# Using Electronic Catch Documentation and Traceability Systems within the Ecosystem Approach to Fisheries Management Framework to Promote Sustainable Fisheries and Conserve Marine Biodiversity
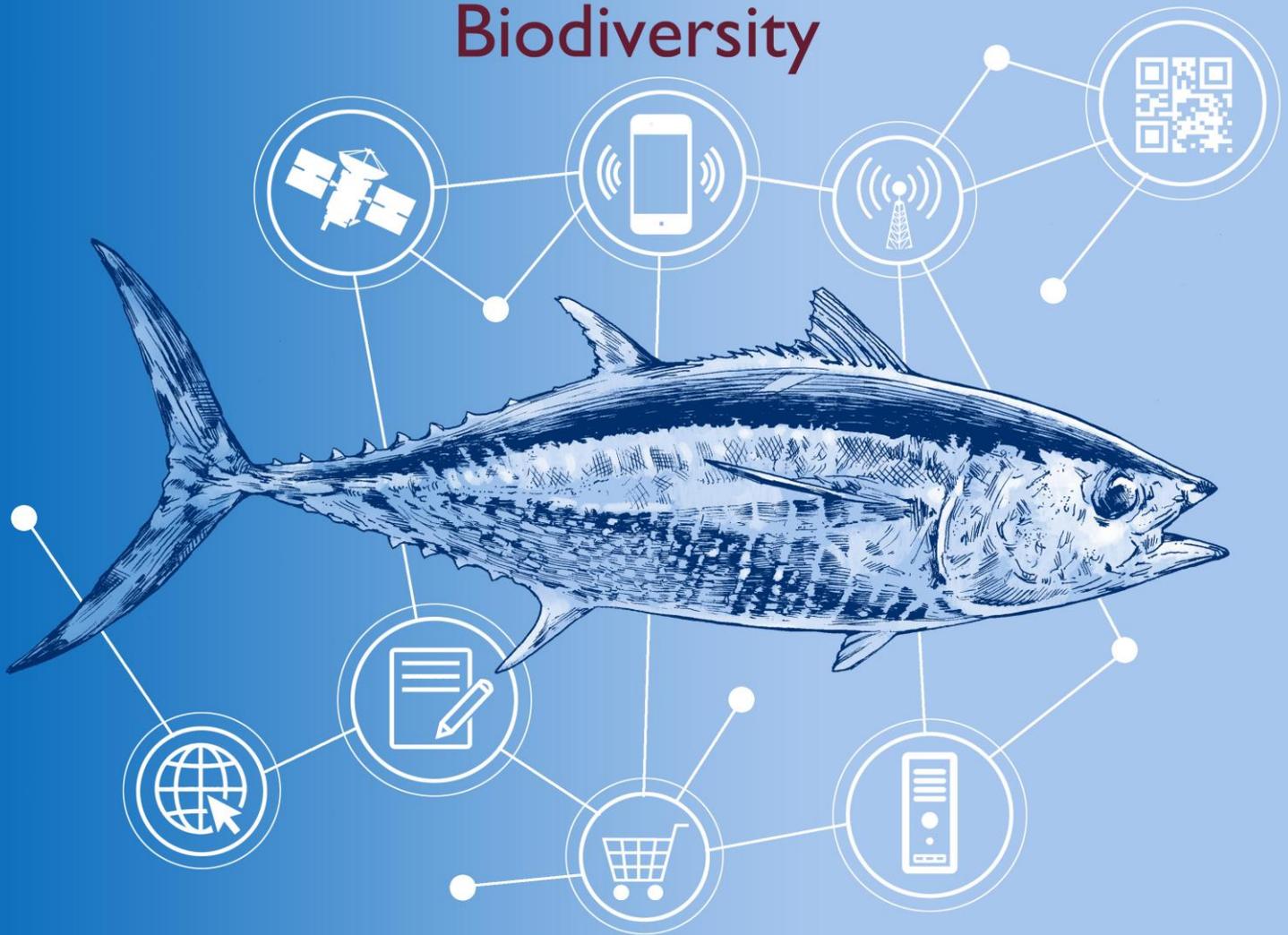
Experiences and Lessons Learned in Indonesia and the Philippines

THE USAID OCEANS AND FISHERIES PARTNERSHIP

ABOUT THE USAID OCEANS AND FISHERIES PARTNERSHIP

The USAID Oceans and Fisheries Partnership (USAID Oceans) is a five-year activity that works to strengthen regional cooperation to combat illegal, unreported, and unregulated (IUU) fishing and conserve marine biodiversity in the Asia-Pacific region. USAID Oceans is a partnership between the U.S. Agency for International Development (USAID), the Southeast Asian Fisheries Development Center (SEAFDEC), and the Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security (CTI-CFF) that works with public and private sector partners across Southeast Asia to develop and implement electronic catch documentation and traceability systems, improve sustainable fisheries management using an Ecosystem Approach to Fisheries Management, address human welfare and gender equity concerns, and develop public-private partnerships in support of these efforts.

For more information, visit *www.seafdec-oceanspartnership.org* or contact *info@oceans-partnership.org*.

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ACRONYMS AND ABBREVIATIONS

|	
BFAR	Bureau of Fisheries and Aquatic Resources
CPUE	Catch Per Unit Effort
CTI-CFF	Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security
EAFM	Ecosystem Approach to Fisheries Management
eCDT	Electronic Catch Documentation and Traceability
FAME	Futuristic Aviation and Maritime Enterprises
FAO	Food and Agriculture Organization
FIS	Fisheries Information System
FMA	Fisheries Management Area
IDS	Innovative Digital Solutions
IUU	Illegal, unreported, and unregulated
KDE	Key Data Elements
MDPI	Masyarakat dan Perikanan Indonesia
MMAF	Ministry of Marine Affairs and Fisheries
MSUNFSTDI	Mindanao State University Naawan Foundation for Science and Technology Development, Inc.
SEAFDEC	Southeast Asian Fisheries Development Center
SFMP	Sustainable Fisheries Management Plans
USAID Oceans	USAID Oceans and Fisheries Partnership
VMS	Vessel Monitoring Systems

ACKNOWLEDGEMENTS

Illustrations by Donald Bason
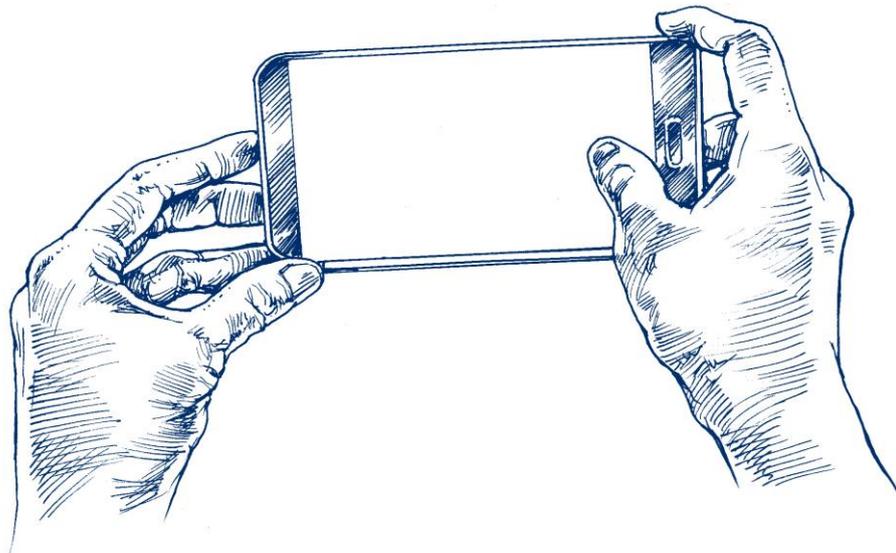
I. INTRODUCTION

The USAID Oceans and Fisheries Partnership (USAID Oceans) works to strengthen regional cooperation to combat illegal, unreported, and unregulated (IUU) fishing to promote sustainable fisheries and conserve marine biodiversity in the Asia-Pacific region. USAID Oceans supports the development of a transparent and financially sustainable electronic catch documentation and traceability (eCDT) systems to help ensure that fisheries resources from Southeast Asia are legally caught and properly labeled. eCDT systems collect and analyze ecological and economic data related to seafood products throughout the supply chain, such that they are traceable from point-of-harvest to seafood import retailers. This eCDT system may ultimately allow consumers to access safe and sustainable seafood products.

USAID Oceans has also focused on advancing and strengthening an ecosystem approach to fisheries management (EAFM) in the Asia-Pacific region, particularly in three countries bordering the Sulu and Sulawesi Seas (Celebes Sea)—Indonesia, Malaysia, and the Philippines. The program aimed for the adoption of an enabling EAFM framework that improves the health, productivity, and the resilience of the whole ecosystem (i.e., ecological and human well-being) overseen by good governance.

Figure 1. The Sulu Sulawesi Seascape sub-region

(Geographically defined as the waters encompassed by the Sulu-Sulawesi Marine Ecoregion, a marine area of over 900,000 square kilometers, bounded among three nations: Indonesia, Malaysia, and the Philippines.)

Between 2016 and 2020, USAID Oceans developed and demonstrated eCDT systems at two "learning sites" located within the Sulu and Sulawesi Seascape:[1] Bitung, North Sulawesi Province, Indonesia; and, General Santos City, South Cotabato Province, Philippines (see Figure 1).[2] The program also worked to strengthen sustainable fisheries management through the development and implementation of sustainable fisheries management plans (SFMPs) at these sites.[3] SFMPs address relevant human welfare issues within the seafood supply chain by helping to inform policy and regulatory decision makers relating to the social services of fisheries, including fair and

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[1] The Sulu Sulawesi Seascape is one of the priority seascapes in the Coral Triangle and a Sub-Regional EAFM Plan for the Sulu-Sulawesi Seascape has been developed to achieve a common fisheries management vision (see https://www.seafdec-oceanspartnership.org/resource/sub-regional-plan-for-managing-transboundary-fisheries-in-the-sulu-sulawesi-seascape/).

[2] For more information on USAID Oceans learning sites, visit https://www.seafdec-oceanspartnership.org/where-oceans-works/.

[3] For more information on USAID Oceans EAFM work, visit: https://www.seafdec-oceanspartnership.org/ecosystems-approach-to-fisheries-management-eafm/.

safe labor practices and gender equity. Through EAFM, the USAID Oceans project worked closely with various partners and fisheries stakeholders at both learning sites to use eCDT systems to support sustainable fisheries management efforts. These included national and local government agencies, academic institutions, civil society groups, people's organizations, private sector technology and fishing companies, research organizations, and donor agencies. While eCDT technologies support the tracking of fisheries and marine resources along the supply chain, these do not necessarily inherently promote sustainability and biodiversity conservation. To be fully effective it is critical that the development of eCDT systems is directly linked to EAFM planning and implementation, and ideally linked to and/or held within the national fisheries information system. Human welfare and gender equity aspects must also be considered to ensure that sustainable fisheries management can link to and benefit from data collected by eCDT systems.

Paper-based or electronic fisheries traceability systems may successfully track and document the movement of marine resources throughout the entire seafood supply chain. They can also be designed to promote fisheries sustainability, support the conservation of marine biodiversity, and track adherence to and/or violation of labor laws and regulations. To do this, traceability data (e.g., catch data) that are actively being collected in real time throughout the supply chain by the eCDT system, can be shared, analyzed, and used by relevant managers for adaptive decision making and fisheries management. Such data may be shared with other governmental entities and stakeholder groups, such as those dealing with agriculture, marine biodiversity conservation, law enforcement, and human welfare, including labor conditions and gender equity.

The purpose of this document is to share USAID Oceans' experiences and lessons learned in using eCDT to promote sustainable fisheries and conserve marine biodiversity in the Southeast Asian region. More specifically, the document's objectives are to:
1. illustrate the use of eCDT data to improve fisheries management with a focus on the small- and medium-scale fisheries sector;
2. describe uses of eCDT system data for guiding or improving fisheries management and biodiversity conservation with EAFM plans; and
3. demonstrate the implementation of eCDT systems through an EAFM approach.

This document is intended primarily for national partners (e.g., officers at national agencies involved in fisheries management and coastal/agricultural development); local partners (e.g., local government units at village, district/municipal, and provincial levels); fishing companies and association; and regional partners and international development agencies (e.g., Southeast Asian Fisheries Development Center/SEAFDEC, USAID and the Food and Agriculture Organization). Secondary audiences include representatives of academe and research institutions and non-governmental and civil society organizations.

II.   EAFM CONTEXT AND APPROACH

EAFM is considered best practice by several countries and regional organizations in Asia and the Pacific for the long-term sustainability of fisheries and the ecosystem services provided to society (e.g., food security, livelihoods, economic security, coastal protection, biodiversity conservation, human health and wellbeing, and gender equity). EAFM is "an approach to fisheries management and development that strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries."[4]

The increased understanding of the interactions among different components of marine ecosystems such as fish, people, habitats, infrastructure facilities and climate, has led to a growing recognition of the need to manage fisheries in the context of their supporting ecosystems (Figure 2). EAFM looks beyond seeing the fisheries as simply "fish in the sea and people in boats." EAFM covers the broader marine system including habitat components such as coral reefs and mangroves and adjoining terrestrial environments; economic activities such as maritime trade, shipping, energy development, infrastructure development, and intensification of coastal agriculture and tourism; social dimensions such as gender equity and degree of stakeholder participation; and governance. Hence, EAFM takes into account the fisheries' impacts as well as the interactions of its various components. EAFM focuses not only on sustainable management of fisheries but also considers other non-fisheries sectors such as coastal development, land-use, shipping, and transportation.
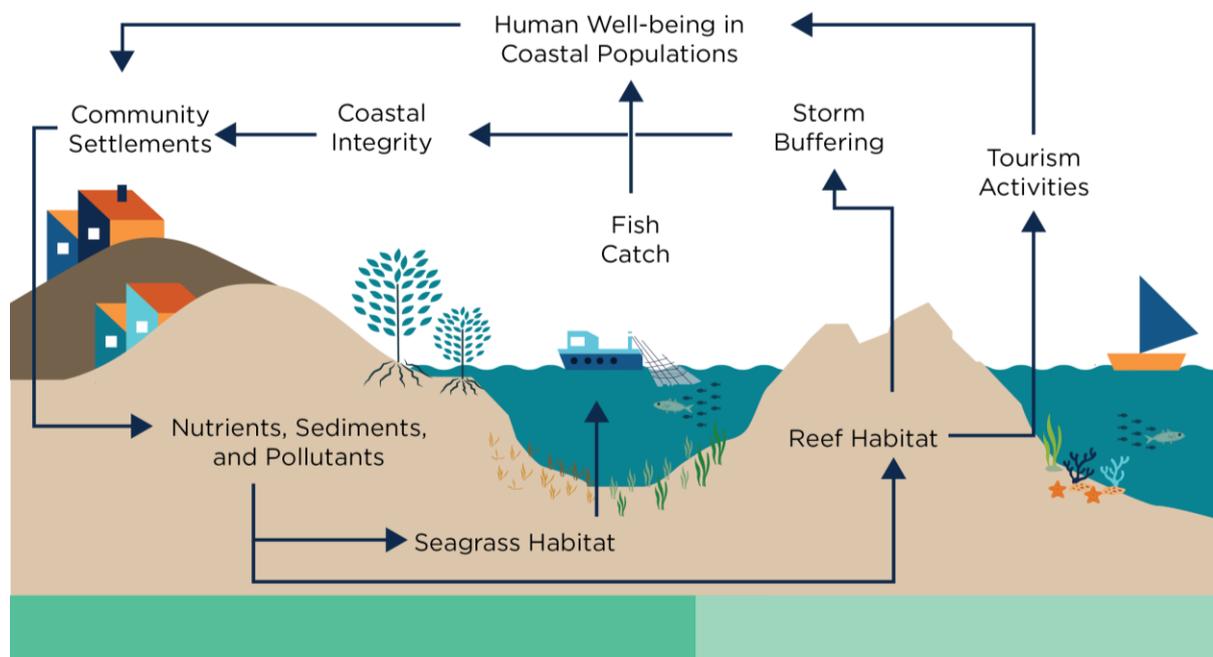
**Figure 2. Recognizing ecosystem-wide connections and effects that different components of the ecosystem can have on each other[5,6]**

Conventional species-based fisheries management not only often fails to address declines in many fisheries resources, but also often fails to protect the people, communities, and societies dependent

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[4] FAO, 2003.
[5] Agardy et al., 2011.
[6] Pomeroy et al., 2013.

upon healthy and productive fisheries ecosystems for food, jobs, economic development, and coastal protection, among other such benefits. EAFM evolved as a new management approach to better match the scales of fisheries governance with the scales of fisheries, their ecosystems, the people dependent upon them, and the nature of threats facing them. What differs in EAFM versus conventional fisheries management is that, at its core, EAFM seeks to manage fisheries within the context of the ecological and social systems in which they exist. Recognizing the need for an ecosystem approach stems from the increased understanding of the holistic nature of fisheries—interactions within and among fish species; habitats and broader marine ecosystems; fish, fishers, and fishing communities; and broader social, economic, and governance systems supporting and influencing them, including those located outside of the countries and even regions. EAFM strives to balance diverse societal objectives by taking into account knowledge about living (including people) and non-living components of ecosystems and their interactions, and by applying an integrated approach to fisheries within meaningful ecological, social, and governance boundaries.

EAFM provides a broad framework for marine resource management to achieve sustainable development through improved **ecological well-being** (e.g. habitat protection and restoration, pollution reduction and waste management, sustainable harvesting of fishery resources) and **human well-being** (e.g. food security, sustainable livelihoods, gender equity, and more equitable distribution of benefits derived from fisheries). EAFM is best guided by an EAFM plan, which focuses on **good governance**, is implemented across different spatial and temporal scales, and can be customized to accommodate prioritization of major issues and objectives.

EAFM ultimately produces EAFM plans at varying levels of governance and geographies. In the Sulu Sulawesi Seascape, USAID Oceans has developed nested EAFM plans, at sub-regional, national, sub-national, provincial, and site levels.[7,8]

III.   eCDT OVERVIEW

The backbone of USAID Oceans' work was the development and implementation of country-specific, financially sustainable eCDT systems that are contextualized within a seafood supply chain (Figure 3).[9]

eCDT systems encourage the collection, sharing, and analysis of verifiable ecological, economic, and human welfare data (called key data elements or KDEs) related to seafood products and the people handling them as the products move through the supply chain, such that they are traceable from point-of-harvest to seafood import retailers. These eCDT systems help ensure that the fishery resources from Southeast Asia are legally caught and properly labelled.

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[7] Pomeroy et. al. 2019a
[8] Pido et al. in prep.
[9] More information on USAID Oceans' eCDT work is available in the following program publications: "Fisheries Catch Documentation and Traceability in Southeast Asia: A Conceptual Overview" (https://www.seafdec-oceanspartnership.org/resource/cdt101/) and "Fisheries Catch Documentation and Traceability in Southeast Asia: Technical Concept and Specifications" (https://www.seafdec-oceanspartnership.org/resource/cdt201/).

Figure 3. eCDT through the supply chain[10]

USAID Oceans' guide, "Data Requirements for Catch Documentation and Traceability in Southeast Asia,"[11] details the minimum recommended KDEs to be captured within each link of the seafood supply chain and provides an overview of those required by predominant import markets and international organizations. Additionally, eCDT system KDEs need to be linked with relevant EAFM plan indicators or variables. Hence, these KDEs and/or indicators need to be harmonized along the nine major links in the supply chain (Figure 4):

(1) point-of-catch → (2) buyers and receivers/suppliers → (3) processors → (4) sellers → (5) domestic transport → (6) exporter and international transport → (7) importer → (8) buyers/retail → (9) end-consumer/customer
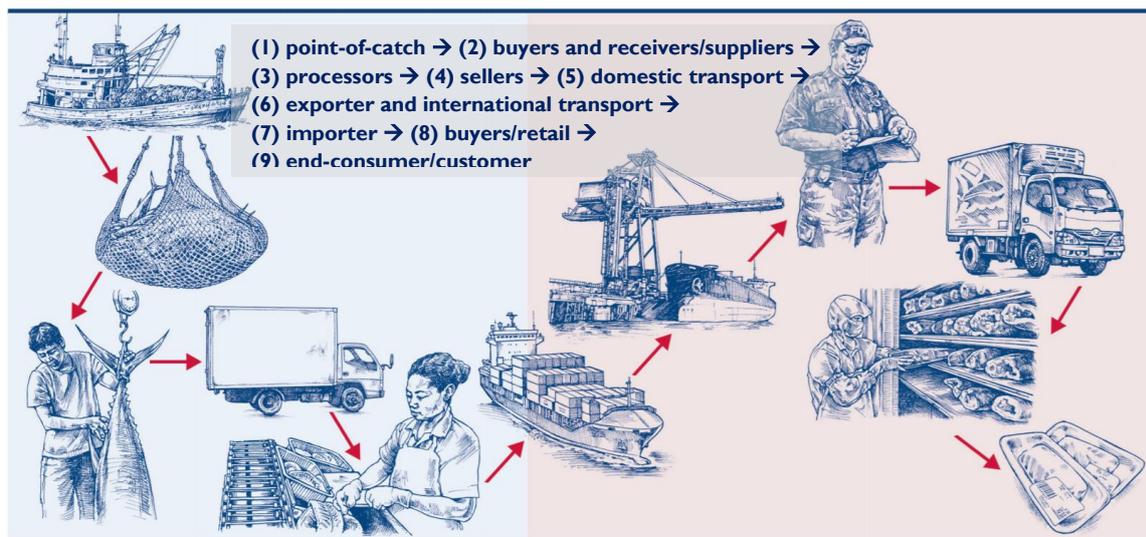
Figure 4. Critical tracking events in the seafood supply chain

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[10] Pomeroy et al. 2019b.

[11] USAID Oceans 2017c. (https://www.seafdec-oceanspartnership.org/resource/kdemanual/)

USAID Oceans has also developed and supported technologies for eCDT to establish connectivity in remote and at-sea areas, provide a mechanism for data collection and transmission through the entire supply chain, and provide value-added user benefits, such as two-way communication, safety at sea, emergency alerts, and business tools and financial management technologies.[12]

IV. EAFM AND eCDT NEXUS

eCDT is an intervention that can be used within EAFM context to address issues of IUU fishing and sustainability of seafood sources (see Figure 5). To be effective, an eCDT system needs to be based on an EAFM plan that provides the direction for achieving desired multiple fisheries management objectives. Hence, relevant elements of the eCDT system need to be effectively integrated into EAFM plans. When effectively integrated, eCDT technologies can support EAFM plans in addressing multiple factors leading to IUU fishing, including illegal business practices, environmental degradation, and human welfare abuses such as forced labor, unsafe working conditions, and gender inequity. It is recommended that eCDT systems collect human welfare KDEs throughout the seafood supply chain in order to support human wellbeing objectives under an EAFM plan.[13]

Integration of human welfare concerns in EAFM and the use of human welfare KDEs from eCDT technologies can support:

- linking existing databases and information systems related to human wellbeing, including sex-disaggregated data on labor and socio-economics status, through an application programming interface (API); and
- knowing demographics about the peopled involved (e.g., sex, social status, and educational background) and working conditions at each node of the value chain, thereby supporting development of policies and interventions that are appropriate for each stakeholder group.
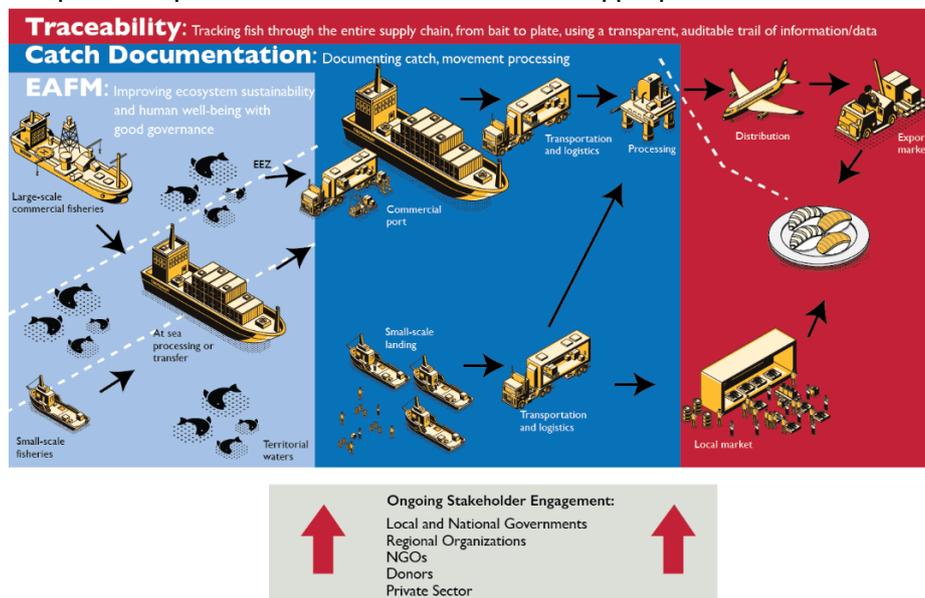

Figure 5. Linkage of EAFM with CDT through the seafood supply chain.

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[12] More information on USAID Oceans-supported eCDT tools can be found here: https://www.seafdec-oceanspartnership.org/resource/technology-solutions-for-electronic-catch-documentation-and-traceability-ecdt/.

[13] USAID Oceans 2017c.

An eCDT system can track marine resources but may not necessarily promote fishery resource sustainability or conservation of marine biodiversity unless data is actively used for management purposes. Hence, USAID Oceans supported the development and implementation of EAFM plans that include guidance on the use of eCDT and fisheries information systems (FIS) for monitoring fisheries, labor practices, and gender disaggregation and making decisions that improve sustainability, and promote human welfare and worker safety among other benefits (Box 1).

Box 1. Benefits of using eCDT technologies under an EAFM plan

- Provides access to ecological and social KDEs to inform decision-makers on fisheries management issues, including IUU fishing
- Is a convenient source of data for decision-makers and other stakeholders
- Encourages voluntary compliance with fishing regulations
- Reduces seafood fraud and mislabeling

Table 1 outlines KDEs that are commonly collected at each node of the seafood supply chain along with data needs by various actors that are often outlined in EAFM plans and captured using eCDT systems.

Table 1. Common KDEs and Data Needs in the Seafood Supply Chain

Supply Chain Node	Common KDEs / Data Needs
Point of catch	• Species harvested • Catch per unit of effort (CPUE) • Catch trends • Fishing grounds • Fishing methods
Buying, receiving/supplying	• Buyer concentration • Seller concentration • Market channels • Name of buyer/receiver company • Buyer/receiver business registration number
Governance/institutional level	• Fisheries management regime • Regulatory mechanisms • Government catch documentation and certification system

An example of catch documentation and traceability policy from the Philippines is the 2014 Bureau of Fisheries and Aquatic Resources (BFAR) Bureau Administrative Circular 251 on Catch Documentation and related anti-IUU management measures.

eCDT has the potential to support fisheries management through (Figure 6):
(i)   supporting fisheries regulation and compliance;
(ii)   providing robust fisheries catch data that is interoperable with fisheries information systems that provides sound scientific advice for adaptive management; and
(iii)   serving as a tool for food safety and traceability.
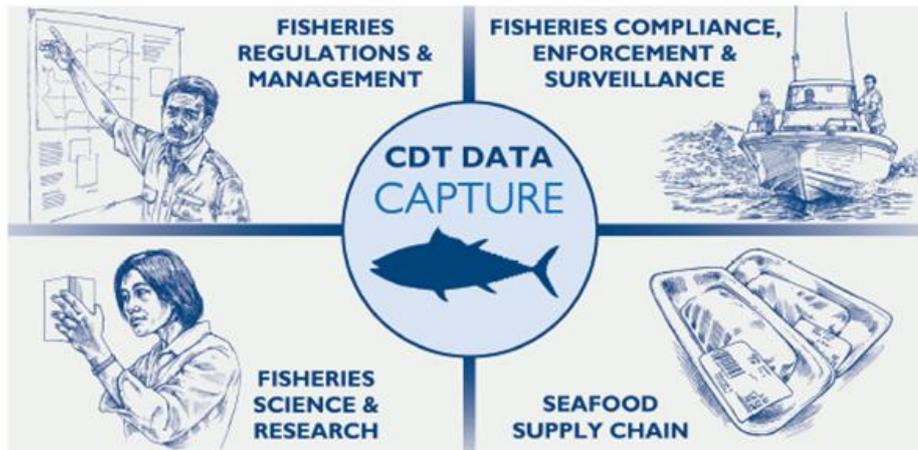
Figure 6. How eCDT data can improve fisheries management, research, and traceability

Access to and analysis of eCDT data allows fishery managers to:

a. Assess fisheries status and reference points for management
b. Use data to as the basis for managing stocks and fish populations in comparison with capacity/effort, fishing vessels and fisher registration, fishing bans, etc.
c. Visualize real-time fishing operations, including violations and intrusions in protected areas (e.g., Marine Protected Areas, fish refugias, etc.) and coastal/municipal waters
d. Triangulate and validate fishery-related recommendations using data
e. Improve strategic planning as well as monitoring, control, and surveillance
f. Crafting science-based policies and programs

eCDT data can provide a range of information, such as fish species and volume and location of catch, that can be useful for fish stock assessment and for informing fisheries management. These data can be useful for both temporal and spatial analysis of the fisheries (Box 2).

Box 2. Linking eCDT to improved FIS and stock assessment

When eCDT data is linked to FMAs, FIS, stock assessment, and management bodies:

- available eCDT data can be analyzed to assess fish resources and stock status within FMAs
- managers have access to timely, up-to-date fisheries stock assessment data that are spatially referenced (with geographical coordinates); and
- accumulated time series data is available for stock assessment (e.g., maximum supply yield estimation needs approximately 10 years of catch data).

In 2019, USAID Oceans conducted an end-of-project evaluation with over 200 stakeholders to identify benefits of using eCDT data for fisheries management. Nearly all participants felt that eCDT provides data that is useful for improving fisheries management policies and that data from the point of catch provide through eCDT tools is valuable for fisheries management (Figure 7).

Figure 7. Reported value* of eCDT for fisheries management at the close of the USAID Oceans project[14]
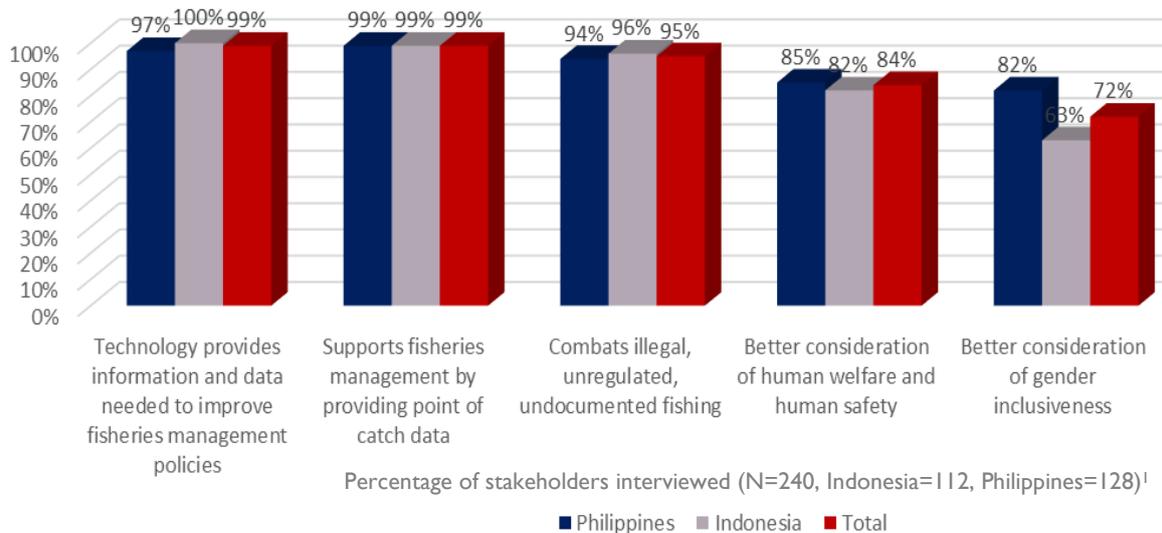
V.   USAID OCEANS IDS DEVELOPMENT EXPERIENCES

Replacing paper-based CDT systems with electronic eCDT systems has provided fisheries managers with real time data and visuals that enable them to make better plans and decisions. The advantages of this transition are demonstrated by USAID Oceans' two EAFM grants awarded to partners in the Philippines and Indonesia—Masyarakat Dan Perikanan Indonesia (MDPI) for work at the Bitung/Manado, Indonesia; and Mindanao State University Naawan Foundation for Science and Technology Development, Inc. (MSUNFSTDI) for work at the General Santos City, Philippines.

The objective of the grants was to develop "innovative digital solutions" (IDS) for using eCDT data to inform fisheries management practices and to demonstrate that eCDT data being collected for fisheries traceability purposes can be linked with existing national fisheries information systems to improve real-time access to relevant fisheries-related data. The IDS were intended to be simple, computer-based systems to capture, analyze, and present relevant fisheries data in a way that can easily be understood or interpreted by fishery managers.

The solutions developed included innovative analytical architectures (e.g., a digital dashboards showing real-time eCDT data and management-related analytical results that can be viewed from a computer and/or mobile device), that can provide fisheries managers and decision makers with relevant, real-time information that informs and enhances fisheries management and facilitates data-driven decision making in an adaptive and novel way. (More detail on IDS available in Table 2 and Annexes I and II.) The IDS have the potential to allow fisheries managers to analyze real-time eCDT data on catch volume, species distribution, and fishing and vessel location. They allow manager to visualize spatial distributions of fishing activities and catch per unit effort data within a particular

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[14] USAID Oceans, 2019.

fishing ground to identify trends in fishing practices and determine species composition of the fisheries/catch. These analyses can improve stock assessment practices to support EAFM (Box 3).

The primary outputs of each grant included not only a working eCDT dashboard, but also technical assistance to relevant national and local fisheries management authorities on how to use the IDS for strengthening fisheries management and enhancing fisheries resource sustainability and marine biodiversity conservation (Table 2).

Access to such eCDT data and tools can also elicit a more active partnerships with the private sector regarding sustainable harvesting in real time. Marine biodiversity is likewise conserved given that fish are caught sustainably using appropriate gear with no or minimal negative impacts to the non-target species and marine habitats.

Table 2. IDS Overview

	Indonesia	Philippines
Grantee	MDPI	MSUNFSTDI
Organization type	Technology organization	Academic foundation
IDS Platform	Web-based	Mobile application (Android)
Data sources	• Ministry of Marine Affairs and Fisheries (MMAF) eLogbook • MMAF integrated vessel registration system (SIMKADA) • MMAF's Online System for Fish Quarantine Inspection & Application Service System (Sister Karolina) • I-Fish (Fisheries Co-Management Committee) • Pointrek and Trafiz	• BFAR to paper-based catch logsheets • BFAR eCDT system • Futuristic Aviation and Maritime Enterprises (FAME) technology
Data coverage	Fisheries Management Area (FMA) 716 (North Sulawesi Province)	FMA 3 (Sarangani Bay and Celebes Sea)
Types of visualization	• Catch • Catch species composition • Map of fishing ground	• CPUE • Catch species composition • Map of fishing ground • Catch area by gear type
Primary users and stakeholders	• MMAF • North Sulawesi Province Fisheries Co-Management Committee	• BFAR National and Region 12 • local government units around Sarangani Bay

The major features of the IDS developed by MSUNFSTDI include map visualization (Figure 8) and data analytics (Figure 9). The map visualizations show fish catch distribution by mapping locations of the catcher vessels within a specified date range. Data analytic features allow users to view data using graphs, which could in turn be used for reporting and presentation purposes.
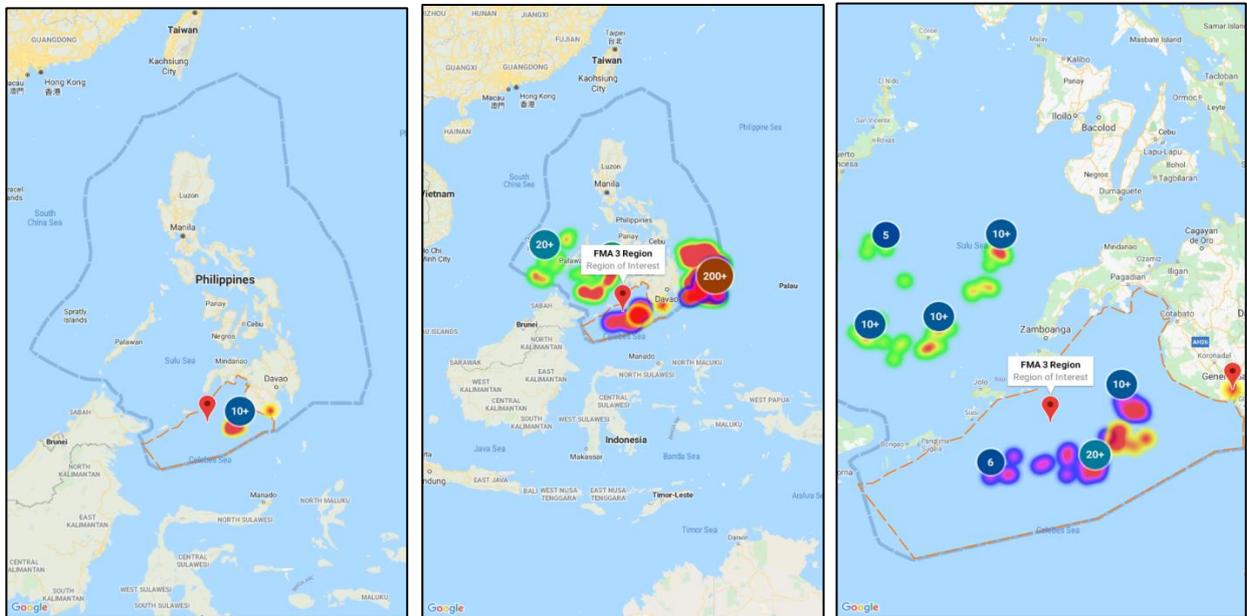
Figure 8. Map of fish catch location by handline vessels (left) and all fishing gears (middle and right)
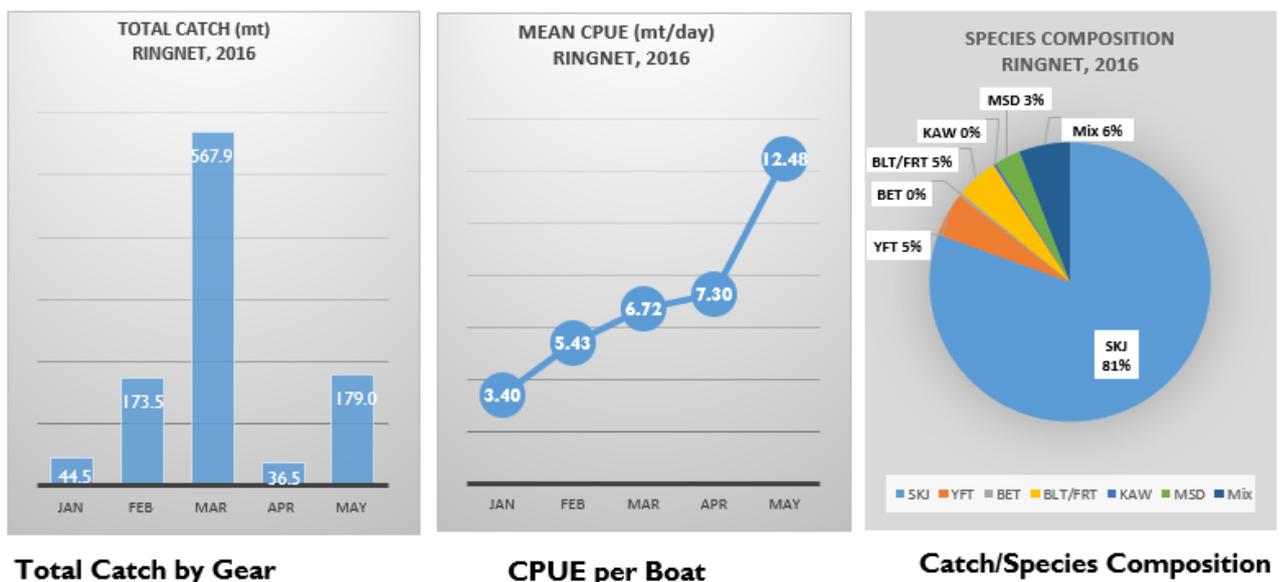
Figure 9. Visualizations of data analytics using the mobile app

In Indonesia, MDPI, developed a web-based dashboard (Annex II) as a minimum viable product for the IDS. The platform default view shows a map of the Indonesian FMAs from which users can choose to visualize data for particular FMAs. For each FMA, users can choose to visualize data through maps or graphs to view catch distribution (Figure 10), total fish catch by gear type (Figure 11), species catch composition, and more.
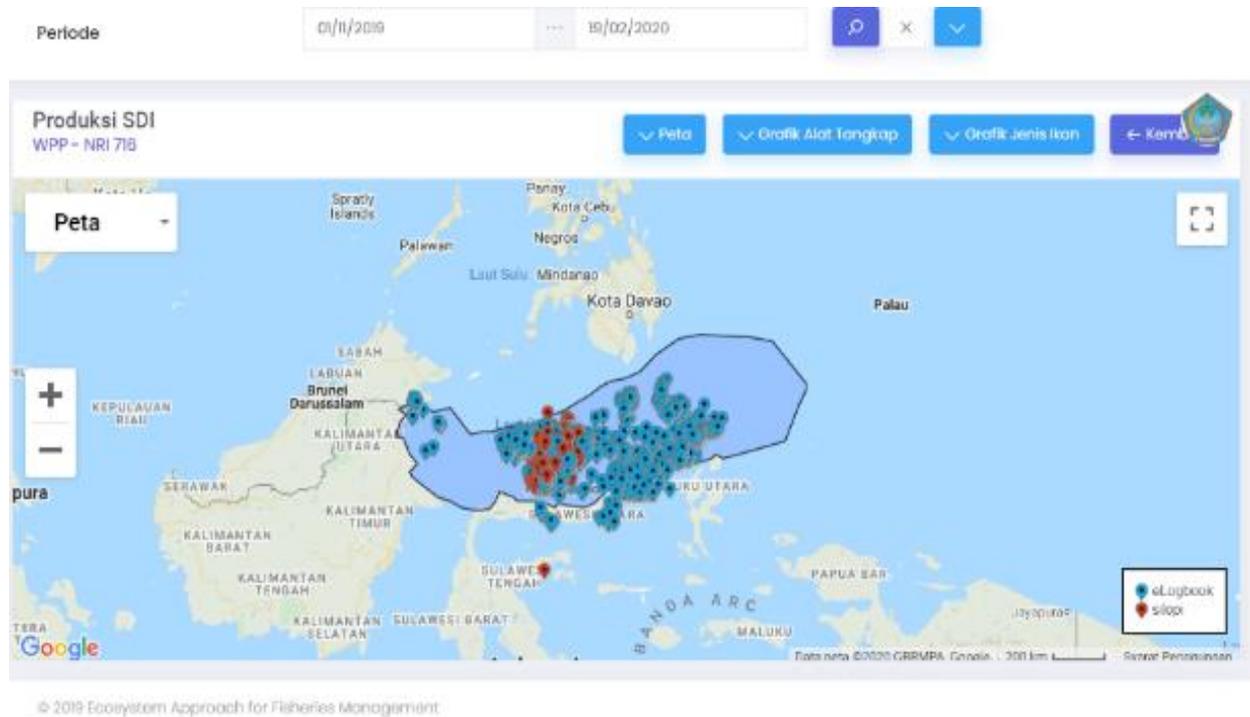
Figure 10. Catch distribution which visualizes the location in map in FMA 716.
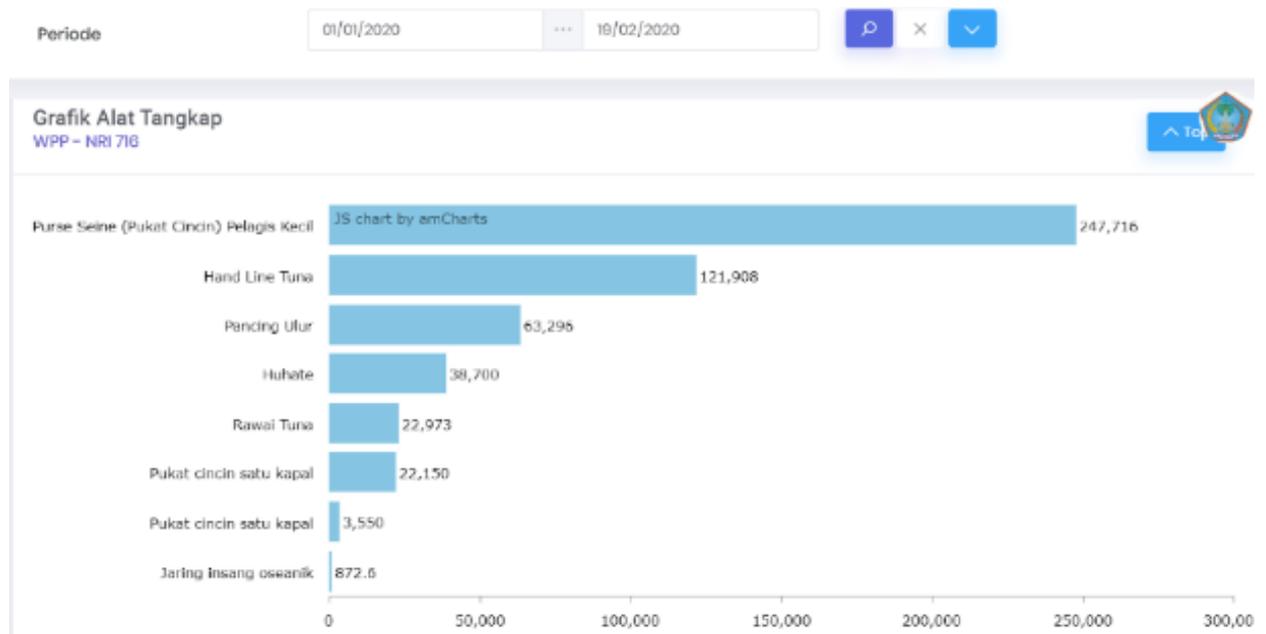
Figure 11. Graph total fish catch based on fishing gear used.

USAID Oceans established an EAFM Technical Advisory Team to provide technical and scientific inputs to both grantees to support their grant deliverables, particularly IDS development. The Team is composed of seven fisheries and fisheries management experts with extensive experience in the Southeast Asia region. During the *Second Joint Meeting of the USAID Oceans EAFM Technical Advisory Team and Grantees,* several concerns related to the IDS were identified (Box 3). These issues fell into three categories: (1) data management; (2) capability of user capability; and (3) use/application (Table 3).

Table 3. Issues identified for the two EAFM Grantees in the Philippines and Indonesia

| Issue Category	Concern	Details
Data management	Data and database reliability	The databases and data sets input into the IDS are not always entirely accurate. As a computer-based system, the IDS automatically removes erroneous data. Therefore, poor-quality data can result produce spurious or duplicative results. IDS should include data verification mechanisms to ensure that data are reliable and to avoid duplication.
	Security and access	Key concerns related to IDS security and access include: • Need to determine level of access for participating national and local government agencies. • The need to provide data access to non-government stakeholders and end-users, including academic institutions and civil society organizations. • Lack of an established hierarchy of access to the IDS systems and corresponding security protocols.
	Linking to other databases/systems	The IDS developed by the grantees are not yet integrated into the FIS of the national fisheries management agencies such as BFAR in the Philippines and MMAF in Indonesia. In the Philippines, for example, the current IDS need to be linked with the National Stock Assessment Program. Examples of relevant KDEs that can be pulled from these systems if integrated include landing data and catch rates.
	Incomplete data	The current IDS only store and analyze the datasets that are input directly into the eCDT system from registered boats. Thus, unregistered boats, which are common in Southeast Asia fisheries, are not captured in the system.
	Data verification	The eCDT data used by IDS needs to be linked with the National Stock Assessment Program for data verification, (e.g., verification of fish species, volume of catch, fishing location).
	Data consolidation	The eCDT data and IDS need to be integrated into FIS and interoperable with other fisheries databases.
User capabilities	Technical expertise and assistance	The capability of the users to effectively use the IDS is at stake. At this stage, the knowledgeable IDS users are the grantee programmers and information technology experts who developed the IDS. Once the grant period is complete, there is not guarantee that these experts will still be available to further develop, deploy, and update the IDSs, or provide technical assistance to users.
Application	Upscaling and downscaling	The current IDS are being used in FMA 716 and FMA 3 in Indonesia and the Philippines, respectively. The application of these tools on both a smaller and broader scale is not yet clear. Grantees should explore opportunities for upscaling and downscaling (e.g., linking IDS to national, sub-national, and local level FIS).
	Intellectual Property Rights of outputs	The Intellectual Property Rights of the grantee's outputs are currently considered public goods. However, the property rights may pose constraints after the USAID Oceans project has closed if the grantees further develop the IDS with additional data analytics and functionalities.

Despite these concerns, the work done through the EAFM grants to collect and analyze available eCDT data to inform local and national fisheries management decisions relates directly to core assumptions underlying the USAID Oceans' Theory of Change (Figure 12) that access to real-time, fisheries-related data from eCDT systems will enhance fisheries management, thereby promoting marine biodiversity conservation and sustainability of fishery resources. Demonstrating how eCDT data can be used to improve fisheries management and timely decision-making was an important component of the USAID Oceans' exit strategy. The program highlighted incentives and enhanced technical capacity for partners to use real-time eCDT data for improved fisheries management decision-making and strengthened fish stock assessments.

If…	then…
…the eCDT system is robust, meets stakeholder needs, and provides economic incentives…	the system will be adopted and supported,
…eCDT data are integrated into fisheries management systems…	fisheries governance will be strengthened, and
…capacity and cooperation are built...	users will endorse and sustain system use
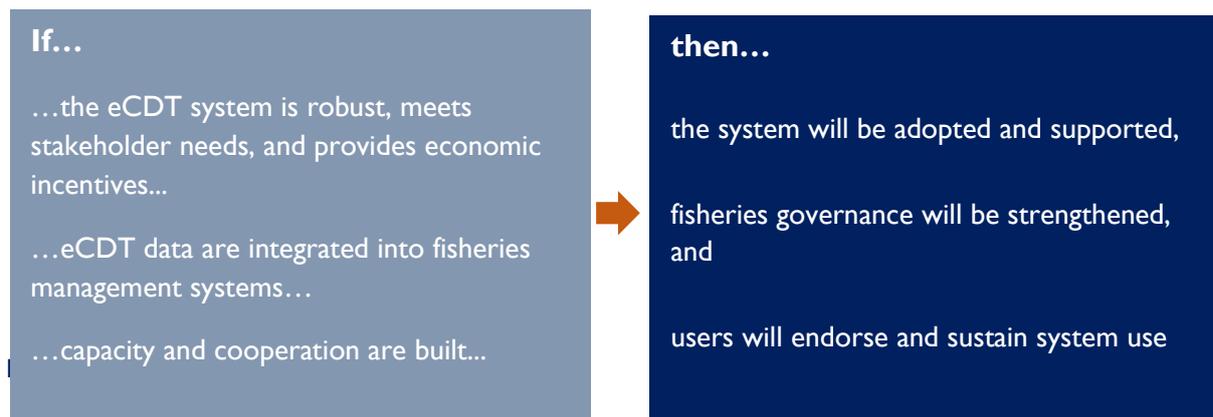
WAY FORWARD

The potential to use eCDT data for fisheries management in Indonesia and the Philippines needs to continue to be pursued. Both countries have established FMAs to support a science-based and participatory governance framework for managing FMAs. The FMAs were delineated based on approximate stock boundaries, range, distribution, and structure. Both MMAF and BFAR should continue engaging scientists from government and academe to further develop IDS for using eCDT data for real-time fisheries management. Other technical experts are also needed to review the data generated by the eCDT system as inputs for stock assessments and assessing other FMA parameters. In addition, more eCDT pilot projects could demonstrate how eCDT system data can be used to develop policies such as closed seasons, harvest control rules, and other management strategies that support EAFM. Furthermore, linking eCDT data with the National Stock Assessment Programs will provide more robust evidence-based guidance for managing FMAs, including considerations of other fisheries, fishing gears, and fish species (see Table 4).

Table 4. Examples of how IDS analysis and visualization of eCDT data can guide fisheries management

Data analysis / visualization	Management Interventions
Catch and CPUE trends	• Harvest control measures based on stock status • Species or gear-specific management measures – temporal fishing closures, etc.
Catch species composition	• Gear restrictions based on gear/fishery impacts on fisheries resources
Fishing ground mapping	• Species- or gear-specific management measures – spatial fishing closures, establishment of fish conservation areas, etc. • Enforcement of and compliance with fishing zones and protected areas

Table 5 outlines proposed next steps to be undertaken to further develop digital solutions to support the use of eCDT data for fisheries management. These recommendations are closely associated with Table 3 (Issues identified for the EAFM Grantees) and fall into three broad categories (1) organization and management; (2) IDS system development; and (3) transboundary fisheries management.

Fisheries managers in Bitung, Indonesia demonstrate the eCDT systems they use to inform decision-making. Credit: USAID Oceans/F Maruf

Table 5. Next Steps Beyond USAID Oceans

Category	Next steps	Responsible party
Organization and management	Continued collaboration with partners	National Fisheries Agencies (e.g., BFAR, MMAF)
	Linking with appropriate institutions	
	Link IDS with vessel monitoring station (center and requirements)	
	Sharing and promoting eCDT technologies to other Southeast Asian countries	
IDS system development	Ongoing system upgrades/enhancements	National Fisheries Agencies, Academe, NGOs, private sector
	Data layering (habitats, species, users, etc.)	
	Linking eCDT technologies (e.g., FAME, Pointrek, Trafiz) with the IDS	
Transboundary fisheries management and context	Transboundary collaboration (i.e., interoperability of IDS between Indonesia and the Philippines within Sulu-Sulawesi Seascape, and implementation of sub-regional EAFM plan)	Regional Fisheries Agencies (e.g., CTI-CFF, SEAFDEC) in collaboration with National Fisheries Agencies and NGOs in Indonesia, Malaysia, and the Philippines
	Identification of commonalities between Philippines FMA 3 (Celebes Sea) and Indonesia FMA 716 (North Sulawesi) for collaborative management of fisheries resources	

In terms or organization and management, collaboration of IDS developers with the appropriate institutions that are directly involved in fisheries management is essential. At the national level, in the Philippines, these include BFAR headquarters and regional offices. At the local level, these may involve the local government at both the provincial and municipal/district levels. Local academic institutions should also play a role in operation of the IDS as these entities have colleges or units that have expertise in computer science and/or IT.

Part of IDS system implementation is regular system upgrades. MSUNFSTDI's application currently operates on an Android model. Very soon, though, the IDS shall be upgraded and made applicable to other mobile operating systems (e.g., iPhone) and web-based systems. Additionally, MSUNFSTDI will enhance the IDS though data "layering", meaning overlaying data input and stored in the IDS with other data related to fisheries habitats, economic activities, and users of marine/coastal resources as these data accumulate over time. The IDS may then display more sophisticated, three-dimensional visuals to aid in fisheries planning and management.

It is also paramount that IDS systems are complimentary to other eCDT technologies. USAID Oceans has supported the development of seven eCDT technologies used throughout the fisheries supply chain; the IDS developed by the two grantees need to be streamlined and/or integrated with these other eCDT technologies as well as outside systems, including national eCDT systems. Four of the eCDT technologies supported by USAID Oceans, which are currently linked with the IDS, are Trafiz, FAME vessel transponders, Pointrek vessel monitoring system (VMS), and TraceTales (Table 6).

Table 6. USAID Oceans-supported eCDT Tools

Tool	User	Description
Trafiz	Middle-buyers in small-scale fisheries	Trafiz (pioneered in Indonesia) is an Android-supported mobile application for small-scale fish suppliers and buyers that provides a first data entry point for seafood products upon landing. Trafiz allows users to enter and submit catch data via a mobile device and cellular connectivity.
FAME technology	Small-scale fishers	FAME, a private company based in the Philippines, developed a vessel transponder that is a form of VMS. The transponder is an eCDT device that records information from the point-of-catch for small-scale fishers. The transponder also increases on-board communication capabilities and safety at-sea. The FAME transponder pilot highlighted the critical role of the first buyer given that first buyers carry essential information of the fish caught from the point of catch up to the landing station (e.g., location of catch, landing location, fish species, boat and fisher identification).
Pointrek VMS	Captains on Large- and Medium-Scale fisheries vessels	The Pointrek two-way communication VMS, unlike traditional VMS, allows communication to and from a command center or shoreside user and the vessel. Typically, a VMS is used by government authorities to track locations and monitor activities and movement of fishing vessels. VMS can also be used by fleet owners as a tool for fishing fleet management. Pointrek's VMS functionalities include two-way communication and real-time catch reporting. Pointrek was developed by the Indonesian-based company, PT. Sisfo developed Pointrek as a web-based application that uses satellite networks to monitor the movement of vessels. Pointrek VMS provides real-time, electronic VMS and catch data via an onboard mobile tablet. It also allows person-to-person communication from ship to shore though onboard Wi-Fi for connected mobile devices via text message, email, SMS applications.
TraceTales	Processors in small- and Large-Scale Fisheries	Developed by MDPI, TraceTales enables processing companies to capture data throughout the processing stage. This digital system enables processors to quickly and easily compile the information required for distribution and export by various national and international traceability requirements. TraceTales not only enables data capture, entry, and analysis.

Ongoing IDS implementation needs to account for the opportunity to facilitate and strengthen transboundary collaboration. Currently, the IDS developed by MSUNFSTD is built on an android-specific platform while the IDS developed by MDPI uses the web-based technology. Regardless of the technological configurations, there are common KDEs that are collected from both tools for Philippines' FMA 3 and Indonesia's FMA 716. There needs to be interoperability for both systems so the data outputs and results generated may be jointly utilized for transboundary collaboration so both countries can work together to manage fisheries resources in the Sulu-Sulawesi Seascape.

In the future, IDS data analytics and dashboards will be incorporated within a Fisheries Monitoring (FishMon) Center. A FishMon Center is a land-based facility of a national fisheries agency that collects data from various sources (e.g., VMS, eCDT systems), validates and stores them, and makes the information available for operational and administrative control as well as data analysis. FishMon Centers allow policy makers to visualize events happening within the sector in real time. When

establishing FishMon Centers, operational requirements—building, human resources, supplies, equipment—of such a center must be appropriately budgeted for.

Fisheries Monitoring Center in BFAR Region 12, Philippines. (Photo credit: BFAR 12)

Finally, in order to advance the use of eCDT data to inform fisheries management, the USAID Oceans EAFM Technical Advisory Team and EAFM grantees recommend strengthening EAFM practices in the following ways:

1. Identify public, private and non-governmental management constituencies to support eCDT and its links to fisheries management

2. Advance legal and policy support to mainstream eCDT and EAFM at national and local levels

3. Work towards interoperability of various fisheries information and eCDT systems

4. Harness the potential use of eCDT for EAFM through capacity building, data and technology sharing, and coordination

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ANNEX 1. PHILIPPINES IDS FLYER

INNOVATIVE DIGITAL SOLUTION:
Supporting fisheries management and catch documentation data analysis

INTRODUCTION

The USAID Oceans and Fisheries Partnership (USAID Oceans) is working to strengthen regional cooperation to combat illegal, unreported, and unregulated (IUU) fishing, promote sustainable fisheries, and conserve marine biodiversity in the Asia-Pacific region. In line with these objectives, USAID Oceans has awarded an Ecosystem Approach to Fisheries Management (EAFM) Grant to the Mindanao State University Naawan Foundation for Science and Technology Development, Inc. (MSUNFSTDI) to **design an innovative digital solution (IDS) to use electronic catch documentation and traceability (eCDT) data to improve fisheries management in the Philippines** (GR006-MSUNFSTDI).

Under the grant, MSUNFSTDI is developing an easy-to-use, practical, digital scheme to support catch documentation and traceability (CDT) for municipal/small-scale and commercial tuna fisheries in Sarangani Province and General Santos City, Philippines. Specifically, the grant objective is to build, test, and deploy an IDS that rapidly and intuitively provides real-time information to inform and enable novel and adaptive fisheries management activities backed by data-driven decision-making.

INNOVATIVE DIGITAL SOLUTION (IDS)

The IDS MSUNFSTDI created is an android mobile-based application built using the architecture depicted in Figure 1. The application uses an application programming interface (API) to "talk" to various other CDT databases and sources of information (e.g. Bureau of Fisheries and Aquatic Resources/BFAR's eCDT system, logsheets, private-sector technologies for small-scale fishers).
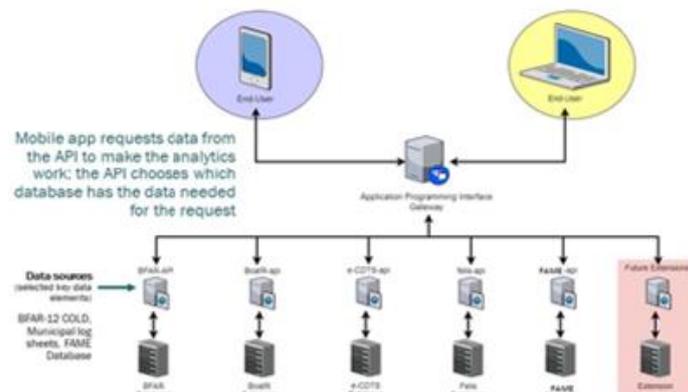

Figure 1. IDS application architecture

The application is designed for five levels of users:

1. National government (BFAR)
2. Industry/commercial fishers
3. Researchers and academe
4. Local Government Units and non-governmental organizations
5. Small-scale fishers

Each user will have a different level of access, with BFAR being the primary user with full access to data. When users log in, they will be brought to the welcome screen from which they will choose which feature they want to use (Figure 2). Under this grant, the IDS was tested using eCDT data from the Sarangani Bay and Celebes Sea (FMA 3) in Southern Mindanao, Philippines.
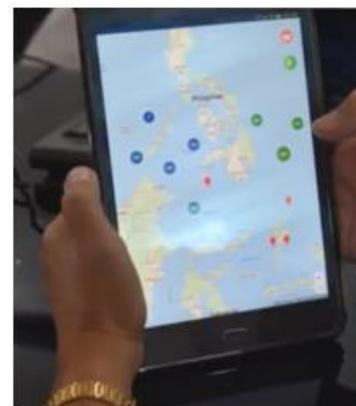
Figure 2. Map visualization (Photo Source: BFAR 12/J. Padro)

DATA ANALYTICS AND VISUALIZATION

The application's two major features are map visualization (Figure 3) and data analytics (Figure 4). Figure 3 shows a visualization of fish catch distribution within a specified data range based on the locations of the fishing vessels at the time of catch. Figure 4 shows charts and graphs available for data analysis and reporting purposes.
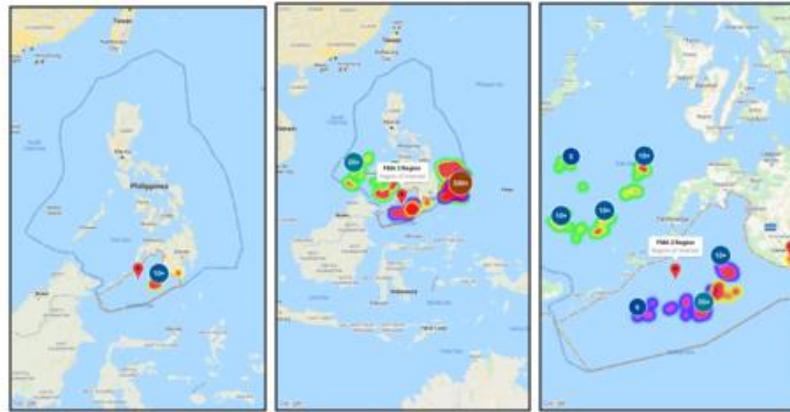

Figure 3. Visualization of fishing activities of hand line (left) and all gears (middle and right) within the Philippine economic exclusion zone.
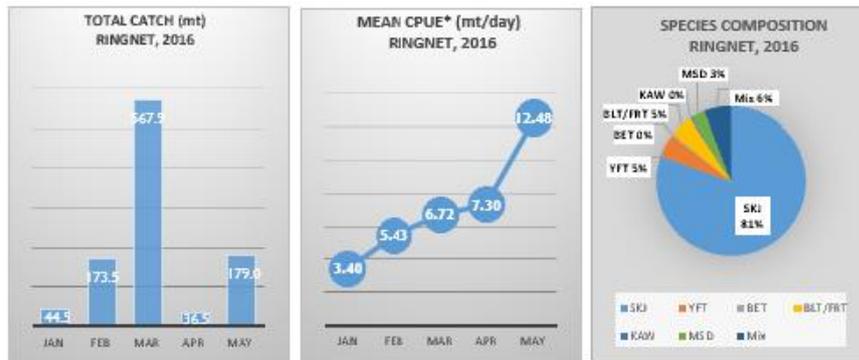
*catch per unit of effort

Figure 4. Data analytic visualization

USING DATA FOR SUSTAINABLE FISHERIES MANAGEMENT

It is envisioned that the IDS can use analytics and visualizations of eCDT data to inform development of management practices and policies. Fisheries management interventions such as closed seasons, harvest control rules, and other strategies can support EAFM plan implementation in FMAs. In addition, linking eCDT data with the National Stock Assessment Programs will provide more robust evidence-based guidance for managing FMAs, including considerations of other fisheries, fishing gears, and fish species.

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ANNEX II. INDONESIA IDS FLYER

INNOVATIVE DIGITAL SOLUTION:
Supporting catch documentation and traceability

INTRODUCTION

The USAID Oceans and Fisheries Partnership (USAID Oceans) is working to strengthen regional cooperation to combat illegal, unreported, and unregulated (IUU) fishing, promote sustainable fisheries, and conserve marine biodiversity in the Asia-Pacific region. In line with these objectives, USAID Oceans has awarded an Ecosystem Approach to Fisheries Management (EAFM) grant to Masyarakat dan Perikanan Indonesia (MDPI) to **design an innovative digital solution (IDS) to use electronic catch documentation and traceability (eCDT) data to improve fisheries management in Indonesia** (GR005-MDPI).

Under the grant, MDPI is developing a web-based data analytics tool that will enable fisheries managers—specifically provincial-level managers in North Sulawesi, Indonesia—to easily use eCDT data to make data-driven decisions and is building stakeholder capacity to use the tool. Through better access to and understanding of eCDT data, management responses can better address IUU activities. For example, in addition to increasing comprehensive and consistent reporting, real-time catch data, including location, can help monitor when vessels are entering protected areas or using unsustainable fishing gear and inform corrective action. This work also supports the Indonesia One-by-One Tuna Alliance, which strives to identify ways to connect data source and engage stakeholders to compile and use CDT data.

INNOVATIVE DIGITAL SOLUTION (IDS):

The IDS allows users to access information on active vessels in designated Fisheries Management Areas (FMAs) and to use this information to support FMA management (Figure 1). Under this grant, the IDS was tested using eCDT data from FMA 716 in North Sulawesi province in Indonesia.

Figure 1. IDS users access key information on FMA 716 and discuss next steps to better manage the area

The IDS architecture allows the application to source data from various databases and/or uploaded spreadsheets and connects the data via an application programming interface (API) (Figure 2).
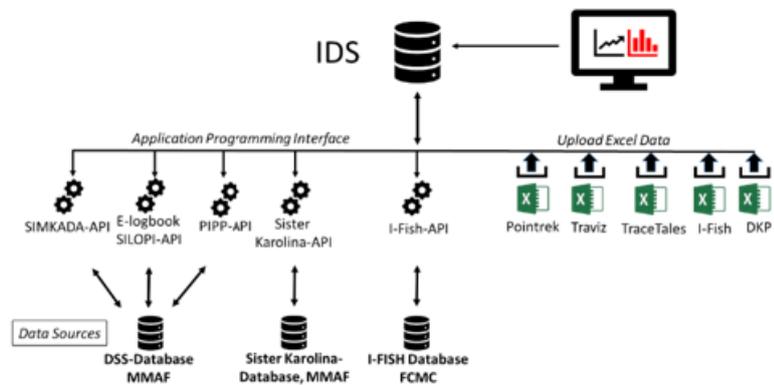

Figure 2. IDS architecture

DATA ANALYTICS AND VISUALIZATION

The application's dashboard allows managers to visualize data such as catch location, total catch, gear used, and monthly summaries of active vessels and catch totals using maps, charts, and graphs (Figures 3-5)
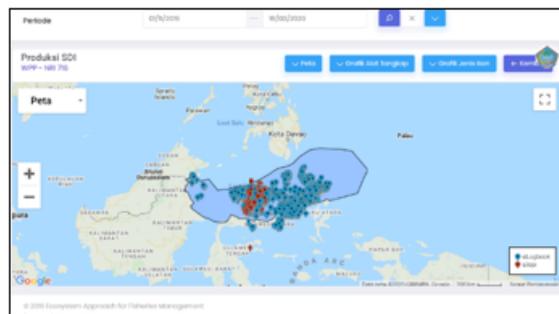

Figure 3. Catch location and distribution
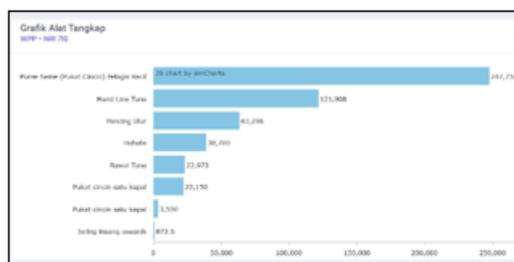
*Figure 4. Total catch based on fishing gear used*

Figure 5. Monthly summary of catch totals

USING DATA FOR SUSTAINABLE FISHERIES MANAGEMENT

It is envisioned that the IDS can use analytics and visualizations of eCDT data to inform development of management practices and policies. Fisheries management interventions such as closed seasons, harvest control rules, and other strategies can support EAFM plan implementation in FMAs. In addition, linking eCDT data with the National Stock Assessment Programs will provide more robust evidence-based guidance for managing FMAs, including considerations of other fisheries, fishing gears, and fish species.

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ANNEX II: AVAILABLE RESOURECES

Explore USAID Oceans' training, technology, and research tools, which provide guidance for implementing fisheries development solutions that support sustainable fisheries, consider new technological advancements, and enhance the human aspects of fisheries. Key resources, available in multiple languages, are listed below. To view and download USAID Oceans full set of resources, visit http://bit.ly/OceansResources

Project Overview Materials

Program Overview Video – Learn how USAID Oceans and its supported technology solutions are working to strengthen regional cooperation to combat IUU fishing, promote sustainable fisheries, and conserve marine biodiversity in the Asia-Pacific region. This video provides an overview of what eCDT technology is and the benefits it can bring to a range of partners—from local fishers to international consumers. bit.ly/Oceansoverview

Fisheries Catch Documentation and Traceability in Southeast Asia primers – "CDT 101" provides a conceptual overview of USAID Oceans' approach to eCDT, exploring Southeast Asia's fisheries, technology, and partner landscape. "CDT 201" provides a deeper, more technical look at the program's technical approach and outlines specifications used for system design, testing, and implementation. bit.ly/cdtprimers

Data Requirements for Catch Documentation and Traceability in Southeast Asia – This guide presents a framework for critical tracking events (CTEs) and key data elements (KDEs) recommended to be captured using eCDT systems, including those recommended for enhanced human welfare. It includes a glossary of terms, definitions, and intended uses of all relevant and required KDEs within a traceable, wild-caught seafood supply chain. bit.ly/oceanskdeguide

Technology Solutions for Electronic Catch Documentation and Traceability booklet – This booklet provides an overview of USAID Oceans-developed and supported technology tools for electronic catch documentation and traceability. These tools establish connectivity in remote and at-sea areas, provide a mechanism for data collection and transmission through the entire supply chain, and provide value-added user benefits, such as communication, safety, and business tools. http://bit.ly/eCDTbooklet

Technology Impacts: Business Benefits of Electronic Catch Documentation and Traceability Technologies – This resource shares impact studies on how eCDT technologies can establish connectivity in remote and at-sea areas; provide mechanisms for data collection and transmission through the entire supply chain; and offer value-added user benefits, such as communication, safety, and business tools. http://bit.ly/39qLhXk

Gender training videos – Video 1 introduces viewers to the important role that women play in the seafood supply chain—from preparing boats for sea to managing seafood sales. Video II provides a more in-depth look at gender research, including the importance of conducting gender research to inform fisheries management and important tools for conducting this research. These videos are developed to be used in trainings for fisheries managers at all levels as well as program implementors working in fisheries. http://bit.ly/2vD3UsE

Learning site posters – Download USAID Oceans' series of posters that communicate key behaviors and practices needed for sustainable fisheries. The four posters cover illegal, unreported, and unregulated (IUU) fishing; safe and fare workplaces; catch documentation and traceability; and catch handling. Available in multiple languages. http://bit.ly/siteposters

Learning Site Lessons Learned reports – These reports document lessons learned, recommendations, and next steps from USAID Oceans' experience developing and testing cutting-edge seafood traceability systems; implementing sustainable fisheries management plans; empowering women and promoting gender equity; and bringing together government and industry to ensure seafood traceability in the project's two learning sites in General Santos, Philippines, and Bitung, Indonesia. http://bit.ly/Oceanslessonslearned

Research and Training Guides

Assessing Fisheries in a New Era: Extended Guidance for Rapid Appraisals of Fisheries Management Systems and Technical Annexes provide new and extended guidance on appraising fisheries management systems that make use of new technology advancements and acknowledge the human and gender-related aspects of fisheries. Download the RAFMS guide here: http://bit.ly/RAFMSguide, and the technical annexes here: http://bit.ly/RAFMSannex

Gender Research in Fisheries and Aquaculture: A Training Handbook can be used to build team's understanding of gender equity, its importance in development, and practical tools and research methodologies that can be used to obtain valuable information about the human dynamics of fisheries**.** http://bit.ly/gender-research

Transformational Fisheries Development: Simplified Steps for Public Sector and Industry Engagement provides step-by-step guidance for identifying, evaluating, and implementing partnerships between the public and private sector to greatly enhance eCDT and other fisheries development ventures. http://bit.ly/PPP-guide

Using Electronic Catch Documentation and Traceability (eCDT) to Sustain Fisheries and Conserve Marine Biodiversity shares USAID Oceans experiences and lessons learned using eCDT to sustain fisheries and conserve marine biodiversity in Southeast Asian region, with a particularly focus on the use of eCDTS data to improve fisheries management and biodiversity conservation. https://bit.ly/3aVz9hZ