablers

Comprehensive Legislation	Weak
Governance	Weak
Market Orientation	Weak (domestic); Moderate (export)
NGO Support	Moderate
Political Support	Weak
Financial Resources	Moderate
Expertise	Weak

Five- to Ten-Year Outlook for Comprehensive EFIS: Poor

Africa

Morocco

Morocco's fisheries are managed by its Ministry of Agriculture, Fisheries, Rural Development, Water and Forests.[158] The country has well-established markets with the EU, incentivizing the government and its fisheries to meet monitoring, reporting, and traceability requirements; and several EFIS mechanisms are in place.

EFIS Status

ET: In agreement with ICCAT and EU regulations, Morocco's industrial fleet is equipped with VMS.[159]

EM: The government of Morocco does not require EM through camera and sensors systems.

ER: As part of a fisheries protocol agreement with the EU, Morocco established a system for electronic exchange of catch data and VMS positions.[160] Moroccan vessels fishing in the ICCAT RFMO report electronically as it is mandatory in that region.[161]

ETr: Morocco has made progress towards seafood labeling and traceability. It specifies measures for labeling seafood in its Halieutiis Plan, implemented in 2009[162] and although not yet fully integrated, it established a computerized traceability system (SAMANCA) to reduce paper and improve traceability.[163] Morocco holds potential for adopting and implementing EFIS with significant growth in the technical capacity of their seafood industry resulting in part from the Japan-Morocco economic and technical cooperation in the fishing sector.[164] Morocco has one FIP for European sardine with an objective of improving data availability and transparency.[165]

Key Enablers

Comprehensive Legislation	Moderate (domestic); Strong (export)
Governance	Moderate
Market Orientation	Moderate (domestic); Strong (export)

[158] Ministry of Agriculture, Fisheries, Rural Development, Water and Forests, http://www.agriculture.gov.ma/en/pages/missions
[159] COMHAFAT-ATLAFCO, 2015, "Tuna Transparency Initiative…"
[160] COMHAFAT-ATLAFCO, 2015; Blaha, Borit, and Thompson, 2015, "Traceability of Fisheries Products…"
[161] ICCAT, "Electronic Bluefin Tuna Catch Document Programme", https://www.iccat.int/en/eBCDprog.asp
[162] Kharmaz, 2013, "Labeling and Institutional Marketing of Moroccan Seafood"
[163] Blaha, Borit, and Thompson, 2015
[164] IIAS Newsletter, 2016, "The Green March brings forth the desert treasures…", https://iias.asia/the-newsletter/article/green-march-brings-forth-desert-treasures-japanese-cooperation-moroccos-south
[165] FisheryProgress.org, "FIP Directory", https://fisheryprogress.org

NGO Support	Moderate
Political Support	Moderate
Financial Resources	Weak
Expertise	Moderate

Five- to Ten-Year Outlook for Comprehensive EFIS: Good for export fisheries

Appendix 2 – EFIS Status by Regional Fishery Management Organization

Appendix 2 provides supporting information for Table 2, summarizing the status of electronic vessel tracking, monitoring, reporting, and traceability by UNCLOS-designated Regional Fisheries Management Organizations (RFMOs) and other regional management groups. Regional summaries were sent for external review to WWF personnel with EFIS expertise for each region, and feedback was incorporated when received.

Tuna RFMOs

CCSBT
The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) Convention was established in 1994 to formalize quotas and conservation measures to support Southern bluefin tuna stocks.[166] CCSBT has regulations and mechanisms in place for tracking vessels and catch; however, there are minimal EFIS requirements for vessels fishing in the Convention Area, with CCSBT only requiring electronic vessel monitoring.

EFIS Status
ET: The CCSBT requires vessels to be equipped with VMS prior to authorization and transshipment of SBT.[167] Cooperating Non-Contracting Parties (CPCs) must adopt the VMS requirements of the RFMO Convention Area where southern bluefin tuna (SBFT) vessels are operating; and the CCSBT VMS Resolution specifies that when vessels are fishing for SBFT outside of any RFMO area they must comply with the IOTC VMS requirements.[168]

EM: CCSBT does not have requirements for electronic monitoring using camera and sensor technologies.

ER: CCSBT reporting requirements include a mix of paper-based and electronic reporting, with the Executive Secretary required to compile raw data from the catch documentation system (CDS) into an electronic database.[169]

ETr: CCSBT has a complete multilateral harvest and trade CDS with an objective of eliminating IUU fishing, which came into effect on 1 January 2010.[170] However, this remains paper based rather than electronic.

IATTC
The Inter-Amer tropical tuna Commission (IATTC) is responsible for the conservation and management of tuna in the eastern Pacific Ocean, with over 20 members and 5 cooperating non-members.[171] Member states diverge widely in terms of comprehensive legislation, governance, and resources for EFIS and for fisheries management more broadly. As with many RFMOs, it is challenging for the IATTC to implement EFIS beyond electronic vessel tracking.

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[166] CCSBT, "Origins of the Convention", https://www.ccsbt.org/en/content/origins-convention
[167] CCSBT, 2018, "Minimum performance requirements to meet CCSBT obligations", https://www.ccsbt.org/sites/ccsbt.org/files/userfiles/file/docs_english/operational_resolutions/CPG1_Minimum_Standards.pdf
[168] Koehler, 2018
[169] CCSBT, 2014, "Resolution on the implementation of a CCSBT CDS", https://www.ccsbt.org/sites/ccsbt.org/files/userfiles/file/docs_english/operational_resolutions/Resolution_CDS.pdf
[170] Hosch and Blaha, 2017; CCSBT, "Monitoring, Control, and Surveillance", https://www.ccsbt.org/en/content/monitoring-control-and-surveillance
[171] IATTC, "Main Page", http://www.iattc.org/HomeENG.htm

EFIS Status
ET: The IATTC has VMS requirements, implemented through national programs, whereby all commercial vessels 24 meters or great in length harvesting tuna or tuna-like species in the Eastern Pacific Ocean must be equipped with VMS.[172] In 2018, the IATTC considered developing a stand-alone VMS scheme by comparing VMS schemes of other tuna RFMOs.[173]

EM: The IATTC does not require EM using camera and sensor technologies. It has been recommended, however, that the IATTC increase monitoring for the swordfish fishery in the Convention, using either EM or human observers.[174] The EU has provided limited funds for interested Ecuadorian industry members to trial camera systems for tuna purse seine vessels.[175]

ER: The IATTC does not require ER. In 2017, the IATTC undertook an evaluation of transitioning observers to record data electronically instead of via paper, and found that it was not economically feasible.[176]

ETr: The IATTC has a trade documentation scheme (TDS) to monitor trade of bigeye tuna, with TDS being a precursor to CDS and does not fully capture the dynamics between harvest and trade.[177] Ecuador, working in close partnership with the IATTC, has been implementing a FIP for mahi mahi since 2009, with the fishery now undergoing formal evaluation for MSC certification and expected to be certified by December 2019.[178]

ICCAT
Established in 1966, managing tuna and tuna-like species fisheries as well as pelagic sharks fished in the Atlantic Ocean and adjacent seas, the International Commission for the Conservation of Atlantic Tunas (ICCAT) is one of the oldest and largest RFMOs (both in terms of membership and geographical area) counting 53 Contracting Parties.[179] ICCAT has made progress towards EFIS for bluefin tuna, being one of several RFMOs with an electronic catch documentation system (CDS) in place for recording and reporting harvest and trade data.[180]

EFIS Status
ET: ICCAT has had ET requirements in place since 2008, with vessels 20 meters in length or greater, and 15 meters or greater for Eastern Atlantic and Mediterranean bluefin required to be equipped with VMS.[181] As of 1 January 2020, VMS requirements will apply to all vessels above 15 meters. ICCAT does not, however, have a centralized VMS entity, nor does it have strict reporting procedures or penalties for VMS technology failure or non-compliance.[182]

EM: ICCAT does not have EM requirements with sensor and camera systems.

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[172] Koehler, 2018
[173] IATTC, 2018, "93rd Meeting", https://www.iattc.org/Meetings/Meetings2018/IATTC-93/PDFs/Docs/_English/IATTC-93-05_Possible%20development%20of%20a%20stand-alone%20IATTC%20VMS%20scheme.pdf
[174] FishSource, 2017, "Swordfish", https://www.fishsource.org/fishery_page/2771
[175] Pers comm, Vishwanie Maharaj, 06/07/2019
[176] IATTC, 2017, "36th Meeting of the Parties", https://www.iattc.org/Meetings/Meetings2017/AIDCP-36/PDFs/Docs/_English/MOP-36-INF-B_Electronic-recording-of-data-by-observers-at-sea.pdf
[177] Hosch and Blaha, 2017
[178] FisheryProgress.org, "Completed: Ecuador mahi-mahi – longline", https://fisheryprogress.org/fip-profile/ecuador-mahi-mahi-longline; http://www.wwf.org.ec/?uNewsID=343990
[179] ICCAT, "Contracting Parties", https://www.iccat.int/en/contracting.html
[180] Hosch and Blaha, 2017
[181] Koehler, 2018
[182] Pers comm, Alessandro Buzzi, 06/11/2019

ER: ICCAT requires ER through its electronic bluefin catch documentation system (eBCD), operational since of 2016.[183] Some CPCs have reported technical challenges with using the eBCD system. ICCAT does not yet have an electronic reporting scheme for other tuna, and there has been discussion of expanding eBCD for other species.[184]

ETr: ICCAT's eBCD is a complete multilateral harvest and trade CDS for bluefin, with an objective of eliminating IUU fishing.[185] Although it is a good tool to prevent IUU fishing and trade, loopholes have still been proven to exist.[186]

IOTC

The Indian Ocean Tuna Commission (IOTC), established in 1993, is responsible for the management of tuna and tuna-like species in the Indian Ocean.[187] As with many RFMOs, there is a large disparity of enabling conditions for implementing EFIS among its member states, limiting its ability to require electronic recording and reporting of fisheries data other than vessel tracking.

EFIS Status

ET: The IOTC has a VMS Program implemented through national programs, whereby the Members and cooperating non-contracting parties must adopt VMS for vessels 24 meters or greater in length, and for all vessels operating within the IOTC area of competence.[188]

EM: The IOTC does not have a requirement for EM systems using camera and sensor technologies; however, there have been recent discussions and action on incorporating EM into the IOTC monitoring program. Resolution 16/04 on the implementation of a regional observer scheme (ROS) is focused on improving observer coverage via EM, with a pilot project initiated in Sri Lanka, to be followed by Pakistan and Iran. Further, at the Working Party on Data Collection and Statistics 2018 there was a recommendation to the Scientific Committee of the IOTC to assist with verification of alternate data collection systems in small scale fisheries, such as crew, observers, electronic monitoring, and port sampling.[189]

ER: The IOTC does not require ER, and reporting is primarily paper-based. CPCs that use electronic logbooks can submit reports by taking screen captures.[190] There was, however, recent discussion on electronic reporting at the 2018 Commission meeting and the IOTC Secretariat was tasked to develop minimum standards for data collection and reporting.[191]

ETr: The IOTC has a trade documentation scheme (TDS) to monitor trade of bigeye tuna.[192] There is no provision for electronic traceability.

[183] ICCAT Rec. 17-09, https://www.iccat.int/en/eBCDprog.asp
[184] ICCAT, "Report of the 13th Meeting…", https://www.iccat.int/Documents/Meetings/Docs/2019/REPORTS/2019_IMM_ENG.pdf; Hosch, 2016
[185] Hosch and Blaha, 2017
[186] WWF, 2018, "80 tons of illegal bluefin tuna…", http://www.wwfmmi.org/newsroom/latest_news/?uNewsID=336793
[187] FAO IOTC, https://www.iotc.org/
[188] Koehler, 2018
[189] Pers comm, Umair Shahid, 06/12/2019
[190] IOTC, Resolution 15/01, http://www.iotc.org/compliancne/fishing-logbooks-templates-samples
[191] Pers comm, Umair Shahid, 06/12/2019
[192] Hosch and Blaha, 2017

WCPFC
The Western and Central Pacific Fisheries Commission (WCPFC) manages and conserves highly migratory fish stocks in the Western and Central Pacific.[193] Although individual members may not have strong enabling conditions for implementing EFIS, WCPFC is at an advantage with a coalition of coastal states (Parties to the Nauru Agreement, PNA) who have experience in developing and implementing iFIMS, an integrated and interoperable EFIS.

EFIS Status
ET: Since 2009, the WCPFC has operated a centralized VMS, with all vessels over 24 meters in length fishing for highly migratory stocks on the high seas within the Convention Area required to be equipped and comply. The RFMO has adopted VMS Standards, Specifications and Procedures, and Standards Operation Procedures.[194]

EM: The WCPFC does not have requirements for EM using camera and sensor technologies, and requirements for observer coverage varies within the region.[195] Some WCPFC member countries have utilized and trialed EM systems, including Australia, the Solomon Islands, Papua New Guinea, and Fiji, and the WCPFC Commission adopted a recommendation encouraging EM to help fill data gaps.[196]

ER: The WCPFC allows both paper-based and electronic reporting; and the PNA, which operates within the WCPFC, requires electronic logbook reporting as part of iFIMS.[197]

ETr: The WCPFC does not have a TDS or CDS for monitoring harvest and trade. However the "audit and traceability" element of iFIMS aids verification of chain of custody of fish that is essential for exporting tuna to international markets and for gaining Marine Stewardship Council certification for the skipjack and yellowfin purse seine free school fishery.[198]

Non-tuna RFMOs

NAFO
The Northwest Atlantic Fisheries Organization (NAFO) Convention on Cooperation in the Northwest Atlantic fisheries applies to most fishery resources in the Convention Area, with the exception of salmon, tunas/marlins, whales, and sedentary species.[199] NAFO was established in 1979 and has 12 contracting parties, many with strong legislation, governance, resources, and expertise that would enable them to implement EFIS.

EFIS Status
ET: NAFO requires all Contracting Party vessels fishing in the NAFO Regulatory Area to be equipped with VMS, and to report position, speed, and course every hour to their national Fisheries Monitoring Center (FMC). [200] FMCs forward data to NAFO's headquarters.

[193] WCPFC, "Home", https://www.wcpfc.int/home
[194] Koehler, 2018
[195] WCPFC, 2018
[196] Banks et al, 2016
[197] WPFMC, 2014, "Electronic Logbook Certification Guidelines", https://www.wcpfc.int/node/6133
[198] Hosch and Blaha, 2017
[199] NAFO, "About Us", https://www.nafo.int/About-us
[200] NAFO, "Vessel Monitoring System", https://www.nafo.int/Fisheries/ReportingRequirements/VMS; ISSF, 2018

EM: NAFO does not require EM with camera and sensor technologies. Observer reports must be submitted in electronic format to the Executive Secretary.[201]

ER: Vessels are required to transmit daily catch information directly to their FMC, and logbook data are submitted in either Extensible Markup Language (XML) or Microsoft Excel within 60 days of completing a fishing trip.

ETr: NAFO does not have comprehensive electronic traceability requirements. Select fisheries and regions have implemented measure for ETr, for example, all halibut caught in the Gulf of St. Lawrence (NAFO Fishing Area 4R) must be tagged with a unique code and register its weight with a monitoring service, allowing the public to trace the halibut back to an individual harvester using a smartphone, tablet or computer.[202]

NEAFC

The Northeast Atlantic Fisheries Commission (NEAFC), which began in 1982, manages fisheries from the southern tip of Greenland, east to the Barents Sea, and south to Portugal.[203] The four major fisheries in the NEAFC Regulatory Area are all pelagic and include herring, mackerel, blue whiting, and redfish.[204] NEAFC has only five members and four cooperating non-members, most with strong enabling conditions for implementing EFIS.

EFIS

ET: As part of its Scheme of Control and Enforcement, NEAFC requires all Party vessels greater than 20 meters fishing in the NEAFC Regulatory Area to be equipped with VMS, and flag states operate VMS for vessels flying their flag and must meet NEAFC minimum operation requirements.[205]

EM: NEAFC does not require EM with camera and sensor technologies.

ER: NEAFC requires contracting parties to maintain a logbook, either paper-based or electronic[206]; and in 2018 adopted an amendment to begin implementing a new electronic reporting system, ERS[207]. Vessels must electronically submit catch reports, landings, and transshipment operations to their national Fisheries Monitoring Centers (FMCs) who in turn submits reports to NEAFC. Contracting parties must also submit official catch figures to the FAO through its electronic STATLANT system.[208]

ETr: NEAFC does not have a fully interoperable electronic traceability system or requirements in place, however, many of its fisheries are traceable due to its strong Scheme of Control and Enforcement which has necessary tools for monitoring, control, and surveillance; and a Port State Control system which helped significantly reduce the amount of illegal frozen fish from entering the European market.[209] In 2012, the Port State Control system was upgraded to digital forms to replace the fax-based system. Further, many of its

[201] NAFO, "Observer Scheme", https://www.nafo.int/Fisheries/MCS/ObserverScheme
[202] This Fish, 2015, "Traceability to help Newfoundland…", https://thisfish.info/generic/article/newfoundland-traceable-seafood/
[203] NEAFC, "Home", https://www.neafc.org/
[204] NEAFC, "Submission re UN General Assembly Resolution 66/68", https://www.un.org/Depts/los/general_assembly/contributions_fisheries/2012/NEAFC.pdf
[205] Koehler, 2018; NEAFC Article 11
[206] NEAFC, "Article 9", https://www.neafc.org/scheme/Chapter3/article9; https://www.neafc.org/scheme/Chapter3/article13
[207] NEAFC, "Press Release from the 2018 Annual Meeting…", https://www.neafc.org/system/files/AM-2018-press-statement-final.pdf
[208] NEAFC, "Submission re UN General Assembly Resolution 66/68", https://www.un.org/Depts/los/general_assembly/contributions_fisheries/2012/NEAFC.pdf
[209] NEAFC, "Submission re UN General Assembly Resolution 66/68"

member states have demonstrated a commitment to traceability for over a decade, with electronic traceability in place for select fisheries, such as Norway's herring fishery[210] and various fisheries in Iceland through a private partnership with industry and supermarkets[211].

SEAFO

The Southeast Atlantic Fisheries Organization (SEAFO) entered into force in 2003 to manage fisheries in the Southeast Atlantic, West of Africa's EEZs. Examples of SEAFO species of economic importance include alfonsino, orange roughy, oreo dories, armourhead, sharks, deepwater hake and red crab.[212] SEAFO has some electronic collection and reporting mechanisms in place, but does not have comprehensive EFIS.

EFIS Status

ET: As part of its System of Observation, Inspection, Compliance and Enforcement, SEAFO requires all Party vessels fishing in the SEAFO Convention Area to be equipped with VMS, and flag states operate VMS for vessels flying their flag and must meet SEAFO minimum operation requirements.[213]

EM: SEAFO does not require EM with camera and sensor technologies.

ER: SEAFO does not require collection and reporting of catch via electronic logbooks, but does require catch reports to be submitted electronically to national Fisheries Monitoring Centers (FMCs) every five days, using Microsoft Excel format.[214]

ETr: SEAFO does not have a fully integrated and interoperable electronic traceability system in place. It has, however, shown a commitment to improving traceability and reducing IUU, for example by banning at-sea transshipments in its Conservation and Control Measures in 2006.[215]

SIOFA

The Southern Indian Ocean Fisheries Agreement (SIOFA), entered into force in 2012 and having nine contracting parties, manages fisheries in the Southern Indian between eastern African and western Australia – adjacent to CCAMLR, SPRFMO, and SEAFO convention areas.[216] Valuable fisheries in the SIOFA region include orange roughy, alfonsino, and toothfish. Excluded are highly migratory species and sedentary species subject to the fishery jurisdiction of coastal states.[217] SIOFA member states vary greatly in their ability to manage fisheries and implement EFIS, and SIOFA aims to account for the needs of developing states.

EFIS Status

ET: As part of its Conservation Management Measures, all contracting and non-contracting party fishing vessels operating in the SIOFA Agreement Area must be equipped with VMS and transmit position reports every two hours.[218]

EM: SIOFA does not require EM with camera and sensor technologies.

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[210] Seafood from Norway, "Seafood Safety", https://herring.fromnorway.com/herring/seafood-safety/

[211] CISION, 2018, https://www.prnewswire.com/news-releases/oliver-lucketts-niceland-seafood-partners-with-king-soopers-and-city-market-300763576.html

[212] SEAFO, "About", http://www.seafo.org/About

[213] Koehler, 2018

[214] SEAFO, "Current SEAFO System", http://www.seafo.org/Management/System_docs

[215] Frontier in Marine Science, https://www.frontiersin.org/articles/10.3389/fmars.2018.00240/full#B26

[216] SIOFA, "Introduction", http://www.apsoi.org/

[217] Australian Government, "SIOFA", http://www.agriculture.gov.au/fisheries/international/siofa

[218] SIOFA, 2018, "Conservation and Management Measures", http://www.apsoi.org/sites/default/files/documents/cmm/Compendium%20of%20SIOFA%20CMM%202018.pdf

ER: SIOFA does not require collection and reporting of catch via electronic logbooks.

ETr: While SIOFA has clearly defined Conservation Management Measures including recording and reporting requirements, it has minimal electronic requirements in place and thus does not require electronic traceability.

SPRFMO
The South Pacific Regional Fisheries Management Organization (SPRFMO) Convention applies to the high seas of the South Pacific, covering about a quarter of high seas areas globally.[219] The main commercially fished species in the SPRFMO Area include Jack mackerel and jumbo flying squid. There are minimal EFIS requirements for vessels fishing in the Convention Area, with SPRFMO only requiring electronic vessel tracking via VMS.

EFIS Status
ET: The SPRFMO Commission requires all vessels authorized to fish in the Convention Area to be monitored by VMS.[220]

EM: SPRFMO has observer program requirements for members. Observer data to be submitted via Microsoft Excel format. EM is recognized as an alternative or complementary to observers in CMM 16-2019.

ER: The use of digital recorders and electronic notebooks for observers is mentioned in CMM, but ER is not required or implemented.

ETr: No evidence of electronic traceability requirements were found.

Other Regional Management Groups

CCAMLR
The Convention on Conservation of Antarctic Marine Living Resources (CCAMLR) has a 25 member Commission, established by international convention in 1982 in response to concerns over the potential increase in commercial krill fishing.[221] CCAMLR also manages icefish, toothfish (*Dissotichus* spp), and other marine living resources in the Antarctic. It established a web-based electronic catch documentation system (e-CDS) for collecting and reporting toothfish harvest and trade data which incorporates EFIS components for these species.[222]

EFIS Status
ET: CCAMLR has centralized VMS whereby national control centers report to the CCAMLR Secretariat in near-real time. All CCAMLR Parties fishing in the Convention Area are required to be equipped with VMS and comply with the transmission requirements and standards set by CCAMLR.[223]

[219] SPRFMO, https://www.sprfmo.int/
[220] SPRFMO, "Conservation and Management Measures", https://www.sprfmo.int/measures/
[221] CCAMLR, "About CCAMLR", https://www.ccamlr.org/en/organisation; FAO, "CCAMLR – VMS programme", http://www.fao.org/fishery/topic/18073/en
[222] CCAMLR, "Conservation Measure 10-05 (2018)", https://www.ccamlr.org/en/measure-10-05-2018
[223] Koehler, 2018, "RFMO VMS"

EM: CCAMLR does not require EM with camera and sensor technologies.[224] It does, however, have an intensive scientific observer program that reflects the conservation and scientific purposed of the founding agreement and thus is not on the agenda to introduce EM.[225]

ER: CCAMLR launched e-CDS in 2005, electronic submission of catch reporting forms became mandatory in 2010, and an upgraded e-CDS became operational in 2017.[226]

ETr: CCAMLR's e-CDS is a multilateral harvest and trade system for toothfish which can produce validated catch certificates[227]; but this has proved challenging to monitor and enforce due in part to lack of political will by all parties involved in toothfish harvest and trade[228].

PNA

The Parties to the Narau Agreement (PNA) is a coalition of eight coastal states[229] that controls about 50% of the global supply of skipjack tuna.[230] The PNA manages its fisheries using the Integrated Fisheries Information Management System (iFIMS) which integrates ET, observer monitoring, and ER, and includes auditing of data and traceability. It provides interoperable support for coastal state, flag state and port state responsibilities associated with monitoring control and surveillance, fisheries science, and traceability requirements of importing countries. Currently the PNA implements iFIMS only for purse seiners and tracking fish aggregating devices. The PNA intends to expand iFIMS to include longline, carrier, and bunker (refueling) vessels in the future.

EFIS Status

ET: VMS electronic vessel tracking and position reporting is required by PNA and is integrated into iFIMS.

EM: Fishery observer management and reporting is integrated into iFIMS, with observers able to directly enter catch data into the system from electronic tablets. The PNA Ministers have put a priority on developing an EM system with camera and sensor technologies, with a goal of having 100% EM coverage of longline fishing vessels by 2023.[231]

ER: The PNA requires electronic catch documentation, port monitoring, and logbook reporting as part of iFIMS.[232] This provides automated cross verification of catch and landings data, allowing a flag state to authorize Catch Certificates and coastal states to monitor vessel compliance.

ETr: The "audit and traceability" element of iFIMS aids verification of chain of custody of fish that is essential for exporting tuna to international markets and for gaining Marine Stewardship Council certification for the skipjack and yellowfin purse seine free school fishery.[233]

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[224] CCAMLR, "CCAMLR Scheme of International Scientific Observation", https://www.ccamlr.org/en/science/ccamlr-scheme-international-scientific-observation
[225] Pers comm, Alistair Graham, 05/26/2019
[226] Hosch and Blaha, 2017
[227] CCAMLR, "Catch Documentation Scheme (CDS)", https://www.ccamlr.org/en/compliance/catch-documentation-scheme; Hosch and Blaha, 2017
[228] Pers comm, Alistair Graham, 05/26/2019
[229] PNA members include the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu.
[230] PNA, "About Us", https://www.pnatuna.com/About-Us
[231] PNA, "Electronic Monitoring Program", http://www.pnatuna.com/content/pna-focuses-electronic-monitoring-program
[232] PNA, "iFIMS", http://www.pnatuna.com/content/ifims-backbone-pna-fisheries-management
[233] Hosch and Blaha, 2017; http://www.pnatuna.com/content/ifims-backbone-pna-fisheries-management

Acknowledgements

The authors would like to thank the following people for their contribution to and review of relevant report sections:

Esteban Arenas
Chris Bishop
Bran Black
Miron Borgulev
Mariann Breu
Alessandro Buzzi
Guillermo Canete
David David
Benjamin Freitas
Alistair Graham
Pablo Guerrero
Brianne Kelly
Michele Kuruc
Amanda Leathers
Vishwanie Maharaj
Vinod Malayilethu
Simon Miller
Fredrik Myhre
Doohyun Park
Umair Shahid
Erik Raudzens
Nicolas Rovegno
Pakawan Talawat (Mod)
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