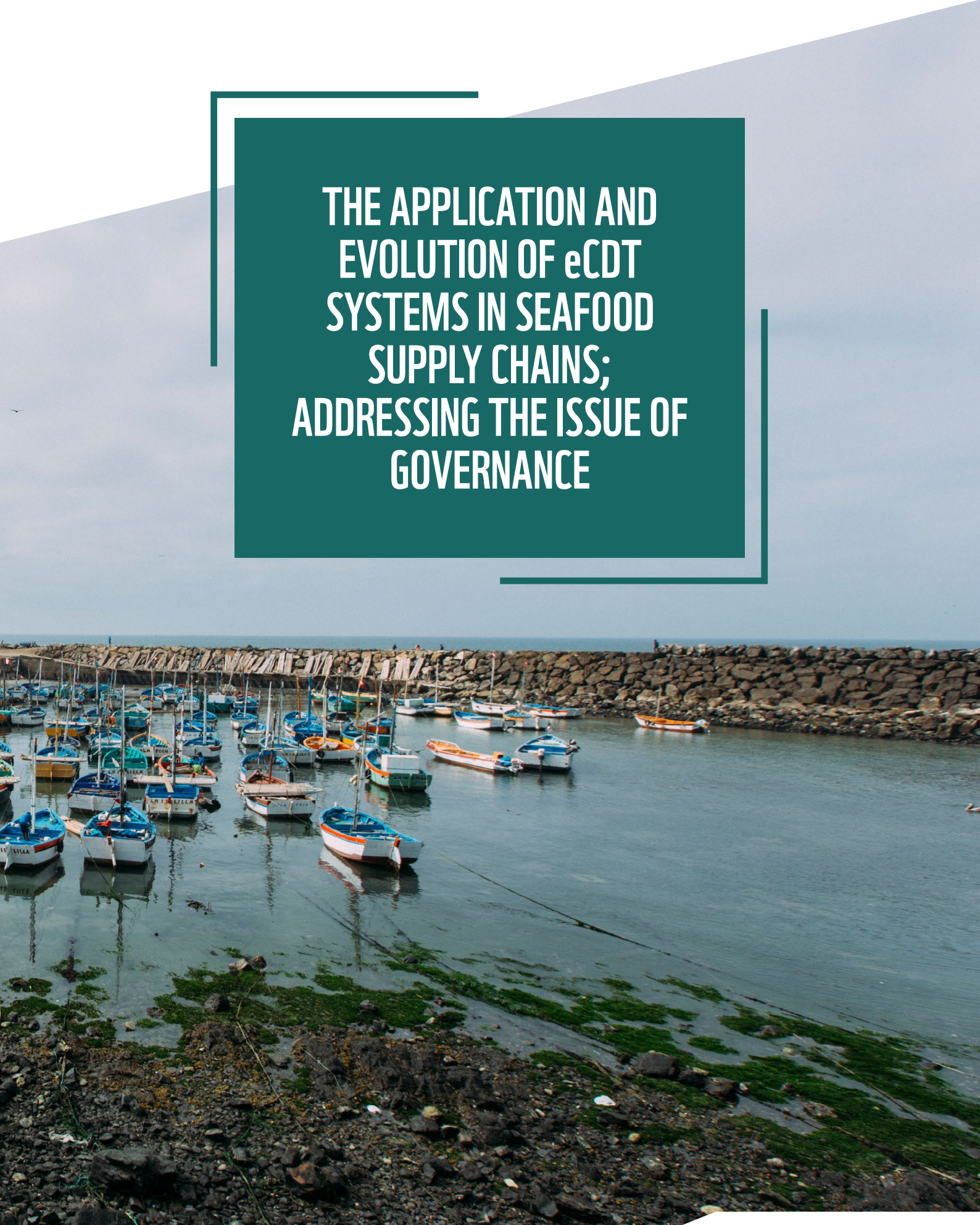
# THE APPLICATION AND EVOLUTION OF eCDT SYSTEMS IN SEAFOOD SUPPLY CHAINS; ADDRESSING THE ISSUE OF GOVERNANCE



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# Acronyms & Definition of Terms

| | |
|---|---|
| AIS | Automatic Identification System |
| API | Application Programming Interface |
| CCTV | Closed-circuit Television |
| CQR | Certified Quality Reader |
| CTE | Critical Tracking Event |
| DMC | Data Management Committee |
| DSA | Data Sharing Agreement |
| eCDT | Electronic Catch, Documentation, and Traceability |
| EPCIS | Electronic Product Code Information System |
| ER | Electronic Reporting |
| ETP | Endangered, threatened, and Protected |
| FIP | Fisheries Improvement Project |
| GDST | Global Dialogue for Seafood Traceability |
| GPS | Global Positioning System |
| HCD | Human-Centered Design |
| IMO | International Maritime Organisation |
| KDE | Key Data Element |
| MDPI | Masyarakat dan Perikanan Indonesia |
| ML | Machine Learning |
| MMAF | Indonesia Ministry of Marine Affairs and Fisheries |
| MSC | Marine Stewardship Council |
| NGO | Non-governmental Organisation |
| NOAA | U.S. National Oceanic and Atmospheric Administration's Fisheries agency |
| PSMFC | Pacific States Marine Fisheries Commission |
| RFM | Remote Electronic Monitoring |
| ROI | Return on Investment |
| SALT | Seafood Alliance for Legality and Traceability |
| SIMP | Seafood Import Monitoring Program |
| SME | Small and Medium-Sized Enterprise |
| SMS | Text Messaging Service |
| VMS | Vessel Monitoring System |

# Figures & Tables






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We need good information about fishing. That is the bottom line if we want fishing that coexists with healthy marine ecosystems and fisheries that support sustainable livelihoods. And it is the bottom line if we want seafood products to reach markets around the world starting from practices that are legal, equitable, and humane. In short, securing a responsible and durable future for seafood depends on a combination of data-rich fisheries management and transparent, traceable supply chains.

Today, we have the digital technologies necessary to achieve these goals. Affordable and practical solutions are widely available, ranging from on-board cameras to satellite location devices, simple electronic logbooks, internet-connected scales, QR codes, blockchain, digital inventory control, and much more. A new term—"electronic catch documentation and traceability" (eCDT)—has lately been coined to describe the combination of these technologies into a linked set of systems that together provide ready access to reliable information and the means to share that information securely across the globe.

# Foreword

Unfortunately, we are still some way from getting these technologies into the hands of all the people and businesses who need them. But the availability of technology itself is no longer the rate-limiting factor. Instead, multiple early experiences teach us that the main obstacles to widespread and successful adoption of eCDT are human and institutional in nature. Broadly speaking, it is the governance of eCDT systems—how they are organized, financed, administered, and interconnected—that pose the greater challenges. Certainly, we must also increase the resources available to catalyze the shift to digital information management across the diffuse and often marginalized seafood production base. But in many cases, improved eCDT governance is itself a key to unlocking the needed resources.

In this paper, WWF has commissioned several leading eCDT experts—teams with both on-the-ground experience and access to global perspectives and knowledge—to open a conversation about eCDT governance and approaches to identifying best practices. This work links with the emergence of early norms for eCDT system design developed through multi-stakeholder consultations by the Seafood Alliance for Legality and Traceability[1], and with the accelerating adoption of industry-wide standards promulgated by the Global Dialogue on Seafood Traceability (GDST).[2] The paper provides an initial theoretical framework for thinking about the issues surrounding eCDT governance, along with the recommendations and reflections of the authors and some examples drawn from specific case studies.

As noted by the authors themselves, this paper is intended to be a conversation-starter, not a definitive treatise. WWF's principal goal in commissioning and publishing this work is to highlight the need for more purposeful attention to the issue of eCDT governance, and to help guide further investigation and ongoing dialogue.

**WWF**



1 SALT, Comprehensive Traceability Principles, available (as of February 2022) at https://www.salttraceability.org/traceability-principles/

2 https://traceability-dialogue.org/

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# Executive

Electronic catch documentation and traceability (eCDT) systems are driving the digital transformation of the fishing sector, improving data accuracy, speed, and accessibility. According to the Seafood Alliance for Legality and Traceability (SALT)[3], a comprehensive eCDT system "*includes ecological, social, and economic data that accompany seafood products, allowing governments to strengthen the effectiveness of fisheries management, support legal and equitable human welfare conditions for seafood laborers, and identify and prevent illegal and mislabeled products from entering domestic and international markets.*"

For the purposes of this report, eCDT technologies include the following:

- Satellite (VMS/AIS/GPS)
- E-logbooks
- Onboard cameras
- Electronic reporting data collection systems
- Data storage, sharing, and analysis systems

Today, three of the most significant barriers to effective technology adoption in fisheries are siloed data collection, a

# Summary

lack of interoperable systems, and failure to set clear roles and responsibilities around data collection, ownership, analysis, sharing and application.[4]

**A siloed approach**

Even when players agree on the importance of data collection, they often want to collect information in their own way. Thus, eCDT systems are frequently developed or modified with minimal coordination across fisheries or along seafood supply chains, resulting in a lack of transparency, misaligned and confusing standards, and uncoordinated as well as siloed data collection and transmission. Effective eCDT requires a high level of collaboration among supply chain actors that is not commonplace, which in turn requires building trust.

**Lack of interoperability**

The proliferation of proprietary eCDT systems developed at different points in time, for different purposes, and for different sectors of the fishery supply chain create significant challenges for interoperability—the technical ability of systems to directly and automatically exchange information.

**Lack of clear roles and responsibilities**

A historical lack of transparency in seafood supply chains has led to a crisis of trust. Whether refusing to trust data protocols to protect sensitive information or only seeing value in data ownership, stakeholders from both industry and government continue to be confused and often misled in their understanding of data ownership and sharing. Once again, bringing together folks that are not accustomed to working together requires an investment in relationship-building and the establishment of clear rules of participation, to ensure representation and accountability.

**eCDT Governance Questions & Answers**

There are a number of critical questions that still need to be answered for the successful utilization of eCDT systems in fisheries. These include: Who owns the system and its data? How is access granted and to whom? Who covers the costs? And how should these decisions be made? Without alignment among stakeholders on the answers to these questions, eCDT systems will only have limited efficacy--data collection without application cannot drive impact.

**Today, three of the most significant barriers to effective technology adoption in fisheries are siloed data collection, a lack of interoperable systems, and failure to set clear roles and responsibilities around data collection, ownership, analysis, sharing and application.**



3 https://www.salttraceability.org/what-is-salt/our-focus/

4 In this context, we are defining "data application" as the act of applying results from data analysis to specific management, enforcement, or marketing efforts (eg--data *application* would be the action taken of sending enforcement agents to intercept an illegal vessel that was identified through the use of AIS *analysis)*

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***Who owns the system and its data?***

Trusted third-party technology providers play a critical role in creating and implementing eCDT systems, and are often the best choice for system ownership. Additionally, the ideal eCDT system is built on open source software, so that the source code can be inspected, modified, and enhanced[5] by any user. These conditions facilitate sharing of costs and labor for software development and maintenance among everyone involved.

As data collectors, fishers and industry should have a say on who the data is shared with. Effective use of eCDT systems in fisheries hinges on fishers willing (and able) to collect accurate data--without them, the rest of the system becomes close to useless. So fishers' needs, incentives, and benefits must be identified and highlighted early on.

***How is access granted and to whom?***

Sharing data reduces duplication of effort and cost in data collection and encourages collaboration, accountability and transparency. Beyond legally mandated information, data collectors should have a say in what information is shared, with whom, and under

5 https://opensource.com/resources/what-open-source

what conditions. In an ideal system, all stakeholders would be consulted during this process and come to an agreed-upon data set.

One way to alleviate monitoring concerns and ensure clear roles and responsibilities is through the use of data sharing agreements (DSA), formal contracts clearly documenting what data is being collected and shared and how it can be used, by whom, and for what purposes. Once agreements around data collection and use are established, it is critical to design and implement interoperable systems aligned to the Global Dialogue for Seafood Traceability (GDST) standard.

Governments should promote systemic interoperability and empower their statistical offices with capacity, resources, and the right policy and legal frameworks to take on coordination of data curation and use across the government, and share data with the public using an online platform. Finally, policies are needed to commit governments to mandate data collection, making the collected information open by default, with clear exemptions relating to confidentiality.

Results sharing back to data collectors is key for fishers and industry to be able to benefit from informed decision-making.

***Who covers the costs?***

When the State owns the system or is directly contracting a technology provider, they usually also assume the system cost. Not all nations have the ability to finance their eCDT systems even when defined by law, creating a funding gap that is sometimes filled by international foundations. Depending on the legislation, industry may also become the ultimate financier when required to do so by the State, be it processing plants, exporters, or end-buyers. In cases where the system is owned by a technology provider, they can charge a licensing fee to different users, who pay according to how much service or storage they require. Diffuse, multi-source funding, as well as innovative financing structures are also options to consider.

***How should these decisions be made?***

The Data Governance Institute defines **data governance** as:[6] "*the exercise of decision making and authority for data-related matters, a system of decision rights and accountabilities for information-related processes, executed according to agreed upon models which describe who can take what actions with what information and under what circumstances, using what methods.*" A good governance system sets the rules of engagement for stakeholder interaction and management activities.[7] For these decisions to stick, there needs to be agreement on how to "decide how to decide;" as well as rules (and the resources to enforce them) around issues such noncompliance, ambiguities, or illegalities.



**Trusted third-party technology providers play a critical role in creating and implementing eCDT systems, and are often the best choice for system ownership.**

6 http://datagovernance.com/
7 https://datagovernance.com/the-dgi-data-governance-framework/




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Electronic catch documentation and traceability (eCDT) systems are revolutionizing the fishing sector by increasing access to critical data needed to:

1) make informed management, business, and legal decisions;
2) establish accountability; and
3) track the social, environmental, and economic sustainability of fisheries.

This shift to digital data systems is especially welcomed in the fisheries sector as a means to overcome some of the significant barriers that currently limit effective resource management and efficient business practices.

Under the current status quo, **seafood supply chain stakeholders are commonly subject to a wide range of data collection requirements imposed by numerous agencies for multiple purposes, including environmental management, licensing, sanitation, sales, and taxes.** Tools and documents such as fishing vessel registrations and licences, vessel monitoring systems, logbooks, sanitation certifications, and export paperwork are all utilized for data collection and analysis.

# Introduction

Each actor generates and records different data sets, later collected and logged by different public administrations or other competent authorities. Records may be kept on paper or electronically, and held by different State and private systems along the supply chain.[8]

These systems have historically been developed by an array of supply chain actors, ranging from the government and industry to NGOs and academic institutions. The multitude of data sources and types, and need for access to data by many different stakeholders in the supply chain makes advancing more integrated data systems that can reliably support effective fisheries management a major challenge.

**Purpose**

This document is is meant to be a conversation starter for electronic catch documentation and traceability (eCDT) practitioners within the seafood sector seeking guidance on effective development and implementation of eCDT systems with a specific focus on the importance of data governance systems, and the impacts of governance decisions on technology, data ownership, access, analysis, and sharing. We define what eCDT systems are (and what they aren't), framing some of the key questions, issues, and current discussions around potential solutions for eCDT data governance.

**Methods**

Research began in October 2020 with a literature review on the uses of eCDT in fisheries, governance issues and lessons, as well as emerging technologies that could provide benefits for the sector. Additionally, we interviewed 22 global experts on eCDT implementation between January and March 2021 for this report ( Annex 5 and 6). These interviews were transcribed, sent to interviewees for approval, and coded using Atlas.TI software to extract participants' most important contributions and group them per themes. Code reports were then exported, summarised, and analysed and compared with the literature to produce this final product.



8 Hosch, G., & Blaha, F. (2017). Seafood traceability for fisheries compliance: country-level support for catch documentation schemes. FAO Fisheries and Aquaculture Technical Paper (FAO) eng no. 619.

# The Value & Challenges of eCDT Systems in Seafood Supply Chains



**eCDT systems applied to seafood supply chains have the potential to improve data collection, standardization and sharing; integrate and manage strategic fisheries information; increase supply chain transparency; highlight red flags for environmental or human rights violations.**

**Electronic catch documentation and traceability (eCDT) systems are driving the digital transformation of the fishing sector;** enabling more accurate, timely, and accessible data to be collected throughout the supply chain. According to the Seafood Alliance for Legality and Traceability (SALT),[9] a comprehensive eCDT system *"includes ecological, social, and economic data that accompany seafood products, allowing governments to strengthen the effectiveness of fisheries management, support legal and equitable human welfare conditions for seafood laborers, and identify and prevent illegal and mislabeled products from entering domestic and international markets."*

**eCDT systems applied to seafood supply chains have the potential to improve data collection, standardization and sharing;** integrate and manage strategic fisheries information; increase supply chain transparency; highlight red flags for environmental or human rights violations, and cover basic issues of personal and business privacy while improving business and management efficiencies. The use of electronic tools provides a unique opportunity to collect, analyze, and share data in close to real-time, laying the foundation for improved management and market decisions to be made by fishers, industry, and government.

## The Use of eCDT Systems for Sustainable and Traceable Fisheries

Currently, **the definition of an eCDT system within seafood supply chains is relatively narrow--generally encompassing only the technologies used to collect, rather than analyze data.** Actors at different nodes in the supply chain can utilize a range of data collection and sharing tools to address a variety of issues, with potential benefits generally categorized as being either economic, environmental, or social (and, in some instances, a blend of two or even all three). For the purposes of this report **eCDT**

9 https://www.salttraceability.org/what-is-salt/our-focus/

**technologies include the following:**

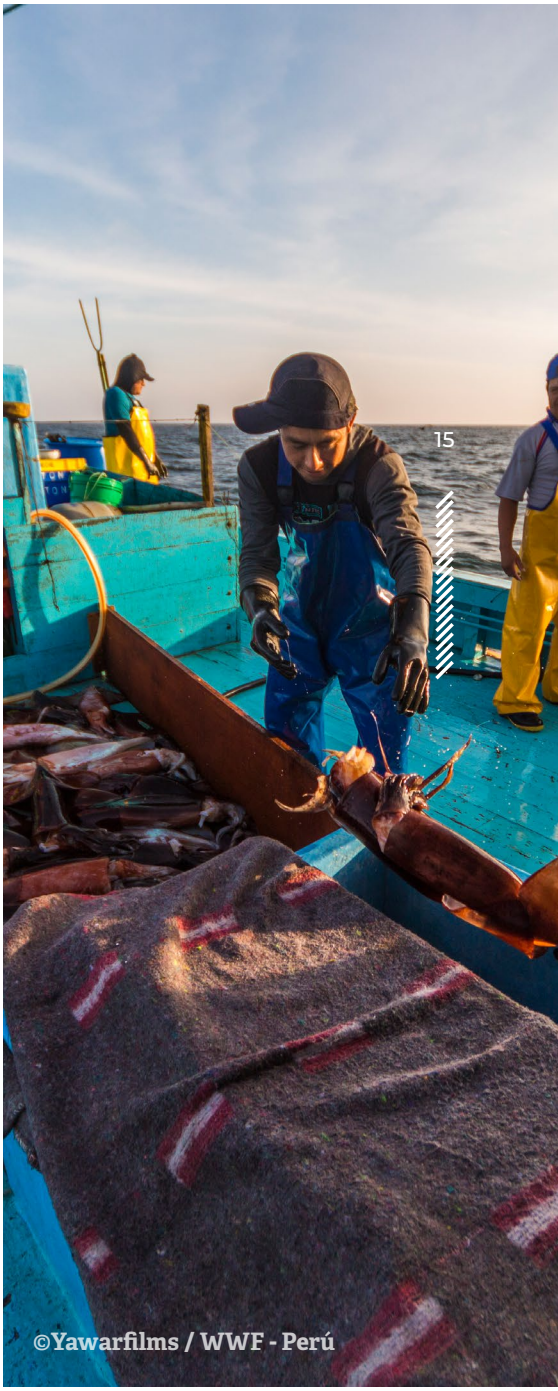
- **Satellite (VMS/AIS/GPS)**
- **E-logbooks**
- **Onboard cameras**
- **Electronic reporting data collection systems**
- **Data storage, sharing, and analysis systems**

The application and combination of technologies utilized will depend on the mandate of the user. Common areas of concern addressed through the use of eCDT systems includes:

- Reducing Illegal, Unreported, or Undocumented (IUU) fishing, as well as opportunities for fraud and corruption along the suppy chain;
- Real-time data to make informed management and business decisions;
- Providing proof of the legality, quality and sustainability of seafood products;
- Risk reduction and rapid response opportunities for issues that might arise along the supply chain.

**The direct benefits of eCDT are improved data accuracy, speed, and accessibility.** While this is an important first step, additional resources need to be made available for the critical following phase of data analysis, sharing, and application,[10] as **without the ability to take action based on data collected, the majority of the eCDT system's potential benefits will not be realized.** In *Annex 2*, we have outlined the main benefits of eCDT use by actor, including market access, reduced paper-work costs, and increased management and business efficiencies.

Below is an example of full-chain use of eCDT systems within a seafood supply chain, including the types of data that would need to be captured at each node to support full-chain traceability:






10 Data application refers to the actions taken based off the analysis of data collected--e.g. directing enforcement agents to assess a fishing zone where satellite images indicate high levels of IUU.

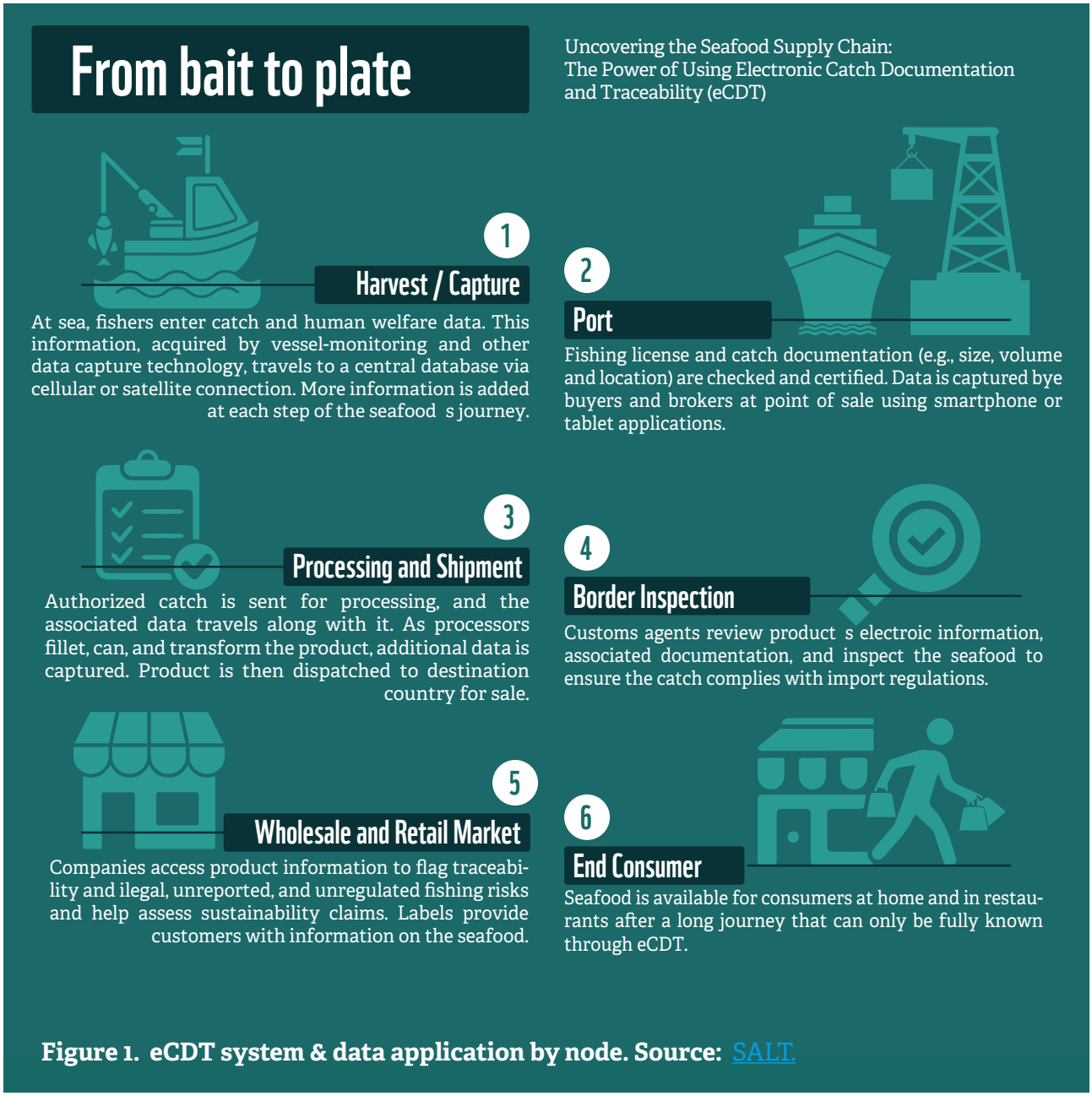



**Figure 1. eCDT system & data application by node. Source:** SALT.



## Current Challenges to the Implementation of eCDT Systems in Fisheries

### Collaboration Issues

While use of electronic tools and systems in fisheries has expanded exponentially in recent years, **many of the potential benefits remain stymied due to a lack of collaboration, communication, and common purpose.** Electronic system components have been developed or modified with minimal coordination across fisheries or along seafood supply chains, resulting in a lack of transparency, misaligned and confusing standards, and uncoordinated as well as siloed data collection and transmission. This situation has many contributing causes, and a range of barriers (some general, some project-specific) that must be addressed to advance interoperable electronic catch documentation and traceability (eCDT) systems and use in fisheries and encourage wide-scale adoption. These include

1. interoperability challenges due to the proliferation of proprietary eCDT systems 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 participant and government goals, species, 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;

4. a resistance by industry and fishers to voluntarily adopt eCDT 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;[11]

5. a lack of implementation of agreed-upon data collection and sharing standards (such as the GDST) within and between stakeholders at local, national, and international level.

**In general, fishers, management authorities, and other stakeholders are resistant to government-mandated change,** including new technologies and particularly those that make participants feel monitored or tracked--in many cases, this is due to skepticism about the government's intentions or what the use of data would mean for their ability to remain in the fishery.[12] Simultaneously, **a historical lack of transparency in seafood supply chains has led to a trust crisis** by consumers into management authorities and the industry that demands the use of traceability technology as a remedy.[14] Because of this dichotomy, there is constant tension between those who collect data and those who use it, **with the benefits of increased data rarely reaching those burdened with its collection.** To help address some of these issues USAID Learn has developed Collaboration Mapping Tools, available in SALT's resource library.

**Technical & Analytic Constraints**

While the current use of eCDT systems in seafood supply chains is commendable, it should not be confused with a stand-alone solution. Primarily, these systems are designed to collect more accurate data more quickly through platforms that permit increased access to and analysis of this data. **Critically, while eCDT systems may improve data speed and access, they cannot automatically guarantee accuracy or authenticity** (although this has the potential to change in the future), which will likely need to be assured through the use of external audits or cross-data verification. **eCDT systems also cannot (currently) independently analyze or apply this data for decision-making,** so the efficacy of the systems ultimately ends up resting on human rather than technological capacity. For Technical Guidance on the Design and Implementation of Electronic Catch Documentation and Traceability Systems, see the USAID Oceans and Fisheries Partnership guidance document in SALT's resource library.

**Many of the potential benefits remain stymied due to a lack of collaboration, communication, and common purpose.**



11 (Sylvia G, Harte M, Borberg J. (2019). Status of electronic collection and reporting of key information in major fisheries.

12 Doddema, M., Spaargaren, G., Wiryawan, B., & Bush, S. R. (2018). Fisher responses to private monitoring interventions in an Indonesian tuna handline fishery. Fisheries Research, 208, 49-57.

13 Mangi, S. C., Dolder, P. J., Catchpole, T. L., Rodmell, D., & de Rozarieux, N. (2015). Approaches to fully documented fisheries: practical issues and stakeholder perceptions. Fish and Fisheries, 16(3), 426-452.

14 Helyar, S. J., Lloyd, H. A. D., de Bruyn, M., Leake, J., Bennett, N., & Carvalho, G. R. (2014). Fish product mislabelling: Failings of traceability in the production chain and implications for illegal, unreported and unregulated (IUU) fishing. PLoS One, 9(6), e98691.

***Needs Analysis Example***

Data recording systems such as e-logbooks can be used to collect critical data elements such as vessel location, trip length, species caught, volumes, and crew information. However, this information is generally siloed post-collection, with different data points populating a variety of forms that are then submitted to a range of databases for access by involved government agencies (although this will be increasingly overcome with the implementation of GDST standards). Agencies are then responsible for analyzing the data collected by fishers through the eCDT systems, a process for the most part conducted by human analysts rather than automated systems. Post-analysis, the information is then shared with the organizational decision-makers, who are responsible for taking actions based on how the results impact their goals and mandates.




**Delayed Return on Investment**

Current utilization of eCDT in seafood supply chains is heavily weighted towards market access, cost-savings, and management measures, with the majority of returns realized over a period of years, not months. This makes it particularly difficult to prove the return on investment (ROI) to supply chain actors, who often do not have the capital available up front to invest in systems that are not guaranteed to create profit. For more information on how to calculate ROI see Future of Fish's toolkit for Calculating Return on Investment in SALT's resource library.

## Cross Geography Barriers

Below is a list of barriers to eCDT implementation that commonly occur across geographies and project types:

- **Competing interests and priorities:** not all fisheries supply chain actors are interested in eCDT for the same reasons or at the same level. This means that getting buy-in and agreeing on a way forward from and with key players like the government, the industry, or fishers is a significant challenge.

- **Data ownership confusion:** despite being inundated with data at every turn, in general, most people are not experts in strategic use of data. Whether it's refusing to trust data protocols to protect sensitive information or only seeing value in data ownership, stakeholders from both industry and government continue to be confused and often misled in their understanding of data ownership and sharing.

- **A siloed approach:** even if some players agree on the importance of collecting data, they probably want to do it their own way. Proper eCDT requires a level of collaboration between supply chain actors they are not used to, which in turn requires building trust. Otherwise, the digital transformation will be no better than current paper-based systems, duplicating efforts, increasing cost, and creating inefficiencies that lead to missed business and management opportunities.

- **Unclear benefits vs. costs:** not defining and highlighting incentives and benefits for different supply chain actors early on reduces acceptance and participation in the system's development and implementation. Additionally, investments tend to focus on pilots, with limited consideration to long-term costs and maintenance.

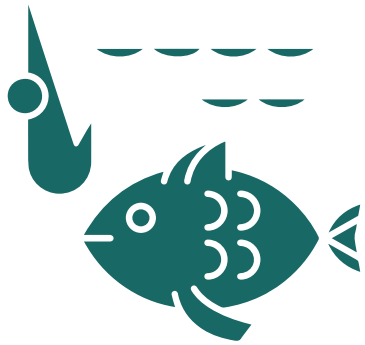
- **Lack of trust between supply chain participants:** bringing together folks that aren't used to working together requires relationship building and the establishment of clear rules of participation, to ensure representation and accountability.

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

- **Lag in policy and training:** lack of regulatory support for the implementation of eCDT systems, does not foster progress. There is also an urgent need of training for government officials to understand and promote eCDT systems and their benefits.

- **Lack of technology infrastructure:** most fishers don't have computers, and yet some existing systems are web-based, which makes access and usability more difficult. Additionally, there are fishers that don't have smartphones, so solutions beyond applications need to be sought for this population. Lack of internet connection in certain locations also needs to be addressed.

# eCDT Governance
# Questions & Answers





The challenges that arise when it comes to collaboration between supply chain stakeholders leads many actors to develop their own eCDT systems.

**The challenges that arise when it comes to collaboration between supply chain stakeholders leads many actors to develop their own eCDT systems.** Unfortunately, if the stakeholder group fails to set a common vision and agree upon what information needs to be collected and shared, by whom, and how, practitioners end up collecting incomplete, overlapping, incorrect, or insufficient information in incompatible formats. For a specific example of such issues, see the Indonesian case study in Annex 2.

While global standards, such as the GDST, around collection of Key Data Elements (KDEs) and traceability implementation are emerging, critical questions remain regarding eCDT system design, ownership, and data access; including the best options for data collection, aggregation and analysis, effective forms of results sharing, and how to ensure sufficient resources for data-based actions.

There are a number of critical questions that still need to be answered (and, preferably, scaled and standardized where possible) for the successful utilization of eCDT systems in fisheries. These include **Who owns the system and its data? How is access granted and to whom? Who covers the costs? And how should these decisions be made?** SWithout alignment between stakeholders on the answers, eCDT systems will only have limited efficacy--data collection without action is not enough to drive change.

## System Creation, Ownership & Stakeholder Roles

Different actors, ranging from governments to NGOs, have taken on the development of eCDT systems, which has resulted in different models of ownership. In some countries the system creation and ownership has been in the hands of government, in others it has been a process entirely led by NGOs or industry, and there are also models that have involved multiple actors. Additionally, as the need for eCDT systems increases, so does the number of third party technology providers willing and able to provide such systems and services.

**Third Party Technology Providers**

**Trusted third-party technology providers play a critical role in creating and implementing eCDT systems, and are often the best choice for system ownership.**

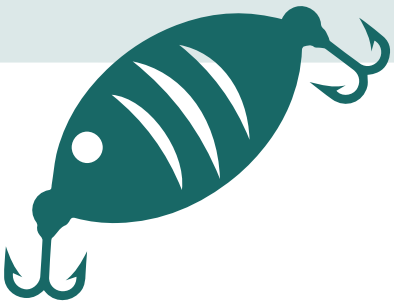
Here's why:

- They are are trained for and best suited to address data security needs and should be able to implement data privacy requirements (which need to be clarified from the onset);[15]
- They can easily understand and implement the GDST or other standards to create interoperability between systems and meet international markets data requirements for export data format;
- They can respond to system errors and maintenance needs in a timely manner and to make system improvements based on user requests;
- They have the capacity to provide data analysis and visualization services based on user needs;
- They can act as a trusted intermediary and provide a buffer when it comes to issues of trust between fishers, industry, and governments.

Preferably, the technology provider is local or has service providers in the same time zone who speak the same language as users, and are able to respond to any technical issues that might arise in close to real time. It is worth noting that utilizing a technology provider as system owner requires a financial mechanism for the long-term sustainability of the business service, which we will address separately. Additionally, **the provision of technical services should not be conflated with the ability to provide effective technical training,** particularly to fishing communities. Effective implementation of any new technology may require hiring of additional personnel capable of clearly communicating both new technical concepts, as well as the purpose and benefits of using this new system for the users.

Ideally, an eCDT system would be built on **open source software,** meaning that the source code can be inspected, modified, and enhanced[16] by any user, permitting efforts and costs of software development and maintenance to be shared between everyone involved.





**Ideally, an eCDT system would be built on open source software, meaning that the source code can be inspected, modified, and enhanced by any user**

15 For guidance on data protection, privacy, and security, see World Vision International's guidance document in SALT's resource library.

16 https://opensource.com/resources/what-open-source

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However, there are currently few examples of open source eCDT systems in use for fisheries management. When open source software is not used, ownership of the source code is an important issue that should be addressed early on with developers to avoid the loss of code if issues arise with the technology provider.

**Government**

In some cases, a trusted technology provider is not available or accepted by supply chain participants. Additionally, **in certain geographies supply chain actors consider that State institutions are best suited to create and operate the eCDT system.** The rationalization for government ownership tends to center around the idea that relevant government actors embedded in fisheries systems can level the playing field for participating supply chain actors, create relevant policy to support sustainable management and equitable access, and provide sufficient financial as well as personnel resources for long-term system maintenance and evolution.

However, in practice, **a number of challenges may arise from government-owned data systems**, including: siloed data collection and data storage, mismatched data needs between government, fishers and industry, insufficient resources, government change and staff

However, in practice, a number of challenges may arise from government-owned data systems, including: siloed data collection and data storage

turnover (potentially leading to a change in State priorities), and a lack of access to data and analytics for relevant system users. While there is no perfect solution, some of these issues may be addressed by activities such as co-design, the creation of interoperable systems based on the GDST standard, and data-sharing agreements, as well as institutionalizing the system into policy requirements. For a specific example, see the New Zealand case study in Annex 2.

### NGOs

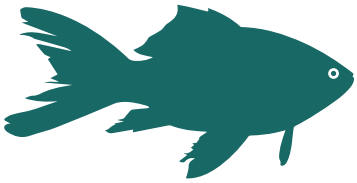
Non-governmental organizations have contributed to the development, adaptation, and implementation of eCDT systems in fisheries around the world. While many of the technologies in use have existed for decades, their application to seafood supply chains and subsequent adoption by fishers, industry, and government, has been heavily influenced by NGOs. These groups **often serve in the role of advisors, intermediaries, trainers, and pilot project leaders for the application of new technologies to fisheries systems**, sometimes even playing a role in system ownership as well.

The main **challenges faced by NGOs are limited and time-bound resources and a general lack of a common vision or effective collaboration between organizations working on similar initiatives.** Competition for limited funding pools can prevent information sharing and cross-geography scaling, while a lack of reliable financing past a 1-3 year period is limiting the efficacy of NGO engagement and creating a cycle of pilots that have limited progress past the implementation stage. For guidance on how to scale traceability see Management Systems International document in SALT's resource library.

### Industry

In many instances, processing plants, exporters, and distributors are already utilizing internal digital systems for business purposes. Similar to fishers, industry has specific goals when it comes to eCDT systems, and the collection and use of such data should not be limited by legal requirements. **In some cases, the fishing industry owns an eCDT system and shares legally required information with the authorities or other participants.** Although a valid option, there are issues of trust with this model that need to be addressed, particularly in regard to small-scale fishers' views of large industry.





NGOs often serve the role of advisors, intermediaries, trainers, and pilot project leaders for the application of new technologies to fisheries systems

Asegurarse de que los recopiladores de datos tienen voz y voto en el uso de la información y se beneficien directamente de ella es vital para garantizar la asimilación del sistema y la recopilación de datos precisos.

**Data Ownership**

When it comes to data ownership, it's not just about equity, it is about practicality--people will only input data to systems they feel ownership of/benefit from. Systems developed by the government tend to have the State assume that fishers and industry will input data just because a requirement to do so is established, but without proper incentives, this is unlikely. Additionally, both fishers and industry tend to have concerns about who will have access to the data and how it will be used. Making sure data collectors have a say in how information is used and directly benefit from the information themselves is vital to ensure system uptake and the collection of accurate data.

**Fishers/Industry**

**The people who collect data should have a say in who it's shared with, and the process of data collection needs to be appropriately incentivized;** without sufficient compensation for information collected, there is no motivation to continue using the system. Effective use of eCDT systems in fisheries hinges on fishers at sea willing to collect accurate data--without them, the rest of the system becomes close to useless. To address these issues, fishers' needs, incentives, and benefits must be identified and highlighted early on; the system should be designed to meet their needs as well as those set out by the government and market. The data should also be shared back with fishers and industry to inform their decision-making. For a concrete example, see the case of the ABALOBI system in South Africa in *Annex 2* of this document.

Both industry and fishers have legal requirements to meet, and eCDT systems can facilitate the collection and sharing of this data with authorities. However, beyond legally mandated information, **data collectors should have a say in what information they share, with whom, and under what conditions.** Determining what data is mandated versus voluntary is a complex process and in many ways situationally dependent--however, in an ideal system, all stakeholders would be consulted during this process and come to an agreed-upon data set, rather than just passing down a mandate from the government.

**Government**

Government bodies require access to certain data sets for a range of reasons, from legal compliance to the ability to make informed management decisions or collect taxes. That being said, one of the main challenges of working with many governments is the desire to own the system and the data, as well as controlling user access. **Seeing eCDT systems as a tool**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**for "control & sanction" hinders the benefits eCDT can bring to different actors, particularly in terms of data empowerment and business improvements,** reason why in the United States there are some government run fisheries data collection regimes that explicitly bar the use of data for enforcement. Additionally, this perspective only furthers fisher distrust of the government and builds resistance to using any technologies that increase government surveillance and enforcement.

**Governments should promote systemic interoperability based on the GDST standards** and empower their statistical offices with capacity, resources, and the right policy and legal frameworks to take on coordination of data curation and use across the government, and share data with the public using an online platform. For a specific example on how the GDST standards are being used as a basis to develop eCDT systems and related policies, see the Mexican case study in *Annex 2.*

> To enable interoperability there needs to be a shared set of expectations around DSAs that should be agreed by all actors sharing information along the supply chain. The GDST is looking into potential standardization and harmonization of DSAs to facilitate agreement among actors.

**Policies are needed to commit governments to make data open by default, with clear exemptions relating to confidentiality,** guidelines for such transparency standards for data are yet to be developed and publicly available.

Data Sharing, Interoperability, and Verification.

**Sharing data reduces duplication of effort and cost in data collection and encourages collaboration, accountability and transparency;** while facilitating data verification through cross-checking and increasing the range of possible analyses. Standardized methods for the validation of self-reported data across geographies are yet to be not established.

One way **to alleviate monitoring concerns and ensure clear roles and responsibilities is through the use of data sharing agreements (DSA),** formal contracts clearly documenting what data is being collected and shared and how it can be used, by whom, and for what purposes. To enable interoperability there needs to be a shared set of expectations around DSAs that should be agreed by all actors sharing information along the supply chain. The GDST is looking into potential standardization and harmonization of DSAs to facilitate agreement among actors. Currently, DSAs usually containing the following items: justification for data sharing, description of the data, intended use, use constraints, data storage and handling requirements, security, confidentiality, data sharing methods, timing and frequency of updates, roles and responsibilities, cost distribution, publication and dissemination of results, termination and modification of the agreement, dispute resolution, governance, and period of agreement[17],[18],[19]. For more information on DSAs see Digital Public's report *Data Sharing Summary One* and *Two* in SALT's resource library.

Once agreements around data collection and use are established, it is critical to design and implement **interoperable systems,**, capable of working with or using the parts or equipment of another system[20]. When it comes to data sharing, it's essential to establish systems capable of aggregating and sharing multiple data types from a range of actors. **Centralized data systems set in an interoperable platform can increase the rate and quality of data collection and submission, and are able to provide specific benefits** to different actors. While interoperabile eCDT systems in fisheries may take a variety of forms, what is definitely undesirable is a) various competing systems that don't exchange information with each other, increasing confusion and complexity for users and duplicating cost and effort for developer, and b) the use of one or more systems imposed on users but don't meet their needs, while preventing the creation or implementation

17 https://ura.uchicago.edu/page/data-sharing-agreements
18 https://www.neighborhoodindicators.org/library/guides/key-elements-data-sharing-agreements
19 https://ocio.wa.gov/sites/default/files/public/TBM/TBM-Data-Sharing-Agreement.pdf
20 https://www.merriam-webster.com/dictionary/interoperability

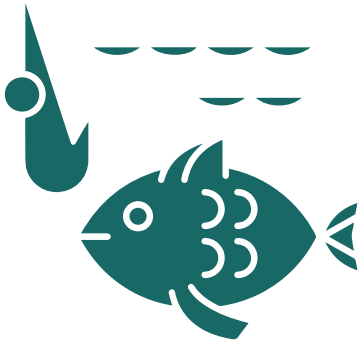
of project-specific best fit solutions.

In order to support information exchange with international markets as well as system scaling, **international interoperability standards** will be essential to underpin the convergence of frontier technologies. These standards are necessary to ensure data can be seamlessly shared or streamed on different platforms and integrated for analysis. Currently, the only recognized global traceability standard for seafood, is the **Global Dialogue on Seafood Traceability (GDST)**[21]; an international, business-to-business platform established to advance a unified framework for interoperable seafood traceability practices. GDST promotes a unified, interoperable seafood traceability framework to improve the reliability of seafood information, reduce the cost of seafood traceability, reduce supply chain risk, and contribute to securing the long-term social and environmental sustainability of the sector. The Dialogue brings together a broad spectrum of seafood industry stakeholders from across different parts of the supply chain, as well as relevant civil society experts from diverse regions.

The GDST developed the first-ever global standards for digital and interoperable seafood traceability by developing internationally agreed upon key data elements (KDEs) to be routinely associated with seafood products, technical specifications for interoperable traceability systems, and standard legal and business formats to facilitate business-to-business information exchange. The GDST process resulted in a decision to build the core elements of the GDST IT standards and guidelines largely as an extension of the GS1 EPCIS standard for event-based traceability. For more information see GDST Standards and Materials on the GDST website.

**External audits and cross-checking of data are still required both for data verification, as well as to ensure that information is being managed as agreed upon by supply chain participants** with the system holder and DSA signatories. Audits are critical both to ensure compliance and legality, as well as for their role in increasing trust and resolving any issues that might arise. It is important to note that **eCDT systems as currently applied to fisheries cannot be used for data verification purposes.** After an eCDT system has been implemented, regular review of the program itself should be conducted to understand whether it is adequately meeting its original goals and objectives and to provide opportunities for refinement or adjustments

As new technologies continue to emerge, there is the potential for data verification to be automated, although human verification of data points measuring issues such as worker welfare at sea will likely not



**Es importante señalar que los sistemas eCDT, tal y como se aplican actualmente a la pesca, no pueden utilizarse para verificar los datos.**



21 https://traceability-dialogue.org/what-is-the-global-dialogue/

be replaced with electronic systems anytime in the near future. For more information on the need for verification see Bradley Soul and Ocean Mind's blog in SALT's resource library.

Data Analysis and Access

Data analysis is generally conducted by the technology provider (who may also be the NGO implementing partner) or government employees. **Results sharing back to data collectors in the form of data visualizations** rather than limiting presentations to a more traditional report format, as this allows users who may be illiterate or uncomfortable with academic writing to access and understand the analyzed data at an equivalent level. Additionally, data collected, an analysis of the data, and most importantly, the uses and benefits of **data analysis should be shared back with users frequently and regularly.** Dissemination of findings should be in an accessible language and format, taking into account considerations such as internet access, disability, language, technical literacy, reading levels, and cultural background. Sharing information with data collectors, allows fishers and industry to organise based on market information and enhances community management of the resources.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**Data access & analysis** may also be improved through the creation of collaborative groups such as **data management committees (DMCs)** for specific fisheries and/or regions, commonly made up of a combination of supply chain actors (fishers, cooperative leaders, industry, government, NGOs, academia). For privacy purposes, data management decisions may be made based on aggregated data analysis which should be presented in a format that is available to all stakeholders, with particular attention paid to the preferred communication methods of local fishing communities (e.g. charts, reports, videos, etc). Ideally, discussions are **professionally facilitated by a trusted third**

**party** and include an analysis of the information presented as well as a discussion of possible corresponding actions to address the findings. This may include responses such as: the temporary closures of certain species or seasons; quota setting; measures to reduce bycatch; changes in fishing gear; creation of a set of recommendations for improvement of working conditions; and a species or regionally specific market analysis.

Such **meetings may be organised by the local government, fishing associations, or NGOs on a monthly, bimonthly, or quarterly basis.** Feedback needs to occur throughout the process to capture lessons learned and act accordingly, and special consideration should be given to the benefits of learning exchanges between regions, countries, and sectors.

In addition to data sharing between stakeholders, creating **public data platforms** for interested parties, such as academics or NGOs can help to **ensure that all actors are subject to the same rules and are being held publicly accountable.** deFor this reason, **any information that isn't considered confidential due to specific and justified criteria should be in the public domain and easily accessible online;** in addition to specific data analysis requests that should be made available for research, audit, or enforcement purposes. The creation of a public website could address common complaints lodged by public authorities receiving multiple requests, as well as fishers, NGOs, or industry in need of specific information, who are often hindered by the tremendous time and effort required for data requests. Ideal government policies will consistently seek to promote user-centered data as a core feature of fisheries management; ensuring that data are available, discoverable, and usable to the greatest extent possible for business, innovation, science, and management.



## Data Governance

The Data Governance Institute defines **data governance** as:[22] "*the exercise of decision making and authority for data-related matters, a system of decision rights and accountabilities for information-related processes, executed according to agreed upon models which describe who can take what actions with what information and under what circumstances, using what methods.*" A good governance system sets the rules of engagement for stakeholder interaction and management activities[23]. Effective systems are only created when the actors involved are able to make decisions about how to manage data and realize value from it, minimize cost and complexity, manage risk, and ensure compliance with a range of legal and regulatory standards. For these decisions to stick, there needs to be mutual agreement on how to "decide how to decide"; as well as rules (and the resources to enforce them) around issues such noncompliance, ambiguities, or illegalities.

Below is an example of a comprehensive data governance framework which includes actors, rules and processes:

> A good governance system sets the rules of engagement for stakeholder interaction and management activities.

22 http://datagovernance.com/
23 https://datagovernance.com/the-dgi-data-governance-framework/

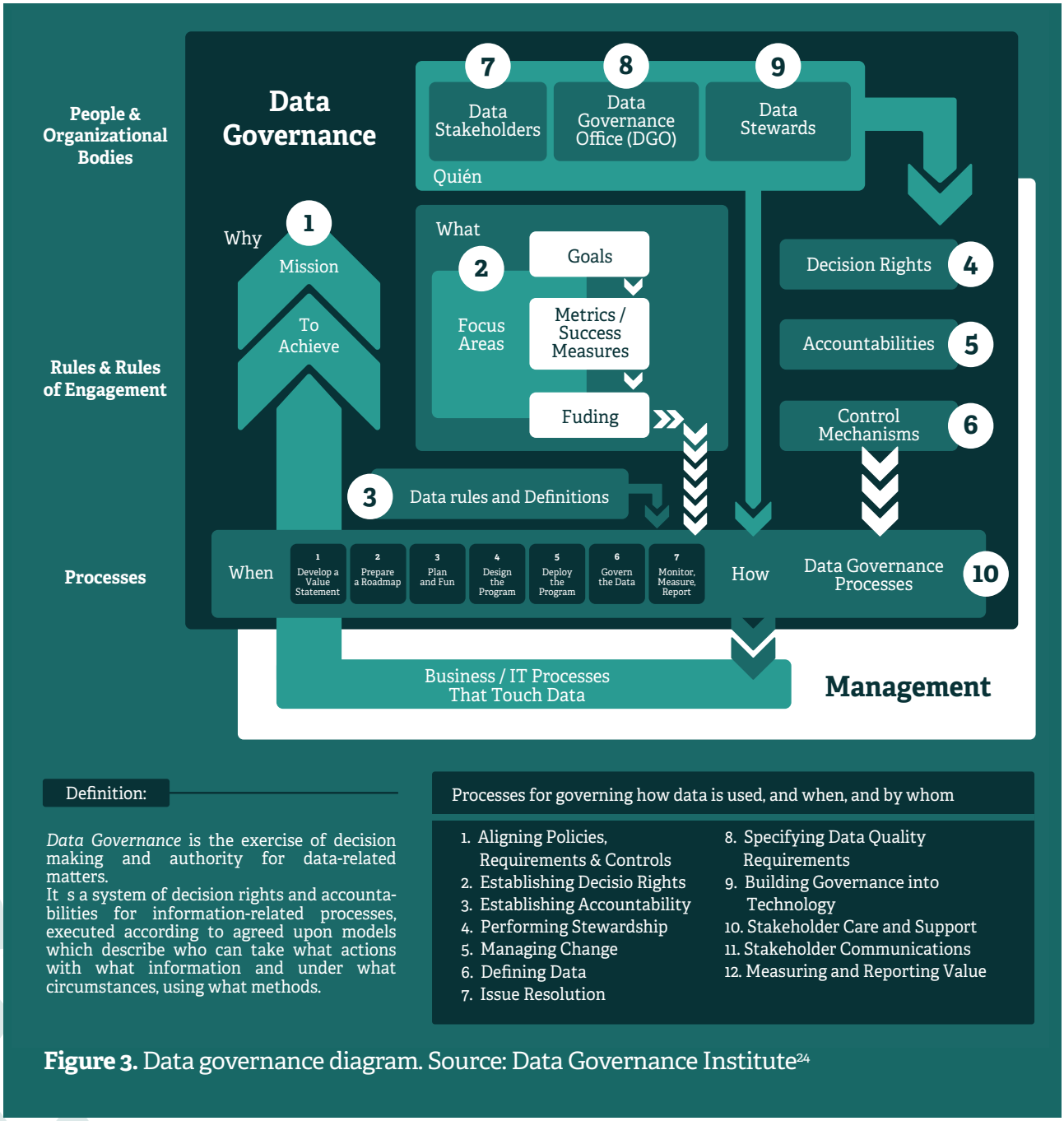


**Figure 3.** Data governance diagram. Source: Data Governance Institute[24]

Integrated and interoperable eCDT systems based on the GDST standard contribute to increased equity, visibility, and empowerment of supply chain actors. That is why, for example, a distributed data system is preferable to a government owned system. **The only way to guarantee equity is by data collectors having a say over how their data is used and who it's shared with.**

Participation of underrepresented groups in data collection exercises, including planning, data collection, dissemination and analysis of data helps build relationships, trust, and collaboration. Decision-making about participation should be transparent and equitable. Reducing inequality contributes to overall prosperity through data access and use, contributing to sustainable development and human wellbeing.

24 https://datagovernance.com/the-dgi-data-governance-framework/

Finding the means to pay for eCDT raises significant challenges, and these challenges can vary depending on the ownership structure of the systems. Guaranteeing the long-term financial sustainability of eCDT systems when not supported by the government is a complex and time-consuming process. Data collection, storage, processing, analysis and application is expensive, and there are significant upfront costs that may not be recovered for years. To better understand traceability technology implementation costs, Future of Fish developed a guidance document available in SALT's resource library.

When the State owns the system or is directly contracting a technology provider, they usually also assume the system cost. Not all nations have the ability to finance their eCDT systems even when defined by law, creating a funding gap that is sometimes filled by international foundations. Depending on the legislation, industry may also become the ultimate financer when required to do so by the State.

In cases where the system is owned by a technology provider, they can charge a licensing fee to different users, who pay according to how much service or storage they require. For example, a third-party provider exploring cost recovery through sales registered through the app can credit transactions (where part of the interest rate covers system maintenance), or have buyers (such as NGOs and academic institutions) pay for the data they want.[25] Whatever model is chosen, **the key is to make sure it's affordable for small-scale fishers, and that the benefits far outweigh costs.**

Generally, it is the brokers (intermediaries) who are giving fishers loans for fuel, supplies, ice, and forward payment for their families, although **artisanal fishers and brokers both tend to have limited access to credits by formal financial institutions due to the fact that they operate in informal economies, unregulated by paper or electronic documentation.** These unregulated business relationships promote a common cycle of financial dependency in which intermediaries loan fishers money for their vessels or gear, locking fishers into selling their products to the intermediary at a set price, often while simultaneously paying (unregulated, sky-high) interest on the original loan.

Linking additional technologies can create a system capable of securely recording and transmitting data regarding price details, sale transactions, invoices, taxes and other financial information increases fisher's direct access to markets, benefits State tax income revenue, and improves the financial formality of the sector. **Financial techno-**



Linking additional technologies can create a system capable of securely recording and transmitting data regarding price details

25 See Philippines case study below


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**logy (fintech) is emergent in the fisheries space, and there are already examples[26] of eCDT systems supporting data sharing with financial institutions;** with the goal of providing banks information required concerning fishers' and intermediaries' economic situation and business in order to unlock access to formal loans. There will hopefully be a day in the near future where fishers can easily access loans by sharing data collected by eCDT systems, breaking long-standing cycles of financial dependency.

26 See Philippines case study below

# Conclusions

This document is a conversation starter on some key issues when it comes to effective development and implementation of eCDT systems, with a specific focus on the importance of data governance, and the impacts of governance decisions on technology, data ownership, access, analysis, and sharing.

Some of the most significant barriers to effective technology adoption in fisheries are siloed data collection, a lack of interoperable systems, and failure to set clear roles and responsibilities. To address these barriers, data collectors, particularly fishers and industry should have a say on what information is shared, with whom, and under what conditions. Additionally, fishers' needs, incentives, and benefits must be identified and highlighted early on, since data collection success depends on their willingness and ability to contribute information to eCDT systems.

When it comes to data ownership, the ideal eCDT system is built on open source software, so that the source code can be inspected, modified, and enhanced by any user; in cases where this isn't possible, agreeing on who is the owner of the code early on is essential to avoid issues later on.

The use of data sharing agreements (DSA) to define ownership and access alleviates privacy concerns and ensures clear roles and responsibilities, contributing to effective interoperability. Additionally, data collected, an analysis of the data, and most importantly, the uses and benefits of data analysis should be shared back with users frequently and regularly.

# & Recommendations

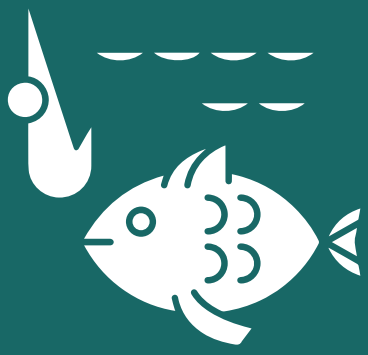
A good governance system sets the rules of engagement for stakeholder interaction and management activities. For these decisions to stick, there needs to be agreement on how to "decide how to decide;" as well as rules (and the resources to enforce them) around issues such noncompliance, ambiguities, or illegalities. Currently, the GDST standard sets the bar for how interoperable systems should be designed and implemented.

Finally, policies are needed to commit governments to mandate data collection and provide sufficient resources for data analysis and application, making the collected information open by default, with clear exemptions relating to confidentiality.

Although the number and variety of scientific papers, reports, best practices, guidelines, standards, and principles for fisheries information management are increasing, some gaps remain. Therefore the authors recommend further research and actions in the following areas:

- **eCDT legislation:** as eCDT systems continue to develop around the globe, an analysis of existing regulatory frameworks that provides guidance on minimum requirements, best practice, and examples of what should be avoided, would help inform governments developing or updating existing policies and regulations, and the supply chain actors trying to influence them.
- **Regional and international collaboration:** gathering information on eCDT systems and data sharing beyond national borders, as well as identifying appropriate regional bodies that should be leading these efforts, would also help increase collaboration and standardization between countries.
- **Technical coordination and interoperability:** The NGOs and technical providers currently creating a wide range of data collection and submission apps for fisheries around the globe will served by improved coordination and information sharing; both so as not to repeat lessons learned, as well as to open the door for collaborative efforts between different types of eCDT systems and technologies.





A good governance system sets the rules of engagement for stakeholder interaction and management activities

- **eCDT alternatives for infrastructure deficient fisheries/actors:** ensuring equitable access to eCDT is very important. Identifying how the sector has responded (or not) to the needs of fishers that have limited access to computers, smartphones, and the internet, can provide guidance to those seeking to address these issues in their own fisheries.

- **Data verification and cross-checking:** the sector is concerned with the validity of the information collected. Defining best practices to address such concerns is important.

- **Data analysis, sharing of results, and changes in the sector due to informed decision-making:** as eCDT systems become more common, a lot of attention has focused on data collection, and rightfully so. But as the systems evolve and implementation becomes more common, documenting how data is analysed, results are shared, and changes in the sector happen, is important to prove the value of eCDT systems in the long-term.

- **eCDT systems data transparency standards:** initial guidelines on what information should be considered confidential due to commercial or privacy purposes, and what data should be of public access and in what formats is really useful information for fisheries actors that are making decisions around these issues, especially including examples of current best practices.

- **Integrate forward-looking technologies and data sets:** issues such as worker welfare at sea, monitoring for climate change impacts, or collection of data required for fishers to build access to credit can all be enabled through the use of eCDt systems combined with additional technologies. Integrating capacities such as onboard cameras, AI systems, environmental sensors, and fintech can create additional system benefits for users outside of traceability.



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# ANNEX 1.

## Emerging Technologies and Potential Applications

While there are some pilot projects in progress to test the use of emerging technologies in fisheries, systemic use is limited and generally only accessible to wealthier nations or projects funded by external foundations. Additionally, **the effective combination of multiple technologies to maximize ease of use, return on investment (ROI), and system benefits is still relatively rare,** and the potential for these tools to be applied in tandem to seafood supply chains is still largely under exploration.

The list of technologies below is not exhaustive, but representative of popular systems identified during the course of our research and through field experience. These technologies should be considered separate but complementary to existing eCDT systems. It should be noted that many of these technologies have existed for years--it is their application to seafood supply chains that is new, and there may be valuable lessons to be learned from other industries (such as agriculture or timber) moving forward.



### Blockchain

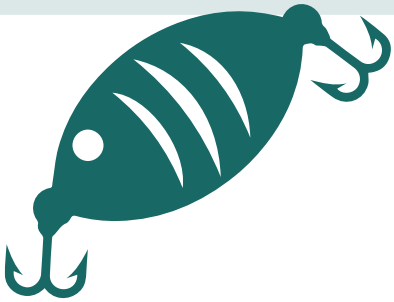
Blockchain is a decentralized and distributed digital ledger or storage facility of transactions replicated at every node and/or by every participant in the network. A decentralized system means that there is no single authority with control over the network, rather, each participant owns their own data and transactions. Blockchain does not collect data, rather it is a secure form of data sharing that is both formally recorded and inalterable.

Blockchain also utilizes persistence, where data is recorded across all nodes of the blockchain, leading to *immutability,* which ensures that data cannot be corrupted. Persistence also provides increased stability through fault-tolerance, where the loss of any node in the blockchain network will not make it unusable. Auditability and transparency are other important characteristics – every single transaction is recorded on the blockchain, which can then be audited later, and transparent in the case of permissionless blockchains, which are open for anyone to view the transactions.[27]

Blockchain-based traceability may work best in fisheries that voluntarily intend to demonstrate their compliance to laws, management rules, and consumer demands, or

**Blockchain does not collect data, rather it is a secure form of data sharing that is both formally recorded and inalterable.**

27 Blaha, F., & Katafono, K. (2020a). Blockchain application in seafood value chains. FAO Fisheries and Aquaculture Circular, (C1207), I-43.



Dado que los pescadores pueden querer organizarse para reducir los conflictos y mejorar las oportunidades comerciales, este tipo de sistemas puede incluso evolucionar en zonas en las que las pesquerías gubernamentales están actualmente poco desarrolladas

in ones that are looking for a self-controlling mechanism to foster trust among competitors. Because fishers may want to organise themselves to reduce conflicts and improve trade opportunities, such systems may even evolve in areas where governmental fisheries are currently weakly developed or totally absent.[28]

Potential utilization of blockchain technology in seafood supply chains include the following:

- **Reduced time lag between data collection and sharing,** as each participant holds an individual proprietary copy of ledger transactions that is synchronized with the entire network-- i.e., each ledger is the same as everyone else's.

- **Increased security and trust between supply chain actors** through decentralization of the ledger system, which may be susceptible to tampering when owned by a single party.

- **Improved data security** by using inalterable data submissions. Once a transaction is recorded on blockchain, it can't be changed without most of the network agreeing to do so, ensuring data security.[29] Blockchain can also improve data verification and encode sensitive data when this is a significant concern for participants.

- With the use of **cryptocurrencies,** blockchain can facilitate the creation of financial mechanisms, where a user pays a cryptocurrency fee to unblock a specific piece of data. These fees can not only help maintain the system but have the potential to provide direct economic benefit to the fisher (data collector) by paying them a percentage benefit for the sale of the data block.

- **Brand differentiation** -- as ethical operators (consumer perspective) and/or efficient and legal operators (buyer perspective).

Idealized benefits aside, it is critical to note that blockchain requires more time, effort, support, and investment than traditional systems, as well as an additional level of expertise, understanding, and training for the people who will use it. Most likely, **use of blockchain does not make economic sense for most small-scale fisheries** that can still benefit from a centralized cloud-based database supported by a strong data governance framework.

Potential barriers to blockchain technology in seafood supply chains include the following:

- **Costs -** use of blockchain can be expensive and may not always be necessary for data that does not have to be secured.

- **Application to fisheries systems** may not always make sense, and data secu-

28 Blaha, F., & Katafono, K. (2020b). Exploring the Suitability and Limitations of Blockchain Application in Seafood Value Chains. INFOFISH International 5/2020.

29 Blaha, F., & Katafono, K. (2020a). Blockchain application in seafood value chains. FAO Fisheries and Aquaculture Circular, (C1207), I-43.

rity issues for management purposes are most likely not proprietary.

- **Ledger and data synchronization** can create information storage inefficiencies, further increasing data storage costs.

- **Environmental considerations -** the environmental impacts of cryptocurrencies such as bitcoin due to high energy consumption and green-house gas emissions are significant and should be considered before integrating into a blockchain project. [30]

***Ejemplo***

Fishcoin[31] utilizes a peer-to-peer network that allows independent industry stakeholders utilize blockchain using a shared protocol. The flow of tokens moves from buyers to sellers in supply chains, powering the blockchain, rewarding those who make the extra effort to capture and communicate data, shifting the economic burden to downstream actors, who need traceability. The Trace Protocol blockchain platform is an open source, scalable platform that addresses the key challenge of who pays what, when, where and how for traceability systems in supply chains, with digital tokens being the medium of exchange for the key data elements (KDEs), allowing the market to price the data, and use the system, as and when they need to. With blockchain traceability becomes accessible for as little as one cent per transaction, the Fishcoin application addresses not only technical but economic accessibility challenges.



## Artificial Intelligence (AI) and Machine Learning (ML)

Although there is no single agreed-upon definition of **artificial intelligence (AI),** in general, it is the process of combining computer science and robust datasets to enable problem-solving. AI encompasses the sub-field of machine learning, consisting of algorithms which seek to create expert systems which make predictions or classifications based on input data. More simply, it may be thought of as "machines that respond to stimulation consistent with traditional responses from humans, given the human capacity for contemplation, judgment, and intention."[32] These software systems make decisions which normally require a human level of expertise, and help people anticipate problems or deal with issues as they come up. Such systems have three qualities that constitute the essence of artificial intelligence: intentionality, intelligence, and adaptability.[33]

**Machine learning (ML)** is defined as a scientific field that seeks to give machines the ability to learn without being strictly programmed.[34] It is a **branch of AI,** and a method of data analysis that automates analytical model building based on the idea that systems can learn from data, identify patterns and make decisions with minimal human inter-

30 Badea, L., & Mungiu-Pupăzan, M. C. (2021). The Economic and Environmental Impact of Bitcoin. IEEE Access, 9, 48091-48104.
31 https://fishcoin.co/
32 https://www.ibm.com/cloud/learn/what-is-artificial-intelligence
33 https://www.brookings.edu/research/what-is-artificial-intelligence/
34 Liakos, K. G., Busato, P., Moshou, D., Pearson, S., & Bochtis, D. (2018). Machine learning in agriculture: A review. Sensors, 18(8), 2674.

vention. Machine-learning algorithms use statistics to find patterns in large amounts of data, which may include numbers, words, images, or almost any other data format.[35]

Potential utilization of AI and ML technology in seafood supply chains include the following:

- AI can **increase efficiencies and decrease costs,** by cross-checking information automatically and raising red flags, making it possible to focus resources at problem points. Additionally, overall accuracy and speed of data analysis may increase.
- AI combined with e-documents can **redistribute data received in a central data platform** and autofill relevant forms from data submitted.
- AI lasers combined with REM can be used to **identify species** (catch and bycatch) size, age, and gender.
- ML can be **applied at sea, at port, or in factories** for activities such as fish identification, species classification, behavioral analysis, feeding decisions, size or biomass estimation, and water quality prediction.

The major barriers to utilization of AI and ML in fisheries are primarily relevance, cost, and comfort--not all situations warrant automation, the relative novelty of the technologies in use may make them cost prohibitive, and, importantly, many people may still be uncomfortable with the use of AI technology.



35 https://www.technologyreview.com/2018/11/17/103781/what-is-machine-learning-we-drew-you-another-flowchart/

36 https://medium.com/syncedreview/ai-provides-solutions-for-the-japanese-fishing-industry-9865cc15cc2f

***Example***

In Japan, Sasebo Kokai Sokki, Sasebo City, and Nagasaki Prefecture are collaborating on the use of navigation and marine meteorological observation equipment for capture fishing. The goal of the project is to offset a declining number of fishers while improving data collection and business efficiencies; utilizing a system that considers market demand and advises fishers how to adjust their catch accordingly. This can prevent fish prices falling due to overfishing, simultaneously reducing the working hours of fishers and associated trip costs as well as the amount of waste going into the water. Market and pricing information is combined with marine weather data from external sources and additional AI data that is largely trained by the fishers themselves. The system at sea logs information about daily catch, seawater temperature, and fishing area, and combines it with other data sources to understand the relationship between fishing yields and weather conditions.[36] An automated analysis (which is where the AI comes in) combining these multiple data sources is then able to provide sustainable and informed market guidance directly to fishers.

## Smart Contracts & Electronic Documents (e-documents)

**A smart contract** is computer code within a blockchain network that can automatically execute when certain conditions are met, without the need for a trusted third party to intervene. These contracts are basically an agreement between the different parties represented in a computer code that is self-executing. The executed code can do many things based on the conditions programmed into it, including transferring the ownership of a digital asset from one entity to another and automating payments to one or more parties.[37]

**e-Documents** are transactional documents exchanged between business or trading partners in an electronic format and manner. Distinct from PDF or image files, e-documents are machine readable and typically exchanged via software or online platforms rather than email. e-Documents may include resources such as purchase orders, invoices, sales receipts, worker contracts, or government-mandated paperwork.[39] There is interesting potential to **connect electronic contracts to eCDT systems in order to increase worker access to documentation** and create a system capable of automatically running cross-checks for potential working violations. This could make it possible to ensure basic standards such as working hours and wages are in line with national regulations governing worker welfare, including social security, pension, and health and disability insurance.

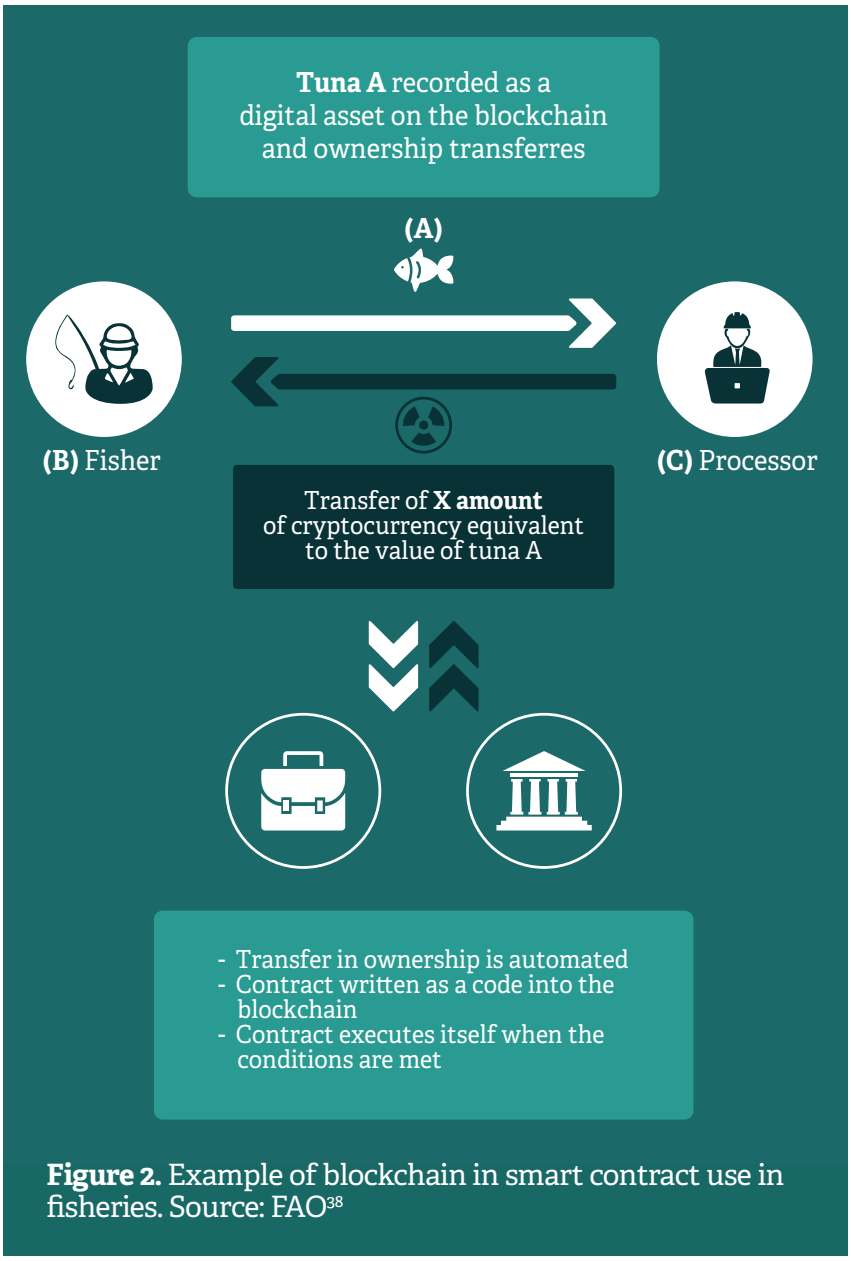



**Figure 2.** Example of blockchain in smart contract use in fisheries. Source: FAO[38]

37 http://www.fao.org/3/ca8751en/CA8751EN.pdf
38 http://www.fao.org/3/ca8751en/CA8751EN.pdf
39 https://www.pagero.com/blog/what-is-an-e-document/

# ANNEX 2.
## Case Studies

### New Zealand

New Zealand had operated an electronic reporting system for around 15 years, before it was decided to migrate to a more sophisticated catch monitoring and traceability system. Since the IT was outdated, it was challenging and too expensive to adapt the existing system to new emerging technologies and data standards.[40] According to New Zealand legislation the industry would have to bear the cost of the government's IT investment, which was in the range of tens of millions of New Zealand dollars. So, the government went out to industry to basically impose the new system along with its associated costs. To which the industry responded that they hadn't been consulted and it wasn't going to work either effectively or at a low enough cost for them, bringing the whole initiative to a stop.

After much negotiation, the industry decided to take the design of the new system into their own hands and budget, and the government provided the specifications required, including reporting quality and number of errors that would be allowed. Currently the system tells a fishing vessel or company how much quota they have remaining. If for example they catch too much of one species, they must move to other fishing grounds, or buy more quota catch entitlements or pay a financial penalty. The system now is widely used, accepted, and considered a model for eCDT implementation, because there are clear governance mechanisms around who owns what data. Additionally, much of the information is available on a public platform or can be requested and additional information can be obtained at a cost.

The eCDT system is also set up in a way that data can be cross-checked. So, if there are a few fishing vessels in the same area and one vessel is reporting a different mix of catch and bycatch, a compliance flag will be triggered in the system for auditors to inspect that vessel when it arrives back at port.



**Lessons learned:**
Develop and implement an engagement strategy with supply chain stakeholders from the start, including the possibility of co-management and ownership, reach out and explain the system and its benefits, to get feedback and eventually buy-in. Don't expect that by imposing something as the authority, it's going to work. A data ownership and sharing protocol should also be developed and socialized early on, so all parties understand and accept it. Engagement takes time, but it's the only way to ensure that the eCDT system is going to meet the expectations of users.

40 Sylvia G, Harte M, Borberg J. 2019. Status of electronic collection and reporting of key information in major fisheries.

## Filipinas

USAID Oceans started working in the Asia-Pacific region in 2015 to combat IUU. In General Santos (Tuna Capital of the Philippines), they developed and tested seafood traceability systems with government and industry (where only paper-based systems previously existed), implemented sustainable fisheries management plans, and promoted gender equality in the seafood supply chain. The work was carried out in 5 phases: (1) coordination and partnerships, (2) research and analysis, (3) design & stakeholder engagement, (4) testing & implementation, (5) scaling and expansion (USAID 2020). eCDT benefits included cost savings, operational efficiencies, two-way communication, maritime security, and safety at sea. Then USAID partnered with WWF-Philippines to expand the project to other fisher tuna fishing communities where WWF was already working through a Fisheries Improvement Project (FIP) on vessel registration and licensing, as well as the use of tuna tags with unique identification numbers. The FIP had been engaging technology providers to identify and develop traceability software for the small-scale handline tuna fisheries of the Philippines. The USAID and WWF partnership intended to establish an electronic database in collaboration with local governments and the whole handline tuna supply chain (WWF-Philippines 2020).

The establishment of traceability along the supply chain in fisheries seeking sustainability certifications such as the Marine Stewardship Council (MSC) provides proof that their products are from a responsible fishing practice, facilitating MSC compliance. Fishers that installed transponders on their vessels became more interested when they learned this would not only provide traceability for their catch, but also for sending distress signals during emergencies.

Technology providers need to consider: (1) the need for technology to be affordable but effective, catering to the small-scale artisanal fisheries; (2) the technology should have a mechanism to compensate for the challenging situation in the inconsistency of the digital communication structure of the area without adding significant costs; (3) the technology should be easy to customize.

Currently WWF-Philippines is working with a technology provider named TX in the testing of a new eCDT system named Tracey,[41] where the fisher is compensated for the information they provide. This is a novel technology where data is stored on blockchain and through a smart contract where tokens are provided in exchange for the inputted data. In the current pilot WWF is providing the funding for the tokens, but ultimately the idea is to sell the



Fishers that installed transponders on their vessels became more interested when they learned this would not only provide traceability for their catch, but also for sending distress signals during emergencies

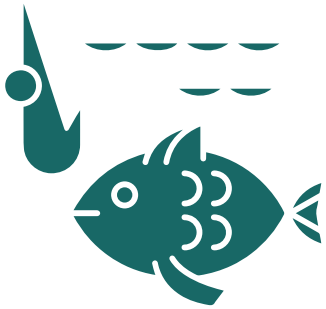
41 https://tx.company/projects/tracey/

data on an online marketplace. Essentially, it's a smart wallet where you have bitcoins and these tokens can be cashed out at shops, pawn shops, banks, or money exchange places. They can even be used as a governance participation mechanism, where those that hold the more tokens have more of a say in the management of the eCDT system.

Tracey also offers access to microfinancing through a financial institution. WWF-Philippines has partnered with Union Bank so more fishers submit their catch data and log their trade data for banks to be able to create a credit profile for them and assess the risk of providing them loans by using the information to build a credit worthiness tool. This is important for banks in the Philippines because currently they have to pay an annual fine to the government for not being able to serve the micro and small and medium-sized enterprise (SME) market.

How to maintain the long-term financial sustainability of the project is still being looked into. But the idea is that fishers are data owners, TX is the system holder, and buyers or financial institutions pay for the seafood data they need or license fees to access the system, which covers the cost of maintaining the system and increases fishers incomes by paying them for the inputted data through the tokens.





**Lessons learned:**

Lack of transparency in the supply chain needs to be addressed for fishers to fully realize the economic benefits of traceable seafood. Regional coordination is essential to national and site-level eCDT system design and implementation. National and site-level technical working groups need to be established early and meet regularly to address issues that emerge from the eCDT system and support sustainable fisheries management, as well as gender equity and human welfare. Agreements on roles and responsibilities between government and private sector should be clearly articulated, particularly regarding data confidentiality, access and integration between private and government systems. Fishing associations are instrumental to support research and analysis, identify "first movers", facilitate partnerships and support implementation. And small-scale fishers should be included in the eCDT system design. eCDT testing is time-intensive and requires frequent interaction and capacity building of stakeholders. Small-scale pilots provide tangible benefits that can support expansion and provide the basis for driving regulations that enforce the use of eCDT systems in a phased approach.

## Indonesia

In 2018 the Indonesia Ministry of Marine Affairs and Fisheries (MMAF) with assistance from USAID Oceans launched an electronic logbook that is currently being piloted across the country along with an online traceability and logistics system called STELINA. Data entered into STELINA will be secured internally within MMAF's system, which is the repository for all ministry data and IT systems. The data generated by STELINA is intended to inform the ministry's data reporting, but data exchange has yet to be fully developed (Marine Change 2020).

To incentivize compliance, MMAF intends to draft and introduce a regulation to require use of the system by all traders and processors/exporters buying and selling in-scope fish species. While this can be a powerful incentive for traders in some places such as major ports, enforcement will be especially difficult in remote areas where a large proportion of fish is caught. Therefore, to increase compliance, MMAF has an agreement with the state-owned Bank Rakyat Indonesia to offer collateral-free loans to traders that use STELINA.

There are reportedly multiple online systems administered by other MMAF DGs, and even other ministries, that still require data sharing agreements for STELINA to function as designed. It could be another five years before the system is fully developed and deployed.

TraceTales[42] was developed in 2018 by the Indonesian NGO Masyarakat dan Perikanan Indonesia (MDPI), to digitize paper traceability for processing companies. TraceTales allows processors to electronically track their inventory as it moves through the processing factory—from receiving, to filleting, to packaging, to freezing and shipping. TraceTales is only available for fresh/frozen processing operations producing yellowfin tuna products, but will soon be available for finished goods. For private transactions, users of the system will be charged an annual licensing fee based on the number of stations inside their processing facility, but the pricing level has not yet been finalized. Benefits include increased assurance in meeting import requirements, greater ability to meet customer requirements, enhanced efficiency and business intelligence, increased accuracy and efficiency in operations and data management, and increased capacity for data analysis and business decision making (USAID 2019).

USAID Oceans developed Trafiz,[43] a mobile catch documentation application that enables the first buyer or fish supplier to collect and submit traceability data. So USAID recommends (1) Pointrek for

For private transactions, users of the system will be charged an annual licensing fee based on the number of stations inside their processing facility



42 https://mdpi.or.id/tracetales/what-is-tracetales/

43 https://www.seafdec-oceanspartnership.org/traceability-tools/trafiz/

first-mile traceability which uses VMS technology, (2) Trafiz to collect landing site data, (3) TraceTales for processing plants, and is assisting the government to develop STELINA to integrate the information from these and other existing systems in Indonesia. Some of the reported benefits are: increased communication for fleet and plant management, reduced staff reporting time, enhanced ability to manage and record raw materials received from small-scale fishers, increased ease in complying with market requirements (USAID 2019).

One of the challenges in Indonesia is that there is no overarching eCDT legislation and there are about 20 eCDT systems currently being used in the country, about half of which are privately owned and the other half belong to the government, but they are not integrated with each other (Mangunsong 2019). The government has several different technologies in place across the supply chain, each with a different objective and they don't interoperate. Eventually these systems should feed into STELINA, which ultimately should become the data aggregating hub.

**Lessons learned:**

The lack of articulation between government institutions and the many existing eCDT systems that don't interoperate with each other makes the situation in Indonesia quite complex. Although the creation of STELINA as a government-owned data hub can potentially solve many of these issues, it's going to take time and work. In the meantime, MDPI established data management committees (DMCs), which consist of local NGOs, local industry, academia, and local government. They meet regularly to review eCDT data for fisheries management. So, if one province wants to revise the social KDEs like income, minimum wage, etc. they can. They collect the data from different systems, but since the catch data is the same, there is consistency. This is a good example of putting data to use for the benefit of local communities. Additionally there is a need for the government to support existing systems in Indonesia by providing or improving electricity and internet infrastructure, as well as socializing existing systems and capacity building and co-design processes for any new developments.



## South Africa

ABALOBI[45] is a smartphone application for small-scale fishers in South Africa that was initially developed with grant funding. The app allows fishers to own and access their data through user-centered visualizations. It was co-designed over a 2.5-3-year period with South African fishing communities and recently reached the point of financial sustainability through a logistics fee charged through the app, a 17.5% commission on the sales that happen through ABALOBI's digital marketplace, much less than what an intermediary would usually charge.

Fishers can use ABALOBI as an accounting tool to better handle their income and expenses. ABALOBI proves a lot of capacity building, and the app allows fishers to demonstrate their activity, which helps them access formal fi-

44 https://www.seafdec-oceanspartnership.org/news/connecting-the-seafood-supply-chain-traceability-solutions-in-indonesia/

45 http://abalobi.info/

shing permits. Still, the fishers own the data and decide who they want to share it with.

Fishers are also able to share their stories through the app and consumers can scan a QR code that links to the who, what, when, and where behind the product. Additionally, ABALOBI increases gender equity by creating a split payment system that allows fisherwomen to log their activity and receive separate payment from the vessel owner.

ABALOBI organizes monthly data meetings, where each community can see their data projected on the wall and fishers can connect through their phones and go through the visualizations and analyze the content. Over time the agendas and issues discussed in these meetings should be defined by the fishers, contributing to local decision making, where they can use the data to create new ventures, or make decisions around seasonal closures, catch size limits, etc. And ultimately the ABALOBI team is using global standards to work towards interoperability.

**Lessons learned:**
The ABALOBI experience reinforces the importance of fisher ownership of and empowerment with the data. Their user-centered design was key in delivering a tool that fishers want to use on a regular basis. Organizing monthly local data sharing meetings is a great example of data-based fisheries management decision-making that empowers the participating communities. The ABALOBI approach is for fishers to set the pace towards how systems become more transparent over time. Thinking about scalability and affordability for fishers at scale, as well as the long-term financial sustainability of the system early on is important.

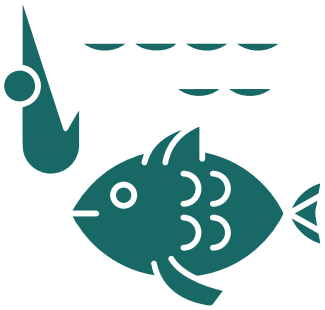


## Mexico

CONAPESCA, Mexico's National Commission for Fisheries and Aquaculture has established a technical consultative committee to advise in the development of a national seafood traceability standard. Representatives from NGOs, the private sector participate, and other federal agencies including the Agricultural Health Service (SENASICA) and National Fisheries Institute participate, but some actors such as the tax authority and fisher representatives are absent. Still, advancing has been difficult due to the different levels of technical knowledge in the group, starting with a shared understanding of what traceability actually is, how it should

be implemented and by whom.

The Mexican regulation is being developed in accordance with the Global Dialogue for Seafood Traceability (GDST) guidelines to ensure interoperability and compliance with international regulations. Mexico has a solid foundation since existing laws and regulations cover almost all of the GDST-recommended key data elements (KDEs). After the technical committee completes the draft, the regulation must go through a series of public review processes before it becomes official. CONAPESCA must show that the regulations do not create additional cost for the supply chain participants, demonstrating that the benefits outweigh the costs is vital. The system design is based on a centralized data hub and is being designed to minimize both the financial burden and workload for users.



**Lessons learned:**
While the development of the Mexican national traceability standard is still in progress, it sets a great example of a collaborative development process that uses the GDST global standard as a basis. Although such a process has its challenges, the expected end result is an eCDT system that is a step ahead in terms of clarity of needs, objectives, interoperability, benefits, and buy-in. One of the recommendations is to keep the technical group on the smaller end to avoid long winded discussions that slow down the process.



## Chile

In 2013 Chile established its first fisheries electronic reporting legislation and in 2017 they approved the resolution that established the traceability system required to provide the fisheries data. The implementation of the system was carried out between 2015 and 2018, and 2019 was the first year that previous systems were discontinued, making 2020 the year of complete traceability.

SERNAPESCA is Chile's fisheries (sea fish landings norms), aquaculture (animal production and environment harvest standards), and seafood safety (to meet international market requirements) authority. Yet these three areas weren't initially articulating as much as was needed to establish an interoperable eCDT system, so standardizing concepts was one of the first challenges.

The processing of physical documents was unmanageable, and the paper declaration system was complex for the users. Additionally, the data collected did not allow for analysis of events or sequence of events. It did not facilitate catch monitoring from the moment of landing to the market. The information was aimed at providing official

statistics, with a rather synoptic and reactive value.

A couple of years ago it would have been unthinkable to have near real-time marketing information. Eventually they went from receiving information with a 10-day delay to data received practically in real time, which has helped respond to IUU issues and natural hazards. The eCDT system provides market clarity and visibility of the fisheries supply chain. SERNAPESCA also provides the aggregated data to users for their commercial management.

SERNAPESCA intends to integrate and monitor resources with a focus on citizens and to sustain and ensure sustainability. To that end SERNAPESCA provides training for users and is planning a communication campaign that informs and engages consumers on the origin of the seafood they consume through a label. Additionally, they are executing three pilots with two salmon companies aimed at interoperability, where they are changing from SQL platforms to APIs. If everything goes well, they will open it and SERNAPESCA will be able to interoperate with private software through pre-established APIs ultimately leading to an open data platform so the information can be shared with the world.



**Lessons learned:**
Even though coordination was an issue in the government, the fact that SERNAPESCA is the one authority that oversees all fisheries, facilitates having a centralized information system. Additionally, the user-centered approach that seeks to interoperate with private platforms, as well as provide aggregated data back to the users, demonstrates forward thinking. Having legislation in place made uptake easier, as the traceability system was seen as a tool that facilitated compliance for users. Starting simple by having the information of what is happening first is important to inform next steps, because the supply chain doesn't always work as one imagines, and that proof of concept is very important before diving into more complex issues.

## Peru's Forestry Sector

When it comes to wood, traceability begins in the forest, from the moment a usable tree is located and identified. What drives the effort is the desire of companies, owners of harvesting rights, and producers in general, have to demonstrate that their wood product is legal and traceable. Since it is normal in the sector to have an excessive volume or a missing volume, both issues incentivizing illegality.

SERFOR, the Peruvian national forestry authority, has been working on determining a traceability mechanism within the framework of what is established in the Forestry and Wildlife Law that came into force in 2015. Currently SERFOR has computer tools

that help in the verification of information on the traceability of timber forest products, which covers stages such as harvesting, transformation and forest transport, while also working in parallel on a control module that will integrate the information throughout the entire production chain. Meanwhile, GIZ designed a free system called DATABOSQUE, which covers information in the utilization stage, designed to facilitate compliance with obligations and function as a management and control tool that helps companies deal with timber harvesting information, for which GIZ provides training to companies that want to use it.

In DATABOSQUE each user is the owner of their data and what they share is what the authority asks for. Still, some companies and forest harvesting rights holders have developed their own systems to meet specific needs. Therefore, GIZ is ensuring that DATABOSQUE can interoperate with existing private systems and, also with computer applications already developed by SERFOR within the framework of the SNIFFS Control Module, understanding the importance of interoperability between systems.



**Lessons learned:**

The regulation of forest traceability established in Law 29763, Forestry and Wildlife Law and approved in its Regulations in 2015, has been developed through a participatory process, which is extremely important. Although some applications for exploitation, transformation and transportation have already been gradually made available by the government since 2019, in some cases the sector had already developed their own systems. Fortunately, the State understands the importance of interoperability to incorporate the information from these systems into the Control Module instead of competing or seeking to eliminate them. Highlighting the benefits of eCDT beyond just control is important, and SERFOR clearly understands the importance of a user-centered approach and including the needs of regional authorities from the beginning. Engaging industry players who are truly committed to long-term sustainability is also vital, as they can become the "first movers" that inspire the rest of the sector.

# ANNEX 3 .

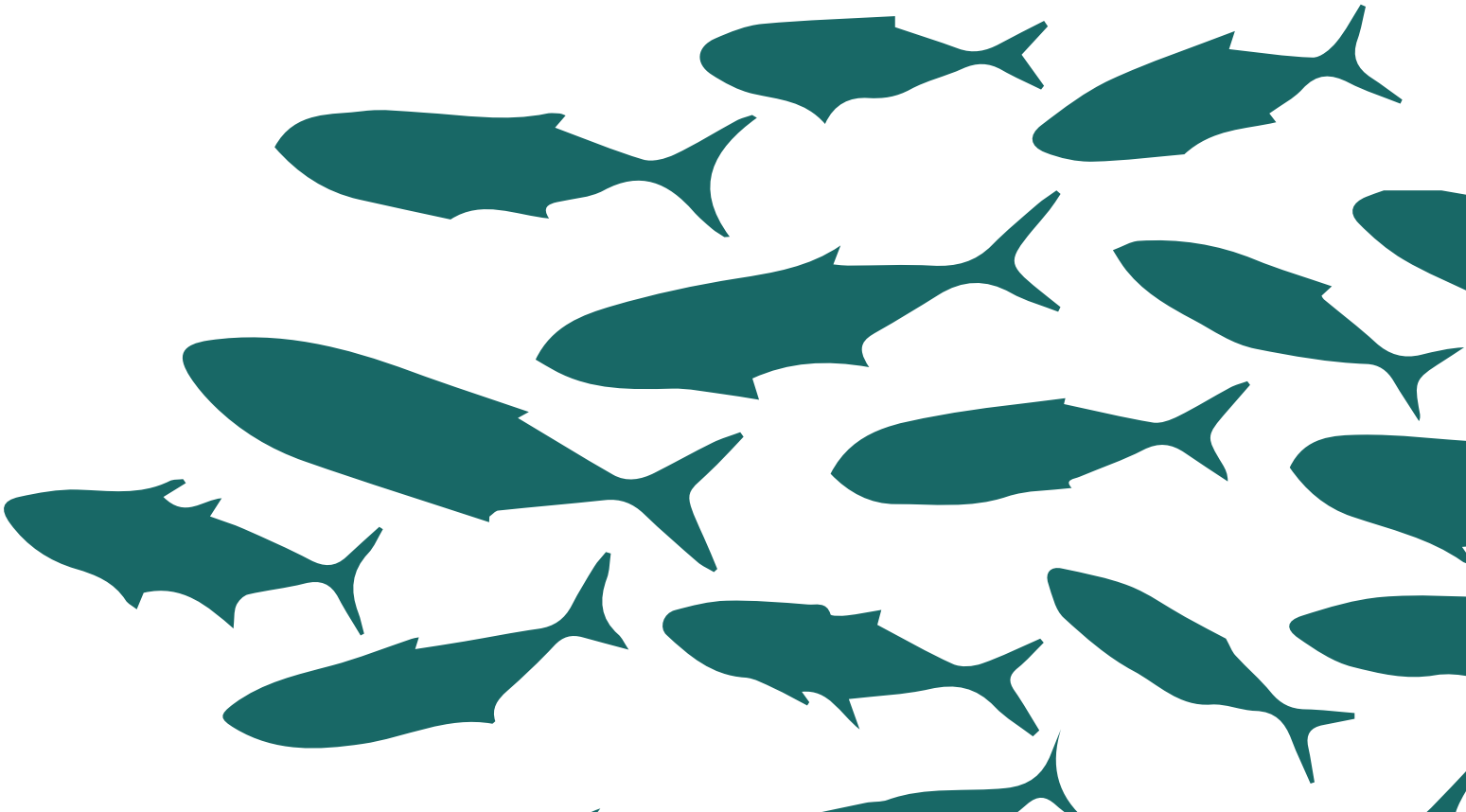
## Current Benefits Realized from eCDT Systems in Seafood Supply Chains

| CATEGORY | ACTOR | | |
|---|---|---|---|
| | **Fisher** | **Industry** | **Government** |
| **Economía** | + Increased access to local and international markets<br>+ Increased access to certifications and/or creation of local brand<br>+ Proof of community impact and/or legality to attract direct investment<br>+ Sharing of data analyses back to communities and investors to demonstrate value<br>+ Reduced legal risk via having more data available, reduces corruption costs<br>+ Improved access to financial credits and insurance<br>+ Ability to create invoices and tax payments, reduces penalties for non-compliance<br>+ Faster transfer of data to customers speeds up payment process | + Faster transfer of data to customers speeds up payment process<br>+ Improved operational efficiencies, including inventory management and monitoring<br>+ Reduced risk by catching errors before product leaves the facility and faster recall response<br>+ Cold chain temperature tracking to ensure food safety and improved product quality consistency<br>+ Reduced insurance premiums<br>+ Ability to more strategically distribute product to maximize shelf life and reduce waste<br>+ Real-time information for sales improves communication with customers<br>+ Increased staff performance rates and reduced errors<br>+ More consumers making data-driven purchasing decisions in favour of socially and environmentally | + Reduced paperwork costs and fraudulent information<br>+ Reduced monitoring and enforcement costs |

| | | | |
|---|---|---|---|
| | | responsible products secures long-term market access<br>+ Faster reporting strengthens adaptive management (forecast and planning)<br>+ Improved compliance with legal and import reporting requirements, reduces trade barriers<br>+ More accurate and complete product information, increases marketing/branding options (including story telling)<br>+ Avoid penalties for non-compliance<br>+ Increased monitoring for food safety and other issues<br>+ Increased access to insurance<br>+ Ability to create invoices and tax payments, reduces penalties for non-compliance<br>+ Faster transfer of data to customers speeds up payment process | |
| **Environmental** | | + Improved data accuracy of environmental credentials of seafood products<br>+ Increased access to data drives improvement in fisheries management and business practices<br>+ Improved sourcing decision-making based on environmental criteria (including IUU) that reduces unsustainable products from entering the supply chains<br>+ Improved compliance with environmental requirements set by | + Improved stock assessments accuracy and timeliness<br>+ Ability to track quota data and real-time fishing activities to take immediate response<br>+ Increased ability to monitor bycatch of ETP species and other environmental impacts<br>+ Improved quality and timeliness of reports to regional fisheries management organizations<br>+ Reduced uncertainty in catch data and fishing effort<br>+ Informed fisheries ma- |

| | | | |
|---|---|---|---|
| | | certifications, NGOs, buyers, and consumers<br>+ Improved stock health increases volume/ revenues<br>+ Improve compliance with national and international reporting requirements | nagement policies (e.g., IUU, harvest control rules)<br>+ Improved ability to detect IUU seafood products<br>+ Improved ability for monitoring and surveillance of fishing effort and violations |
| **Social** | + Improved ability to hold supply chain actors & governments to account on environmental performance | | |
| **Data (Cross-Actor)** | • Increased data amount, quality, accuracy, and timeliness<br>• Increased data collection efficiencies, including reduced error rates and delay between data collection and analysis<br>• Increased accessibility to data by multiple parties in a timely manner<br>• Reduced delay between data collection and analysis, improves timely response<br>• Increased number and efficiency of analyses (types and frequency) for informed decision-making<br>• New types of analyses made possible (e.g., meta-analyses)<br>• Improved ability to verify and triangulate data | | |





# ANNEX 4.

## Potential Future Benefits Realized from eCDT in Data Analysis and Application by Collaborative Seafood Supply Chains

| CATEGORY | ACTOR | | |
|---|---|---|---|
| | Fisher | Industry | Government |
| Economía | + Increased ability to monitor wages, working hours, and payment through VMS and vessel trip logs<br>+ Time savings due ability to log in from anywhere to update data, makes legal compliance easier and faster<br>+ Increased empowerment, visibility, and market access<br>+ Increased income and community benefit<br>+ Fisher-Consumer direct communication increases market drivers<br>+ More accurate and complete product information creates price premiums and differentiated market access<br>+ Use of data and imagery connected to transparent, accessible platforms to increase direct investment opportunities | + Increased customer base created for (socially) value-added products<br>+ Improved reputation in international market leads to increased sales opportunities<br>+ Increased customer base created for value-added products, strong information systems allow for rapid and sustainable expansion<br>+ Reduced legal risk via having more data available, reduces corruption costs | + Increased revenue from taxes and export<br>+ Increased supply chain visibility to see patterns in potential infractions/ lack of compliance and strategically deploy limited resources |

| | | | |
|---|---|---|---|
| **Environmental** | | | + Reduced IUU and bycatch<br>+ Improved target stock health<br>+ Reduced impact on ETP species<br>+ Consistent data collection, analysis, and application over time leads to a sustainable, informed, and effective long-term management plan |
| **Social** | + Improved working conditions, including social benefits and safety at sea<br>+ Increased participation by women using data and tools for direct negotiation and sales<br>+ Increased community participation<br>+ Public accountability serves as a strong deterrent for unscrupulous vessel operations and leads to a decreased likelihood of abuse and illegal activities<br>+ Creation of a rights-based framework from the repeated use of data to prove legal right to fish<br>+ Pride in knowledge, product, and ownership increases participation and empowerment; leading to a more equitable supply chain<br>+ Encouraging younger generations to view fishing as a viable and attractive career<br>+ Pride in consumption choices leads to long term change in buying habits that support worker welfare | + Improved compliance with social requirements set by certifications, NGOs, buyers, and consumers | + Increased ability to monitor working conditions through remote electronic monitoring (REM) cameras on fishing vessels<br>+ Increased ability to monitor threats of violence and intimidation<br>+ Increased ability to monitor if there is access to benefits as allowed by law<br>+ Increased use of data to flag potential labour violations and improve resource allocation creates a safer, more equitable supply chain<br>+ Improved collaboration and transparency between supply chain actors and government agencies, driven by joint efforts around data collection, analysis, and application<br>+ Increased sense of accountability and trust in government |

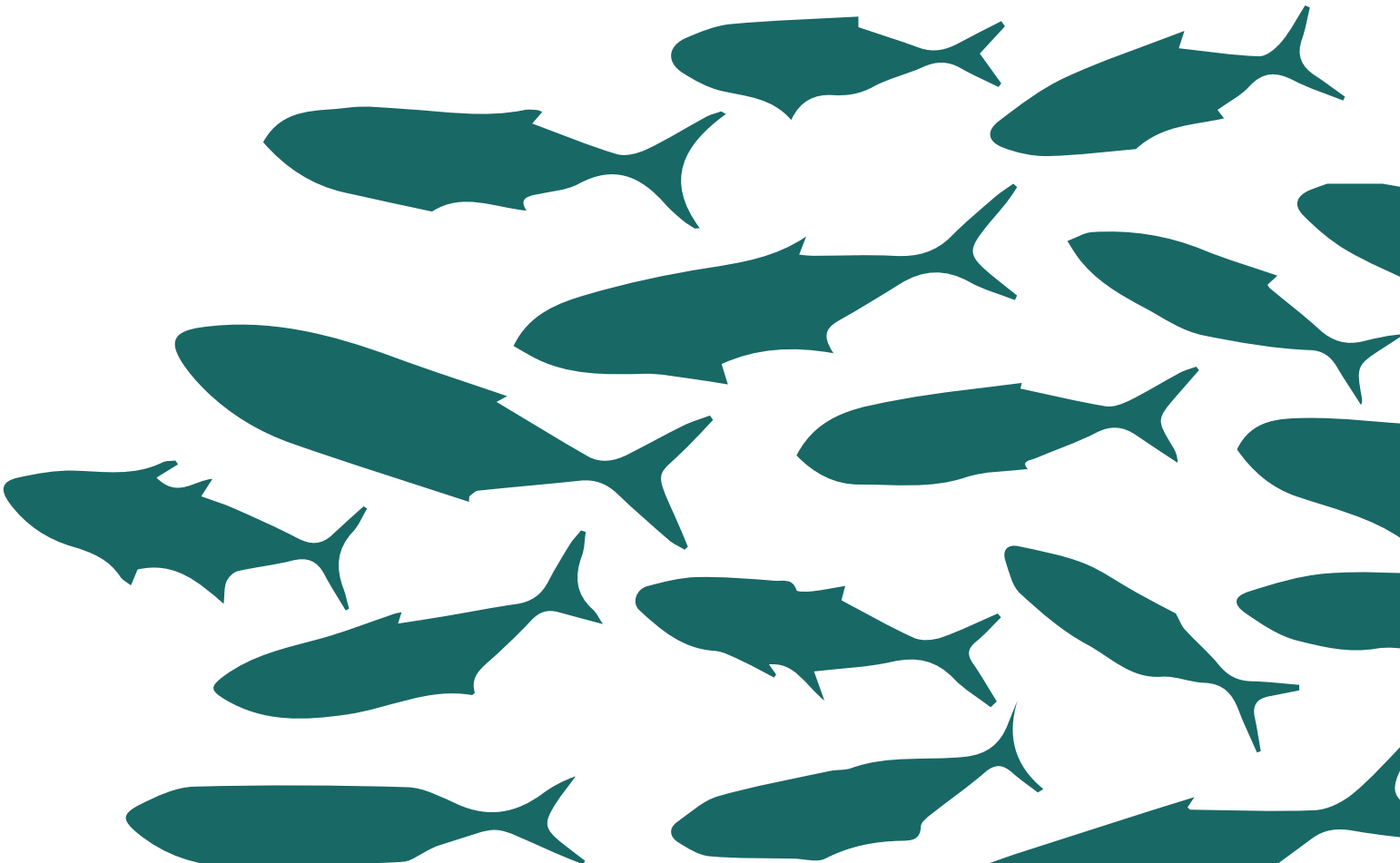
# ANNEX 5.

## List of Research Participants

| Name | Position | Organization | Country |
|---|---|---|---|
| **Bubba Cook** | Western and Central Pacific Tuna Program Manager | WWF-New Zealand | New Zealand |
| **Thomas Burke** | Senior Food Traceability Scientist | Global Food Traceability Center (GFTC) | United States |
| **Cecilia Blasco** | Executive Director | SmartFish Rescate de Valor, AC | Mexico |
| **Lucy Holmes** | Senior Program Manager for Seafood Finance | WWF-US | United Kingdom |
| **Farid Maruf** | Regional Catch Documentation and Traceability Specialist | USAID Oceans & Fisheries Partnership | Indonesia |
| **David David y Raisa Pandan** | Fisheries Technical Officer under the Sustainable Tuna Partnership Project. & Project Officer | WWF-Philippines | Philippines |
| **Ben Sheppard** | Managing Director | TX - Tomorrow Explored | Finland |
| **Adriana Sanchez** | Responsible Seafood Strategy Director | Iberostar Hotels | United States |
| **Mark Zimring** | Director Large Scale Fisheries Program | The Nature Conservancy (TNC) | United States |
| **Helen Packer** | Lead Seafood Stewardship Index | World Benchmarking Alliance | Germany |
| **Karen Villeda** | Program Director | MDPI | Indonesia |
| **Pablo Guerrero** | Marine Conservation Director | WWF-Ecuador | Ecuador |
| **Francisco Blaha** | Fisheries Specialist | International Advisor | New Zealand |

| | | | |
|---|---|---|---|
| **Roxanne Nanninga** | Director of Sustainability, Diversity & Inclusion | Thai Union | United States |
| **Brynn O'Donnell and Sara Lewis** | Senior project manager and Traceability director at Fish Wise | SALT (Seafood Alliance for Legality & Traceability) | US |
| **William Pariona** | Forest management advisor at GIZ | GIZ | Peru |
| **Esteban Donoso** | National Deputy Director | SERNAPESCA (Fisheries Authority) | Chile |
| **Serge Raemaekers** | Managing Director of ABALOBI | ABALOBI | US |
| **Michael Harte** | Professor and Associate Dean of Undergraduate Programs, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University | University of Oregon | US |
| **Dave Colpo** | Senior Program Manager at Pacific States Marine Fisheries Commission | PSMFC | US |
| **Edel Gutierrez** | Managing Director of Plenumsoft Marina (NAVIC / NADIR). | Plenumsoft Marina | México |
| **Gaston Chucos y José Parado** | Members of the Directorate for the Management of Forest Heritage and Wildlife Management | SERFOR (Autoridad pesquera) | Peru |





# ANNEX 6.

## Interview Questionnaire

| Personal Information | |
|---|---|
| **Name:** | **Country:** |
| **Institution:** | **Position:** |

**Briefing and Consent**

- *Provide participant with information sheet and respond to any questions*
- *Confirm participant's consent to participate in the research*

**Questionnaire**

1. Can you briefly describe your role and activities related to electronic catch documentation and traceability (eCDT) systems?
2. Which actors are currently involved in the design, governance, funding, and implementation of the eCDT system?
3. What are the different interests stakeholders have in participating in eCDT?
4. Why was the eCDT system created, and what purpose is the system designed to meet in the long term?
5. Who created and who will eventually own and be in charge of the maintenance of the eCDT system and its data?
6. Who is collecting the data that goes into the system and how is the information verified?
7. Who has access to the system and the data after it is collected and who is responsible for analyzing the data?
8. Who is responsible for communicating or implementing the results of the data analysis?
9. Are the various actors involved with the system communicating/collaborating with one another? If so, how so? If not, why not?

10. How are decisions about ownership and access made and how are concerns about data ownership and access addressed?

11. Can you share examples of the challenges with eCDT governance? What do you view to be the most critical barriers, and why?

12. What are some potential solutions or lessons learned from the identified problems/barriers?

13. Can you provide some examples of innovative models or emerging best practices for eCDT governance?

14. Do you have examples to share on how new technologies such as block chain, smart contracts, cryptocurrencies, etc. being associated with novel forms of data governance and use? In your opinion, what are the right technologies for the needs of the projects and users?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