Food and Agriculture Organization of the United Nations

GUIDANCE DOCUMENT: ADVANCING END-TO-END TRACEABILITY

Critical tracking events and key data elements along capture fisheries and aquaculture value chains

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PREPARATION OF THIS DOCUMENT

Preparation of this guidance document was coordinated by the Value Chain Development Team, FAO Fisheries and Aquaculture Division, as part of FAO's Strategic Framework (Better Production, Better Nutrition, Better Environment and Better Life), and the Blue Transformation Roadmap Objective: Upgraded value chains ensure the social, economic and environmental viability of aquatic food systems. This publication will contribute to equipping stakeholders with technical capacities to support inclusive, transparent, efficient and sustainable aquatic food systems, thus enabling a more efficient market access for fisheries and aquaculture products. In particular, this guidance document assists countries to ensure the identification of the origin of fish and fishery products as specified under Article 11.1.11 of the Code of Conduct for Responsible Fisheries (CCRF).

The development of this guidance document spanned over the period of 2020-2022 where a first version was released for an electronic public consultation, in March-April 2021, that was commented on by a wide range of stakeholders from 42 countries globally. A second version underwent three regional virtual consultations in 2021 and 2022 with the participation of more than 120 representatives from 34 countries and 6 international and regional fishery and aquaculture organizations from Asia, Near East and North Africa, and Latin America.

The paper was written by Francisco Blaha, Vincent André and Yahira Piedrahita, FAO consultants and international traceability experts, under the lead of Nianjun Shen, Senior Fishery Officer, and Nada Bougouss, Fishery Officer. Revisions were provided by Mariah Boyle, John Bostock, Dimitar Taskov, Seonyoung Park and Lucia Lopez de Aragon, FAO consultants. Assistance from Claire Ward for language editing, and Zoe Brandizzi for the layout are gratefully acknowledged.

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PREFACE

The *Guidance document: Advancing end-to-end traceability* responds to a critical need for consensus towards establishing end-to-end traceability through globally agreed and standardized understanding of the critical tracking events (CTEs) along the fish value chain, as well as sources of key data elements (KDEs) related to fish production and product identification.

In particular, the Guidance aims at developing insights and addressing gaps in developing and implementing traceability systems for both the private sector and government. Supported by deliberations through various consultations between 2021 and 2022 (FAO, 2022b), it also provides technical advice in the enforcement and adequate verification of traceability in fish value chains, and seeks to act as a benchmark of existing traceability systems to evaluate their efficacy and identify associated gaps.

The document addresses these objectives through the identification of CTEs and KDEs along the fish value chain (**sections 3** and **4**) and, where possible, the identification of supporting standards based on the standards and guidelines of the Global Dialogue on Seafood Traceability (GDST).

It includes discussion and recommendation narrative (**sections 5** and **6**) whereby the overarching takeaways and advice is to: a) identify and define standardized KDEs and CTEs for commercial and regulatory traceability; and b) follow strict due diligence using a holistic and integrated approach involving all stakeholders at legal, commercial and operational level prior to commitment.

The Guidance recognizes the globalized landscape in the trade of fisheries and aquaculture products, coupled with the inherent fragmentation of associated value chains rendering the implementation of efficient traceability systems rather challenging. It also recognizes the particular challenges for small-scale producers and developing countries.

ABBREVIATIONS AND ACRONYMS

AIS	automatic identification system
ASFIS	Aquatic Sciences and Fisheries Information System
BSI	British Standards Institution
CA	competent authority
CCRF	Code of Conduct for Responsible Fisheries
COFI	Committee on Fisheries
COFI: FT	COFI Subcommittee on Fish Trade
CTE	critical tracking event
EEZ	exclusive economic zone
EPCIS	Electronic Product Code Information Services
EU	European Union
GDST	Global Dialogue on Seafood Traceability
GPS	global positioning system
GTIN	global trade item number
HACCP	Hazard Analysis Critical Control Points
IMO	International Maritime Organization
IRCS	international radio call sign
ISO	International Organization for Standardization
IUU	illegal, unreported and unregulated (fishing)
KDE	key data element
MCS	monitoring, control and surveillance
MMSI	maritime mobile service identity
MTU	mobile transmitting unit
NGO	non-governmental organization
PSMA	Agreement on Port State Measures
RFMO	regional fisheries management organization
SKU	stock keeping unit
TRU	traceable resource units
UNCLOS	United Nations Convention on the Law of the Sea (1982)
UNFSA	United Nations Fish Stocks Agreement (1995)
UPC	universal product code
VMS	vessel monitoring system

1. INTRODUCTION

There is no single global prescriptive approach or tool for managing fish traceability, yet there is a level of consensus that stakeholders should be working towards end-to-end, electronic and interoperable traceability.

Bhatt *et al.* (2016) note that to reach such a point, there first needs to be a globally agreed and standardized understanding of the CTEs along the fish value chain, as well as sources of KDEs related to fish production and product identification.

Their definitions are:

- CTEs – critical tracking event point at which product is moved between premises or is transformed, or which is determined to be a point where data capture is necessary to maintain traceability; and
- KDEs – key data element input required to successfully trace a product and/or its ingredients through all relevant CTEs.

The objective of this guidance document is to support standardized understanding of the CTEs and sources of KDEs for capture fisheries and aquaculture supply chains. This, in turn, should support the advances in information technology that have given rise to a broad range of digital food traceability initiatives and systems, by establishing a standardized vocabulary and data formatting.

The document endeavours to assist operators and authorities to identify the data that needs to be traced, and to define the parameters of traceability.

1.1 SCOPE AND DEVELOPMENT PROCESS

Scope

This guidance document is intended to support countries in implementing traceability in fisheries and aquaculture value chains. It discusses the role of traceability for official assurance, yet it draws on the efforts and learning from initiatives led by the private sector in implementing traceability throughout the fish value chain.

In the context of value chains, the document considers that value chains for capture and culture fisheries differ from fish to fish and from country to country, and frequently within regions. In this respect it concurs with a study prepared for FAO by De Silva in 2011.

Moreover, a fish value chain can be defined as interlinked value adding activities that convert inputs into outputs, which in turn add to the bottom line and help to create a competitive advantage. A value chain typically consists of inbound distribution or logistics, manufacturing operations, outbound distribution or logistics, marketing and selling and after-sales service. These activities are supported by purchasing or procurement, research and development, human resource development and corporate infrastructure.

Most of the analysis in this guidance document and the resulting recommendations are based on the identification of CTEs and KDEs under the purview of the "regulatory realm" (see **Section 2.2**) for specific state actors; how they are covered and how country-level mechanisms could or should serve to support them or supply traceability solutions in segments where solutions are absent and must be provided by individual states.

This guidance document uses for its analysis the literature and initiatives identifying KDEs as well as traceability standards developed by different industries and non-governmental organizations (NGOs), as well as non-regulatory standards from the "non-regulatory realm" (see **Section 2.3**). Yet, it does not propose any specific KDEs or standards for non-regulatory purposes, such as any form of private certifications, ecolabels, fair trade or social standards, and does not enter the area of organic or bio-certification.

Development process

A two-part process was followed in the development of this guidance document. The first part consisted of a desk study based on secondary sources, bibliographies and the analysis of initiatives by NGOs, governments, the private sector and independent experts, followed by an online public consultation that took place during March and April 2021. Comments and feedback were collected from a wide range of stakeholders from 42 countries.

The second part was the organization of three virtual regional consultations in 2021 and 2022 (Asia, North Africa and the Near East, and Latin America [(FAO, 2022b)]) with the participation of more than 120 representatives from 34 countries and six international and regional fishery and aquaculture organizations. Delegates and participants deliberated on the CTE and KDE listings and provided additional comments to corroborate their relevance and comprehensiveness.

2. TRACEABILITY IN CAPTURE FISHERIES AND AQUACULTURE VALUE CHAINS

Fish and fishery products remain some of the most traded food commodities in the world. In 2018, 67 million tonnes, or 38 percent of total fisheries and aquaculture production, were traded internationally (FAO, 2018). A total of 221 states and territories reported some fish trading activity, exposing about 78 percent of fish and fishery products to competition from international trade.

Overall, from 1976 to 2018, the value of global fish exports increased from USD 7.8 billion to peak at USD 164 billion, at an annual growth rate of 8 percent in nominal terms and 4 percent in real terms (adjusted for inflation). Over the same period, global exports in terms of quantity increased at an annual growth rate of 3 percent, from 17.3 million tonnes. Exports of fish and fish products represent about 11 percent of the export value of agricultural products (excluding forest products).

For the 1976 to 2018 period, exports from developing countries increased by an average of 8.4 percent per year in value terms, compared with 6.8 percent for developed countries. In this same period, developing countries' share of trade in fish and fish products increased from 38 percent of global export value to 54 percent, and from 39 percent to 60 percent of total quantity (in live weight equivalent), supported by strong aquaculture production growth and heavy investment in export market development.

Traceability and its key role in terms of market access for both food safety and legal origin underpin international trade. The steady increase in developing countries' share of international trade flows, with faster rates of growth compared with developed countries, has been a defining feature of the development of the global fish market.

Based on FAO literature (Borit and Olsen, 2016) and experience from the field, gaps and inconsistencies in traceability in fishery and aquaculture value chains might be explained by the following:

- **Standards gap**: there might be a lack of written requirements or published standards for information gathering and sharing that are needed for effective traceability.
- **Awareness gap**: there might be a lack of understanding on what traceability is, and how it differs from other principles that are seen to be similar to safety and quality standards.
- **Commitment gap**: commitment with respect to implementing traceability is probably related to the awareness gap. In addition, the most significant commitment gap is related to companies not understanding how traceability can benefit them financially (see the economic gap below).
- **Implementation gap**: there is often a gap between regulatory requirements and the feasibility of industry implementation. This may come from several factors such as insufficient maintenance of a batch integrity (too much mixing), inadequate document security and, most often, a lack of food safety management control.
- **Technology gap**: there are still challenges related to the availability of technology. Most companies have less robust traceability practices than they could have given their marketing strategy and economic interest. There might also be a lack of affordable, functional and robust technology for automatic data capture. The most significant time and cost related to the

operation of a traceability system is the cost associated with initial data entry that is frequently performed manually. In addition, when data entry has to be performed by small-scale farmers, the capabilities and capacities of the farmers may be a limitation.

- **Economic gap**: it is widely documented that good traceability not only fulfils legislative and commercial requirements, but it also reduces operating costs and underpins company branding and marketing strategies. However, operators required to implement more record keeping, or change working habits, often question the nature of the incentives that they will receive. A cost–benefit analysis of investment in improved traceability is difficult to perform.

2.1 THE APPLICATION OF TRACEABILITY

This guidance document uses the definition of traceability from ISO 9000:2015 (ISO, 2022a) as this incorporates all the critical properties of a traceability system as described in the scientific literature. Thus, traceability of any given product refers to "the ability to trace the history, application or location of an object."

In a product sense, it may relate to: the origin of materials and parts, the product processing history, and the distribution and location of the product after delivery. This definition clearly states what should be traced (history, application and location) and what events should be tracked.

There are several principles or requirements that must be followed for a traceability system to be effective. It is critical that recordings are interconnected and in a format that allows the product to be tracked along the entire supply chain. Thus, units that are traced (traceable resource units [TRUs], e.g. a box of mackerel), and identification or numbering schemes that provide codes/numbers used for the unique identification of TRUs (e.g. GS1 barcodes) are parts of a traceability system.

For this system to be effective, it is essential that the codes of a TRU (either as a raw material or semi-finished product) entering a link in the supply chain are associated uniquely with those of the same item (semi-finished or end product) leaving the link. This ability to identify products individually is the basis of product traceability. Equally critical is maintaining accurate records of the transformation (e.g. splitting, joining) that the TRU undergoes, and sharing the TRU identification code with partners in the supply chain. This approach is consistent with the FAO guidelines on traceability (FAO, 2013).

Based on these arguments, this document maintains that traceability is an infrastructure that can be used by control agencies for two purposes. The first purpose is to retrieve different data for various reasons (such as legal harvest, origin, eligibility, food safety, fisheries management, etc.).[1] The second purpose is to support the verification of these data with other specific tools, e.g. genetic identification of species such as in the case of fish mislabelling.

As discussed in the literature, "a traceability system is quite similar to a filing cabinet in that they both deal with systematic storing and retrieving of data. Importantly, neither a traceability system nor a filing cabinet care about what types of data are being stored" (Olsen and Borit, 2012). This notion has several important consequences. For instance, there is no guarantee that the recordings are true or complete, as both error and fraud can lead to false claims about the properties of the food product, including its origin. There is a clear need to verify these claims and in this area analytical methods and instruments play a crucial role. Similarly, documenting traceability and documenting an ecolabel-type chain of custody are two different concepts. Although traceability can be used as a tool in the

[1] Increasingly there is a call for the use of such data for the labour rights of the crew/seafood workers.

certification process, traceability and certification are nonetheless different processes (Borit and Olsen, 2012).

Traceability by itself makes no claim as to the state of the product or information that can be followed from one point to another through a system. In order to claim that a product has certain values, those values have to be verified, even if the product is traceable back to a specific origin.

The implementation of traceability systems in fisheries value chains was catalysed by market access requirements, which initially were the domain of the European Union health certification (2005) and later on (after 2010) supplemented by the European Union catch certification scheme.

As outlined in the FishWise (2018) paper on traceability: increasingly, companies are publicly committing to sustainable fish sourcing policies, and the challenge is now for those companies to be able to track the origin of their products to ensure that species and attributes of the products are meeting their policies and communicated to the customer accurately. For companies that buy and sell fish, the lack of product origin information and supply chain transparency can pose significant risks. In the past, industry's traceability focus was primarily on food safety concerns. However, the increase in media coverage about the environmental, social, and legal issues associated with fish has led to significant shareholder concerns, potential impacts on brand value, and challenges to the corporate social responsibility initiatives of companies.

The first step towards mitigating and eventually eliminating these risks is to ensure end-to-end, electronic and interoperable traceability systems are in place throughout the supply chain. This work is already underway, with some groups of companies instituting traceability policies and setting standards, often with the assistance of NGOs, government bodies and technology companies.

Borit and Olsen (2020) identified three main categories of traceability standards and norms, which this document also follows: international standards and guidelines, regulatory standards, and industry and NGO non-regulatory standards.

These provide the basis for identifying two main classes of drivers relating to the benefits of traceability:

- **"Negative drivers"** are related to what the firm must do, or more or less feel forced to do. They include meeting specific traceability requirements in legislation, in standards that the firm has adopted, or have been requested by the buyers, customers, consumers and market in question. They also include drivers related to reducing risks, in particular in relation to food safety and food fraud, and to short-term reduction in costs, resource use and waste.
- **"Positive drivers"** are voluntary and relate to the potential for using traceability to add value to the product, improve quality, and aid communication and information interchange in the supply chain. In particular, they include drivers related to brand trust, product differentiation and storytelling, sustainability and ethics beyond what is legally or contractually required.

The distinction between negative and positive drivers is not binary, and the drivers should be viewed as being on a continuous scale ranging from "absolute requirements, all companies must have this degree of traceability, otherwise they cannot operate" (negative), through to drivers only applicable for companies that have traceability and transparency as part of their branding and that will or might record anything that can add value to the product or the production process (positive). This division also sets the two realms in which traceability operates and in which we will base part of the analysis; the regulatory and the non-regulatory (voluntary).

While we recognize the complementarity between both, based on the institutional support nature of the FAO mandate, most of the analysis in this document and the resulting recommendations are

based on the identification of CTEs and KDEs under the purview of the "regulatory realm" for specific state actors: how they are covered and how country-level mechanisms could or should serve to support them or supply traceability solutions in segments where solutions are absent and must be provided by individual states.

Nevertheless, this document uses for its analysis the substantial volume of literature and initiatives identifying CTEs and KDEs as well as traceability standards developed by different industry and NGO non-regulatory standards in the "non regulatory realm".

2.2 THE REGULATORY REALM (OFFICIAL GUARANTEES)

Regulatory requirements exist for all business operators along the value chain, and they are linked to minimum requirements related to what the company needs to do to comply with laws, regulations and standards in order to meet market requirements for traceability, transparency and product documentation, and to keep costs low.

Regulatory requirements for traceability are not uniformly established among the international community, and they vary immensely among countries. Inside each country they may be required for one aspect (e.g. food safety) and not for others (e.g. illegal, unreported and unregulated [IUU] fishing).

Blaha, Borit and Thompson (2015) analysed traceability systems in ten countries, and in all cases the level and extent of the implementation of traceability requirements was driven by official food safety bodies (many in response to market access issues) that did not coordinate their work with that of any other interested parties (i.e. fisheries and customs).

Furthermore, different countries or groups of countries may have requirements of traceability that apply in three different scenarios:

- **Within an organization**: internal traceability, specific to a company or enterprise, is used to meet many business needs (e.g. official regulatory compliance and inventory management), but for the purposes of interoperable end-to-end traceability, the system elements are straightforward.
- **In between organizations across the national fish supply chain**: connecting an internal traceability system to upstream and downstream systems. For example, the New Zealand Ministry of Primary Production requires that anyone processing or storing fish products must record any movement of product between premises or owners in the mandated national E-cert system (MPI, 2023).
- **In between different countries**: connecting a national traceability system to upstream and downstream systems in other countries. For example, TRACES is an online platform run by the European Union Directorate General for Health and Food Safety that enables communication among the competent authorities (CAs) in the European Union, European Free Trade Area countries and non-European Union countries. The objective is to guarantee that the European requirements under its sanitary and phytosanitary measures for animal health, animal welfare and veterinary public health are met. In addition, the European Trade Centre's INTRASTAT system focuses on trade among European Union countries and re-exports from the European Union, but only after a consignment has entered the European Union under its importation protocol.

Many different administrations and regulatory bodies are involved from catch to consumer in most international fish value chains.

The needs, requirements and implementation capacities from these regulatory-based systems are quite unique because they imply the need for official guarantees provided at different CTEs along the value chain inside an organization, inside a country and in between countries.

There is limited information available on which CTEs and KDEs are applicable to these three regulatory-based scenarios. For capture fisheries this guidance document will follow the strategy already established by two FAO publications: *Seafood traceability for fisheries compliance – Country level support for catch documentation schemes* (Hosch and Blaha, 2017) and *Blockchain application in seafood value chains* (Blaha and Katafono, 2020).

These two publications analyse the interrelation of traceability along the value chain based on country-specific traceability mechanisms that are often essential for verifying and corroborating submitted data, based on the state types involved in fishing, landing, processing and trading of fisheries products along the supply chain (i.e. flag, coastal, port, processing and end-market states).

Each type of state carries out functions that contribute to the success of traceability under defined groups of CTEs and a less standardized group of KDEs that relate to the scope and specific application of the expected traceability function or outcome (e.g. food safety or IUU).

In the case of aquaculture, the state type concept is not as clear as it is in the wild capture sector, yet we can identify producer state for feed, hatcheries and farms, processing state(s) and market state(s).

In both cases, it is important to recognize that a single state can act as all of the state types, as is the case of many developing states that focus on capture/production and processing, while many developed economies are the market state for their products. Under this reality, there are specific regulatory requirements that apply to the different CTEs along the value chain and are validated by the collection and verification of KDEs, whose identification is central to the objective of this document.

In addition, a 2021 report by the Seafood Alliance for Legality and Traceability outlines *Comprehensive electronic and catch documentation and traceability (eCDT) principles* for governments that produce or are a source for seafood (SALT, 2021).

2.2.1 CAPTURE FISHERIES

For capture fisheries this segment of the analysis considers the types of states (flag, coastal, port, processing and end market) that have custody of fishery products moving through national supply chains from harvesting, transshipment, landing and processing to the consumer end market.

Each section on a type of state identifies general control elements that should be in place. The types of state analysed in this document for the capture fisheries value chain are:

- **Flag state**: this is the state whose flag is flown by fishing vessels, whose activities it is obliged to authorize and monitor under international law. In international fisheries, targeting species under the management of a regional fisheries management organization (RFMO), flag states also have reporting obligations to the international body as to the activities and catches of their fleet(s). Oversight by the flag state covers harvesting, transshipment and landing operations, the latter typically regarded as the last transaction related to fishing.
- **Coastal state**: this is the state in whose waters a fishing operation may be taking place, in which case the coastal state must provide the necessary oversight to ensure that foreign vessels entering its waters are authorized to operate, and report operations and catches to relevant coastal state authorities.

- **Port state**: this is the state in whose port(s) fish are landed. The port state has legal obligations under the Agreement on Port State Measures (PSMA) or port state measures best practices to ensure that only legal fish are landed by carrying out rigorous in-port inspections of vessels flying a flag other than that of the port state and voluntarily entering its ports to land fish, as well as the applicable requirements for its own flagged vessels.
- **Processing state**: this is the state in which raw products are converted into semi-processed products or end products. The processing state may be the same as the port state, or fisheries products for processing may enter the processing state by sea, air or land. Processing states are important in terms of ensuring that only legally caught, certified[2] fishery products are imported, processed or sold for domestic consumption, export or re-export. The "laundering" of fisheries products into legally certified supply streams occurs mostly at this level.
- **End-market state**: this is the territory in which final consumer products are placed on the market, acquired by customers and consumed, often after importation. The action of the end market state is limited to ensuring that non-certified[3] products cannot gain access to its consumer markets.

2.2.2 AQUACULTURE

For aquaculture, the analysis of standard workflow showing the links between the different operators in aquaculture supply chains is necessary to the implementation of a traceability system. Yet the role of "states" is not as defined as in the case of wild caught fishery products. Nevertheless, traceability is only possible when the operators in the aquaculture value chain implement elements of a traceability system, such as unique identification of operators and products, record keeping, data communication, etc., within the actors of the supply chain.

Standard supply chains include hatcheries/nurseries, feed producers, farmers, collectors and processing plants. The role of the state – later called "authorities" in this section – of the producing country/ies is to make sure that these operators comply with regulatory requirements (e.g. food safety, sustainability of products, feed and other inputs, among others). These requirements mean all applicable government-issued approvals, licenses, registrations, authorizations and verification of good practices along the supply chain must be recorded. The operators (value chain companies) are responsible for the traceability of the products that they put on the market.

- **Feed producers and distributors** are responsible for ensuring that only traceable and safe ingredients are used in the feed manufacturing, and that fishmeal sourcing must be in line with the applicable regulatory requirements. This is a unique juncture where capture fisheries are often a source of ingredients for aquaculture feed. Aquafeed should also be produced with the applicable traceability requirements in the feed production process and distribution.
- **Hatcheries** are responsible for seed production based on the required minimum traceability standards. Hatcheries should therefore establish and maintain effective record keeping from the receiving of the broodstock and/or seeds of aquaculture and subsequently cultivate them into shrimp seedlings, bivalves or fish fry.
- **Farms (or growing farms)** are responsible for their registration with the required authorities and the basic information required (i.e. location, facility identification), as well as land and water

[2] Certified by government through a catch certificate for example. We are not referring to private/ecolabel certifications.
[3] By the processing state.

use for the farming process. This is usually done through a licence to operate which is given to the farm for a definite period. The traceability requirements extend normally to the origin of the seeds, feed, drugs and chemicals used, along with the harvest quantities and other information (e.g. timing, dispatch information, destination, etc.).

- **Collectors/distributors/traders or intermediaries** are responsible for their registration with the required authorities and providing the basic information to keep track of the movement of the aquaculture products, information on the traders or tiers of traders, and the dates and volume of each product purchased until it is sold.
- **Processing plants** are responsible for their official state-type authorization based on regulatory requirements. This is usually done through a licence to operate which is given to the processor based on food safety and other regulatory requirements. This implies the implementation of minimum food safety and traceability requirements. As processors are the final step before products enter the market, processing plants are a critical component in terms of ensuring that raw materials and processing inputs that lack origin and traceability information are not imported, processed or sold for domestic consumption, exported or re-exported.

2.3 THE NON-REGULATORY REALM

The positive drivers exist only for companies that want to use traceability and improved product documentation as part of value adding and branding.

Borit and Olsen (2020) devote a substantial part of their findings to identify selected voluntary food traceability success stories from various world regions, stemming from different initiatives, and expressed in a multitude of forms – from structured reports to short information, and from websites to accounts in online media outlets.

Unlike the regulatory realm, there is substantial information available on which CTEs and KDEs are identified for both the aquaculture and capture fisheries sector-based traceability practices within an organization and across the seafood supply chain.

In addition to required and voluntary governmental requirements, CTE and KDE recommendations are included in certifications and standards, industry guides and projects, and NGO and expert reports. In 2017, FishWise summarized these KDEs in a white paper. In 2020, several NGOs published a "comparative study of key data elements in import control schemes aimed at tackling illegal, unreported and unregulated fishing in the top three seafood markets: the EU, US, and Japan" (EJF, OCEANA, The Nature Conservancy, The Pew Charitable Trusts and WWF, 2020) and a blog shared a side-by-side comparison of the United States of America's Seafood Import Monitoring Programme and the European Union KDEs (Blaha, 2019).

Numerous other guidance documents exist for specific countries and aspects of traceability and combating IUU fishing, e.g. British Standards Institution (BSI, 2017).

Yet, the world of private certifications and ecolabeling is a confounding one. Scores of certifications overlap, compete and sometimes contradict one another. Establishing how they work, what they cover, who operates them and how robust their standards are can be a time consuming, and sometimes almost impossible task. And, while some efforts to benchmark standards have taken place (e.g. the Global Sustainable Seafood Initiative, [GSSI, 2023]) they usually focus on a specific group of certifications, instead of all that may be encountered in a global value chain.

The Seafood Certifications Guide (Seafood Source, 2020) identifies and describes 87 different private certifications. In 2007, Corsin, Funge-Smith and Clausen provided an overview of aquaculture standards and certification schemes to show the multitude of sources in which 30 certification schemes and eight key international agreements relevant to aquaculture certification were identified as addressing sustainability issues and creating a framework for differentiating sources of aquatic products in this respect.

As outlined in the section below, this guidance document uses some of the types of resources listed above to add KDEs to the GDST's KDE list. Many of the GDST's KDEs overlap with the KDEs in use by regulatory and non-regulatory schemes in existence today. The non-GDST listed KDEs presented originate from the quoted FAO publications and the authors' experiences.

2.4 TRACEABILITY STANDARDS AND TECHNOLOGY

It is not the role of this guidance document to recommend a particular set of standards or a type of technology. Yet, it is critical that traceability systems are aligned with international e-business standards such as the one developed by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT). The UN/CEFACT has adopted the Fisheries Language for Universal Exchange (FLUX) – a harmonized message standard allowing fishery management organizations to automatically access electronic data from fishing vessels (UNECE, 2016).

This global body for the exchange of electronic business information has developed specific agri-food sector standards that are endorsed by governments and intergovernmental organizations such as the World Trade Organization, the World Customs Organization and FAO.

The structure of traceability systems must be standardized to facilitate inter-operability. For this purpose, the International Organization for Standardization (ISO) has produced ISO 12875:2011, which specifies how traded fishery products are to be identified and the information to be generated and held by the food businesses that trade the products through supply chains (ISO, 2022b). The standard deals with the distribution of finfish and their products for human consumption, from catch to retailers and caterers, but it does not cover data migration from one stage to another.

Similarly, GS1 (2023) is a vendor-neutral not-for-profit organization that develops freely available standards for global use. It has developed standards for electronic data sharing – GS1 EANCOM and GS1 XML – and the 2015 GS1 *Foundation for fish, seafood and aquaculture traceability implementation guideline* (GS1, 2019).

The role of standards cannot be understated, as interoperability and verifiability among information systems are basic prerequisites for twenty-first century global commerce. Yet, as was the case for the communication and banking sectors, various challenges with regard to operating platforms and shared standards must be overcome:

1. A platform has to be designed that can accommodate all permutations and scenarios as they occur in reality, so that all movements and transaction types can be logged.
2. Industry has to be persuaded to accept the technology and its requirements.
3. The cost of developing and rolling out the system and related training can be substantial.

To meet these challenges, the seafood industry needs a unified set of standards and guidelines to enable coherence and interoperability among seafood traceability systems and to help ensure the verifiability of the data those systems contain.

As a critical initial step, there is a need to establish common global expectations and practices regarding two fundamental things:

1 _ the nature of the information to be routinely associated with seafood products (i.e. the KDEs); and
2 _ the technical design specifications allowing diverse digital traceability systems to communicate with one another (known as interoperability).

Meeting these needs was the purpose of the GDST and the GDST standards and guidelines published in February 2020 (GDST, 2022). The GDST is one of the largest and most diverse business to business seafood industry forums, that includes some of the most important retailers, brands and mid-supply chain processors from around the world and across the entire seafood supply chain (IFT, 2020). The GDST released its *Standards and guidelines for interoperable seafood traceability systems v1.0*. in order to enable interoperability and significantly improve the verifiability for all seafood traceability systems.

The GDST standards have two main parts:

1 _ Standards identifying the minimum data elements that need to be documented and transmitted within GDST-compliant seafood supply chains. These are described in technical detail in the GDST's "Basic universal list of key data elements," covering both wild-capture and aquaculture products.
2 _ Standards governing the technical formats and nomenclatures for sharing data among interoperable traceability systems.

In technical terms, GDST 1.0 is built as an extension of the international traceability standard known as GS1 Electronic Product Code Information Services (EPCIS), which is widely used by major retailers, brands and supply chains across food and non-food product classes (e.g. it is used in the pharmaceutical industry).

The GDST has refined and adapted the EPCIS standard to be "fit for purpose" for the seafood industry and to include innovations that allow companies to integrate with GS1-based systems without making commercial commitments to use proprietary GS1 traceability solution products.

The GDST standards are designed to meet operational business needs. They enable companies to gain insight into their supply chains while allowing them to maintain data access controls to protect business-sensitive information.

Digital record keeping and traceability systems are the future of the seafood industry, with companies that remain dependent on paper-based systems increasingly face competitive disadvantages. However, digitization may remain a challenge, especially for smaller actors in developing countries. This is why the GDST does not require complete digitization of internal company operations but focuses only on digital data transfer between supply chain partners.

As the GDST standards are recent (in line with GS1), have substantial industry input and support, and include KDEs present in major market access requirements, this document uses many of the GDST KDEs. These are referenced in the analysis tables and this report adds supplementary KDEs that relate to regulatory aspects (as the GDST standard was created for supply chain operators). With regard to the standards *per se*, the logic and language proposed by the GDST can be adapted for use with nearly all the KDEs identified.

For easy reference between this document and the GDST KDEs, we identify them by number in the analysis tables in the next section, and maintain as far as possible the original text.

3. CRITICAL TRACKING EVENTS AND KEY DATA ELEMENTS IN WILD CAPTURE FISHERIES

3.1 INTRODUCTION

The identification of CTEs and KDEs for capture fisheries under this section expands on those already established by two FAO publications (Hosch and Blaha, 2017; Blaha and Katafono, 2020), as well as the incorporation of all the applicable KDEs in the GDST basic universal list.

The KDE tables initially identify those that are independent of the type of state, and then identify those considered necessary under the regulatory realm of traceability for each type of state, largely but not exclusively from the perspective of a catch documentation scheme.

3.2 FUNDAMENTALS FOR OPERATORS AND RAW MATERIALS/PRODUCTS

For a traceability system to be most effective it needs to cover the entire chain of events at each type of state. In addition, there is a need for traceability systems that cover events between entry and exit "gates" (into and out of the type of state jurisdictions), so that regulatory controls can establish where anomalies occur and identify those responsible. These controls must cover:

- Registration and licensing of the fishing operation, storage and processing premises to identify value chain operators. In most countries, vessels, fish storage and processing premises must be licensed and controlled by health and/or fisheries authorities, which amounts to a traceability and record keeping system that can support traceability.
- Registration and licensing of all value chain operators. Having a unique identifier and a structure of control for each operator in the supply chain is fundamental for any form of traceability.
- Distribution and transfers among operators' premises or entities. Registration of internal movements of declared species and volumes makes them traceable; this requires six KDEs that must be recorded at every step along a supply chain, namely:
  - unique product identifier;
  - product source – seller and previous owner of the product;
  - product destination – buyer and new owner of the product;
  - species;
  - volume; and
  - product forms.
- All co-mingling or mixing, aggregation, and disaggregation or splitting of batches or units must be tracked and all KDEs associated with new units and previous units must be tracked. In addition, changes of legal ownership or physical possession (e.g. a transportation subcontractor) must be tracked. These events are not included in every table, as this could happen throughout

supply chains, and even several times under the oversight of one "owner" or during one "event". The GDST Core Normative Standard addresses this topic in more detail.

Table 1 summarizes the main KDEs required for the operators' unique identity and unique seafood material identifiers.

► TABLE 1

Main KDEs for the operators' unique identity and unique seafood material identifiers

	CTEs	Main KDEs	Data source	Comments
Operators	Unique operator identity	Unique operator identifier Identifier associated with the operator for the duration of its existence that cannot be re-used by any other operator	Legal fisheries and business operator are to be registered for existing regulatory frameworks such as fisheries, health, tax, labour, etc.	The need to give all operators in a value chain a unique identity is overlooked many times. The more that identity is shared among government institutions, the easier common actions are facilitated. A fiscal identity for taxing purposes is normally necessary for any commercial activity, and that identity can be used by other government organizations.
Raw materials and products	Unique seafood material identifiers	Unique identifier for item/stock keeping unit (SKU)/universal product code (UPC)/global trade item number (GTIN) *identifier of seafood material to distinguish it within a particular facility, company, or globally.* *GDST KDE W01*	Weight ticket, production records, packing lists, etc. Codes on inventory, etc.	No single source exists, yet the more standardization, the better
		Linking KDE *identifier associated with physical product marking a particular instance of seafood material such as a batch/lot number, serial number, or container number.* *GDST KDE W02*	Weight ticket, production records, packing lists, etc. Codes on inventory, etc.	Individual facility/supply chain actor in most cases, yet the more standardization, the better
		Product source – seller and previous owner of the product; refer to unique operator identity	Invoices, weight ticket, production records, packing lists, codes on inventory, etc.	
		Product destination – buyer and new owner of the product; refer to unique operator identity	Invoices, weight ticket, production records, packing lists, etc. Codes on inventory, etc.	
		Species name *GDST KDE W15*	Aquatic Sciences and Fisheries Information System (ASFIS) list of species, scientific name/ FAO 3-alpha code (e.g. YFT for yellowfin tuna) Vessel's logbook/harvest records	
		Volume/weight/quantity *numerically quantifiable amount of seafood with a standard Unit of Measure.* *GDST KDE W03*	Weight ticket, invoices, production records, packing lists, inventory, etc.	Codes for units of measure used in international trade

(Cont.)

	CTEs	Main KDEs	Data source	Comments
Raw materials and products	Unique seafood material identifiers	Product form *commercial short-hand reference of the degree of transformation of seafood from its original living form.* *GDST KDE W16*	Vessel's logbook/harvest records, weight ticket, production records, packing lists, etc.	No single source exists, yet the more standardization, the better
		Expiry/production date *GDST KDE W23*	Calendar date associated with a particular instance of a seafood product indicating the key date in its life cycle	
		Production method *GDST KDE W24*	Categorization on the spectrum of wild capture to captive culture; of the general seafood harvest method	
		Product origin *GDST KDE W25*	Country where seafood underwent the last substantial transformation	

Source: Authors' own elaboration.

3.3 FUNDAMENTALS OF FLAG STATE RESPONSIBILITY

Under the United Nations Convention on the Law of the Sea (UNCLOS),[4] flag states must oversee the operations of fishing vessels flying their flags. The 1995 United Nations Fish Stocks Agreement (UNFSA) (UN, 2021) also mandates this and obliges flag states to investigate alleged violations of conservation and management measures and apply sanctions against non-compliant fishing vessels. The 1995 Code of Conduct for Responsible Fisheries (FAO, 1995) also mandates this approach and places more emphasis on the enforcement regimes of flag states.

Vessel registrations, license registers, vessel monitoring systems (VMS), logbooks, observer programmes, transshipment and landing authorizations[5] enable flag states to discharge their responsibilities under international law and to oversee fishing vessels flying their flags. To provide sound assurances that vessels are operating legally, flag states must ensure that they have verified data that can be supplied to traceability systems, through the following mechanisms:

- Registration and licensing of fishing vessels are conditionally linked, and that registration and licence lists are accessible to and shared by the CA.
- Fishing vessel licences, authorizations or permits may vary in scope and according to the type of fishery.
- The implementation and enforcement of VMS, automatic identification system (AIS) and logbook regimes should be independent of whether the vessels are operating in waters beyond national jurisdiction.
- Standardized logbooks (either electronic or paper-based) that record fishing operations are also a licensing requirement in coastal states and RFMOs.
- A fisheries observer and/or complementary electronic monitoring programme should be implemented and coordinated with those operated by RFMOs or coastal states in which the fleet operates.

[4] See UNCLOS, Article 94.
[5] As defined in the FAO Voluntary guidelines for transshipment (2022).

- Unloading events should be communicated, and where appropriate, authorized by the relevant authorities.
- Transshipments, transfers and landings are regulated, directly or indirectly monitored and recorded.

The more efficiently flag states carry out their functions, the stronger the assurances that IUU catches are denied entry into supply chains. Flag states also have a fundamental role in terms of food safety assurances for products on their vessels, including those that operate in distant waters. These responsibilities are based on the sanitary requirements for fishing vessels, either under national legislation or by market access conditions, as in the case of access to the European Union market.

In general terms, fish processing establishments in a country intending to export products should be registered and approved under the control of the national CA[6] against the applicable standards (which include specific requirements normally referring to good manufacturing practices, infrastructure, hygienic conditions, Hazard Analysis Critical Control Points (HACCP), operations, traceability, labelling, etc.). The same principle applies to fishing vessels on which processing takes place (i.e. freezer vessels and factory vessels). Non-processing vessels (such as ice vessels, small-scale crafts, etc.) may also need to be registered and approved before they can be used to supply exporting establishments.

In order to demonstrate and provide assurances that processing-vessels comply with required standards, flag states must ensure that they have directly or indirectly validated data that can be entered into regulatory traceability systems, through the following mechanisms:

- Fishing vessels are controlled through sanitary inspections and, if in compliance, their processing licences, authorizations or permits under a unique identification are maintained.
- The implementation and enforcement of sanitary regimes for fishing vessels should be independent of whether the vessels are operating in waters of the flag state or in waters beyond national jurisdiction.
- Standard food safety plans and their records are kept for verification.

Table 2 summarizes the main supply chain events and CTEs and KDEs to be overseen by a flag state.

► TABLE 2
Main supply chain stops, identified CTEs and KDEs to be overseen by a flag state

Flag state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	Fishing vessel identity	National flag of vessel GDST KDE W07	Vessel registration from flag state	Name or ISO two-letter country code list – ISO 3166 Small-scale fishing boats should bear some minimum form of identification. This identification should ideally be linked to an official registration/licence by the authorities of the flag state

[6] State authority with the competency for a specific area.

(Cont.)

Flag state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	Fishing vessel identity	International Maritime OrgaAnization (IMO) number/unique vessel identifier (UVI) GDST KDE W06	Maritime authority on behalf of the IMO	Specific to a vessel and should not change when a vessel changes flag
		Vessel registration number GDST KDE W05	Vessel registration from flag state	Specific to a vessel but changes when a vessel changes flag
		Name of fishing vessel GDST KDE W04	Vessel registration from flag state	Databases tend to work on the Latin alphabet, numbers and punctuation but the Romanization of names in non-Latin alphabets is complex (e.g. the vessel name 嘉吉滿 can be written in at least 36 different ways in English)
		International radio call sign (IRCS)	Vessel registration from flag state	Up to seven characters assigned to the vessel by its country of registry; specific to a vessel but changes when a vessel changes flag
		RFMO vessel number	RFMO list of vessels	Specific to the vessels but changes when a vessel changes flag; in some cases is based on the IRCS
		Satellite vessel tracking authority VMS and/or IAS GDST KDE W13	VMS: mobile transmitting unit (MTU) identifier IAS: maritime mobile service identity (MMSI)	VMS: issued by the flag state and/or coastal state and/or RFMOs (when vessels are registered to more than one) can be more than one. Use is compulsory but data is not normally seen in the public domain MMSI: a unique nine-digit identification number; use is compulsory under maritime safety regimes (but not always for fisheries) and data can be seen in the public domain Specific to the vessels but changes when a vessel changes flag
	Fishing vessels' authorization to fish (by the flag state)	Fishing authorization (license number) GDST KDE W11	Licence on board/or present in a database by the fisheries authority of the flag state	Unique identifier of the licence, format depends on the country
		Fishing licence validity	Licence on board/or present in a database by the fisheries authority of the flag state	Period of time for which the fishing license is valid (normally stated in the licence)
		Licensed fishing area(s)	Licence on board/or present in a database by the fisheries authority of the flag state, coastal state or RFMO	Licences can cover fishing in a specific area or the whole exclusive economic zone (EEZ) of the flag state and/or outside the EEZ. High seas fishing is normally under a RFMO (if one exists for the region). Licences do not cover fishing in other countries' EEZs as these are provided by coastal states.
		Fishing gear(s) type GDST KDE W10	Fishing gear/s used aligned with FAO's International Standard Statistical Classification of Fishing Gear	Normally described in the licence conditions in reference to the fishing event. Some vessels are able to operate with more than one type of gear and the licence should reflect this

(Cont.)

Flag state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	Fishing vessels' authorization to fish (by the flag state)	Sanitary licence ID/ approval ID	Sanitary CA of the flag state	Can be needed for market access (e.g. European Union and China)
	Fishing operations dates and zones (shared with coastal state if applicable)	Fishing zone/catch area GDST KDE W14.1-14.4	VMS/AIS/logbook controls	FAO major fishing area, EEZ, RFMO or subnational permit areas
		Availability of catch coordinates GDST KDE W12	Indicate whether global positioning system (GPS) coordinates were collected and are available	
		Start and end dates of vessel trip and date(s) of captures GDST KDE W08, W09	Reporting/logbook	Can be validated by VMS/AIS to some extent
	End of fishing (reporting) (shared with flag state if applicable)	Unloading/port entry request	Reporting/logbook Port entry request	Flag state best practice is to request vessels to seek unloading authorization from flag state (independent of port entry or transshipment at sea) For the port state, port entry request implies the end of fishing operations
		Species name GDST KDE W15	Vessel's logbook/harvest records/electronic reporting ASFIS list of species Scientific name/FAO 3-Alpha code (e.g. YFT)	
		Estimated volume/weight / quantity GDST KDE W03	Vessel's logbook/harvest records/electronic reporting	Numerically quantifiable amount of seafood with a standard unit of measure
		Product form GDST KDE W16	Vessel's logbook/harvest records, weight ticket, production records, packing lists, etc.	Commercial short-hand reference of the degree of transformation of seafood from its original living form. No single source exists, yet the more standardization, the better
Unloading (transshipment at sea, in port or landing, or any combination thereof)	Type of unloading authorized	Landing or transshipment (unloading) authorization GDST KDE W33, W31	Reporting/logbook Port entry request, transshipment authority list of authorizations	Flag state best practices request vessels to seek unloading authorization from flag state (independent of port entry or transshipment at sea) For the port state, port entry request implies the end of fishing operations
		Estimated volume to be unloaded (per product type) Volume/weight /quantity GDST KDE W03	Vessel's logbook/harvest records	Codes for units of measure used in international trade Species' scientific name (ASFIS/ FAO 3-Alpha code [e.g. YFT])
	Transshipment at sea	Receiving vessel's ID (same requirements as a fishing vessel's ID) GDST KDE W19, W20, W29 W30	These include all vessel's ID requirements, as for a fishing vessel	In the case of transshipment to more than one receiving vessel, information needs to capture all receiving vessels
		Receiving vessel's licensing	These include all vessel's ID requirements, as for a fishing vessel	Carriers have to be licensed in the case of transshipment to more than one receiving vessel; information needs to capture all receiving vessels

(Cont.)

Flag state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Unloading (transshipment at sea, in port or landing, or any combination thereof)	Transshipment at sea	Sanitary licence ID/ approval ID	Sanitary CA of the flag state	Can be needed for market access (e.g. European Union and China)
		Dates of transshipment (start and end) GDST KDE W18	Fishing vessel captain/ master's records and transshipment vessel captain/ master's records	Can be validated by VMS to some extent
		Transshipment location GDST KDE W17	Rendezvous area GPS coordinates Fishing vessel captain/ master's records and transshipment vessel captain/ master's records	Can be validated by VMS to some extent
	Transshipment in port (shared with port state)	Receiving vessel's ID (same requirements as a fishing vessel's ID) GDST KDE W19, W20, W29, W30	These include all vessel's ID requirements, as for a fishing vessel	In the case of transshipment to more than one receiving vessel; information needs to capture all receiving vessels
		Receiving vessels' licensing	Similar to a fishing vessel	Carriers have to be licensed in the case of transshipment to more than one receiving vessel; information needs to capture all receiving vessels
		Sanitary licence ID/approval ID	Sanitary CA of the flag state	Can be needed for market access (e.g. European Union and China)
		Dates of transshipment (start and end) GDST KDE W18	Fishing vessel captain/ master's records and transshipment vessel captain/ master's records	Can be validated by VMS to some extent
		Transshipment location GDST KDE W17	Port name and country/ designated port code if flag and port state are signatory to PSMA Fishing vessel captain/ master's records and transshipment vessel captain/ master's records	Port name or rendezvous coordinates if outside port zone
	Landing (shared with port state)	Location GDST KDE W21	Unloading vessel (fishing or transshipment) captain's records	Port name and country/ designated port code if flag and port state are signatory to PSMA, or GPS coordinate for non-port landing
		Dates of landing (start and end) GDST KDE W22	Reporting/logbook Port information Unloading vessel (fishing or transshipment) captain's records	
		First buyer Unique operator identity	Flag state best practices should request vessels to seek unloading authorization from flag state (independent of port entry or transshipment at sea) and report first buyer of product	This is similar to identifying the receiving vessels in case of transshipment

Source: Authors' own elaboration.

3.4 COASTAL STATES

Although international law provides that coastal states have the sovereign right and duty to manage fisheries in waters under their jurisdiction, their current role in traceability is limited.

Vessels registered in coastal states, or foreign vessels operating in the coastal state's waters need to abide by coastal state requirements, therefore it is the duty of coastal and flag states to ensure that fishing operations are legal and monitored.

Access for foreign vessels is to be established in a supportive manner with other flag and port states in the same fishery, particularly if transboundary and straddling stocks are involved. Participation by coastal states in RFMO decision-making and the incorporation of the resulting conservation and management measures into their legal frameworks is a basic way in which coastal states can control the operations of foreign vessels in the same way that flag states do.

The most common approach to access is through fisheries agreements between coastal and flag states that set out the terms and conditions of individual fishing permits and define the obligations of flag states with respect to fishing operations carried out by their vessels.

From a traceability for regulatory compliance perspective, the coastal state's CTEs and KDEs relate to fishing operations and therefore overlap and in many cases supplement the ones requested from flag states.

The licences issued by coastal states normally impose operational conditions that are supplementary to those that may be imposed by the flag state on vessels operating in coastal state waters. The monitoring, control and surveillance (MCS) tools used by coastal states, such as VMS, logbooks and EEZ entry and exit conditions, supplemented by an observer or e-monitoring programmes, enable a coastal state to determine the legality of harvests in waters under its jurisdiction.

The enforcement capacities of coastal states in cases of suspected infringements are often limited, particularly when vessels unload in jurisdictions outside a coastal state. It is essential that coastal states participate in decisions about the validity of data for traceability purposes on the basis of their control of foreign fishing operations in their EEZ.

Table 3 summarizes the main supply chain stops, CTEs and KDEs for a standard supply chain overseen by a coastal state.

► **TABLE 3**

Main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by a coastal state

Coastal state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	Fishing vessel (access/ permission to fish)	Unique fishing vessel ID(s) See Table 2	Vessel registration from flag state Pre-fishing authorization check	Usually as defined for the flag state in section above Coastal state best practices normally include a pre-licensing inspection to confirm identity of vessel
	Fishing vessel's authorization to fish (by the coastal state)	Fishing authorization (license number) *GDST KDE W11*	Licence on board/or present in a database by the fisheries authority of the coastal state	Unique identifier of the licence, format depends on the country

(Cont.)

Coastal state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	Fishing vessel's authorization to fish (by the coastal state)	Fishing licence validity	Licence on board/or present in a database by the fisheries authority of the coastal state	Period of time for which the fishing licence is valid (normally stated in the licence)
		Licensed fishing area(s)	Licence on board/or present in a database by the fisheries authority of the coastal state	They can cover fishing in a specific area or the whole of the flag state's EEZ and/or outside (high seas normally under a RFMO) but not in other countries' EEZs
		Fishing gear type (s) *GDST KDE W10*	Fishing gear/s used aligned with FAO's International Standard Statistical Classification of Fishing Gear	Normally described in the licence conditions in reference to the fishing event. Some vessels are able to operate with more than one type of gear and the licence should reflect this
		Coastal state Satellite vessel tracking authority VMS and or AIS *GDST KDE W13*	VMS: MTU identifier IAS: MMSI	VMS: issued by the flag state and/or coastal state, and/ or RFMOs (when vessels are registered to more than one). Use is compulsory but data is not normally seen in the public domain MMSI: a unique nine-digit identification number. Use is compulsory under maritime safety regimes (but not always for fisheries); data can be in the public domain via NGOs (e.g. GlobalFishingWatch.org) Specific to a vessel but changes when a vessel changes flag
	Fishing operations dates and zones (shared with flag state if applicable)	Coastal zone entry and exits	Communication with coastal state fishing authority Reporting/logbook	Normally set as condition in the licence
		Fishing zone/catch area *GDST KDE W14.1-14.4*	VMS/AIS/logbook controls	FAO major fishing area, EEZ, RFMO or subnational permit areas
		Availability of catch coordinates *GDST KDE W12*	Indicator whether GPS coordinates were collected and are available	
		Start and end dates of vessel trip and date(s) of captures *GDST KDE W08, W09*	Reporting/logbook	Can be validated by VMS/AIS to some extent
	End of fishing (reporting) (at zone exits if applicable under coastal state licensing)	Species name *GDST KDE W15*	ASFIS list of species Scientific name/FAO 3-Alpha code (e.g. YFT) Vessel's logbook/harvest records/electronic reporting	
		Estimated volume/weight/ quantity *GDST KDE W03*	Vessel's logbook/harvest records/electronic reporting	Numerically quantifiable amount of seafood with a standard unit of measure
		Product form *GDST KDE W16*	Vessel's logbook/harvest records, weight ticket, production records, packing lists, etc.	Commercial short-hand reference of the degree of transformation of seafood from its original living form. No single source exists, yet the more standardization, the better

(Cont.)

Coastal state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	End of fishing (reporting) (at zone exits if applicable under coastal state licensing)	Unloading (if known) See Table 2	Vessel's logbook/harvest records/electronic reporting	Complex because distant-water fishing nations in a coastal state's EEZ do not normally notify coastal states about future unloading as they exit the EEZ

Source: Authors' own elaboration.

3.5 PORT STATES

Fishing vessels bring their catch to port for landing directly as catchers, or indirectly on reefers/carriers. The port is the point at which fisheries products move from the seaborne to the land-based supply chain. Few other points are as important for full traceability of fish and fishery products. The use of port state measures to enforce domestic and international fishery laws is now understood as a right and a duty of port states.

The 2009 PSMA requires port states to designate their fishing ports (the ports to which fishing vessels are limited). The PSMA also requires that foreign fishing vessels must be consistently monitored in such ports, and that full dockside inspections may be carried out.

Inspections should not be limited to foreign fishing vessels, even though in practice they are a particular concern. Port and flag states are distinct entities and when fishing operations are at least partly conducted in distant waters it complicates oversight by flag states and increases the relevance of port states with regard to vessel compliance and oversight of foreign fishing.

International law recognizes that states have full sovereignty with respect to ports in their territories, and a state may:

- deny port access to vessels registered in other states;
- prohibit vessels registered in other states from landing or transshipping fish in its ports;
- require vessels seeking port access to provide information about their identity and activities; and
- inspect vessels that are voluntarily in one of its ports.

In port, fishing vessels can be fully overseen because they are close to land-based facilities and the authorities can access the vessels themselves. It is largely the quality of port state monitoring and the work of port-based fisheries officers that reduce the risk of illegally sourced fish entering the land-based supply chain.

Port states must therefore be in a position to monitor all fishery transactions in their ports – mainly landings and transshipments[7] – and subject selected transactions to full-scale inspections, as they are the last line of defence for detecting infringements, denying certification of IUU-derived catches and preventing their entry into land-based supply chains.

Fundamentally a system of authorizations for unloading should be in place to ensure that: 1) permissions are denied in cases of suspected or established IUU fishing; and 2) volumes and species unloaded from fishing vessels are recorded for traceability purposes.

[7] As defined in the FAO Voluntary guidelines for transshipment (2022).

Certain supply chain points overseen by port states are particularly important for traceability:

- **End of fishing trip and port entry** – submission of information to the port state authority where the landing is planned prior to the arrival in port of any fishing vessel. Authorization to unload requires compliance with applicable PSM conditions and an evaluation of the legality of catches linking fishing trips to volumes and species unloaded.
- **Unloading** – can happen in two ways:
  - Transshipment in port – catch information must be handed from the fishing vessel to the reefer master, and be counter-validated by the port state and entered into the traceability system. Port state authorities therefore require a sound understanding of the fishery and its regulatory framework governing in-port transshipments and standard MCS routines and inspections. Reefers unload several harvests at once, making this step of checking paperwork and data complex and essential for MCS controls.
  - Landings in port – once authorization to land is granted, two essential data groups must be completed, overseen and counter-validated by the port state authority:
    - The actual weights landed, in whatever form, must be verified and the means of transport and storage established so that all transactions can be summed to account for their full-landing equivalent weight. This is the first occasion where the accurate actual weight of a harvest can be verified.
    - The amount acquired by every uniquely identified buyer in terms of species, volume and form must be recorded, and the port state should have access to its own data for a traceability system.

Port state authorities are crucial in counter-validating these data groups, which constitute the foundation of national mass balance traceability.

The role of the port state also includes responsibilities in terms of food safety according to national legislation and/or final market access conditions. Some states have specific infrastructure requirements and operational conditions for the authorization of use of unloading places and their unique identity. In the case of market access to the European Union, for example, the port state is to be an authorized country (EC, 2023) otherwise the products are not eligible for this market. Therefore, the country authorization status needs to be traceable.

Table 4 summarizes the main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by a port state.

► TABLE 4

Main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by a port state

Port state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Harvesting	End of fishing (reporting) (*shared with flag State and coastal State if applicable*)	End of fishing/port entry estimate	Port entry notice	
		Fishing vessel identity *(Based on the flag state KDEs, Table 2)*	Port entry notice	Usually as defined for the flag state in section above
		Fishing vessel's authorization to fish *(Based on the flag and coastal State KDEs, Table 2 and 3)*	Port entry notice Can include flag state, coastal state and RFMO	Can be validated with access to regional/RFMO licensing registry
		Fishing operations dates and zones *(Based on the flag and coastal State KDEs, Table 2 and 3)*	Port entry notice EEZ; FAO fishing area, sub-area and division(s) as applicable for RFMO reporting	Can be validated with access to regional/RFMO VMS and/or IAS
		Species Name *GDST KDE W15*	ASFIS list of species Scientific name/FAO 3-Alpha code (e.g. YFT) Vessel's logbook/harvest records/electronic reporting	
		Estimated volume /weight / quantity GDST KDE W03	Vessel's logbook/harvest records/electronic reporting	Numerically quantifiable amount of seafood with a standard unit of measure
		Product form *GDST KDE W16*	Vessel's logbook/harvest records, weight ticket, production records, packing lists, etc.	Commercial short-hand reference of the degree of transformation of seafood from its original living form No single source exists, yet the more standardization, the better
Unloading	Transshipment in port	Authorization to transship to fishing vessel based PSM *unique number associated with a regulatory document, from the relevant authority, granting permission* *GDST KDE W33*	Port use/transshipment authorization by the fisheries authority as per PSM best practices of PSMA	In the case of transshipment to more than one receiving vessel information needs to capture all receiving vessels
		Carrier vessel's ID (*same requirements as fishing vessels ID*, Table 2)	Port entry notice	Can be validated with access to regional/RFMO licensing registry
		Carrier vessel licensing *Usually as defined for the flag state and or coastal states in sections above, Tables 2 and 3*	Port entry notice	Can be validated with access to regional/RFMO licensing registry
		Details of species, product types and volumes on board prior to entry to port (*if any*) *GDST KDE W03, W15, W16*	Port entry notice Cargo manifest/hatch plan Inspection report	Can be validated on arrival inspection
		Sanitary license ID/approval ID	Sanitary CA of the flag state	Can be required for market access (e.g. European Union and China)

(Cont.)

Port state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Unloading	Transshipment in port	Dates of transshipment (start and end) *GDST KDE W18*	Fishing vessel captain/ master's records and transshipment vessel captain/ master's records	Can be validated by transshipment monitoring if in existence
		Estimated volumes transshipped (per species/ product type) *GDST KDE W03, W15, W16*	Mate's receipt, transshipment monitoring estimates, hatch plan, etc.	Can be validated by transshipment monitoring if in existence
	Landing	Landing authorization to unload a fishing vessel based on PSM *unique number associated with a regulatory document, from the relevant authority, granting permission* *GDST KDE W31*	Port use/landing authorization by the fisheries authority as per PSM best practices of PSMA	
		First buyer/unique operator identifier	Unique operator identifier	This is no different to identifying the receiving vessels in the case of transshipments. In the case of landing in more than one site, all information needs to be captured
		Landing location *GDST KDE W21*	Designated landing site ID In port landings: port name Non-port landings: GPS coordinates	A port can have many designated landing sites, either state or privately owned
		Dates of landing (start and end dates) *GDST KDE W22*	Reporting/logbook Port operations log by fishery or port authority	Can be validated by unloading monitoring if in existence
		Volumes landed (per species/product type) *GDST KDE W03, W15, W16*	Estimated (i.e. containers, truck weights) Verified, if in existence, (weight ticket, docket, etc.)	Codes for units of measure used in international trade ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) If weights are verified in port, implies a form of official oversight and verification of volumes and species
Distribution	Factory/ warehouse "weigh in"	Unique operator identifier	Legal fisheries and business operator are to be registered for existing regulatory frameworks under fisheries, health, tax, etc.	
		Volumes received (per species/product type) *Verified net volume, forms and species transferred to individual buyers* *GDST KDE W03, W15, W16*	Port use/landing authorization Invoices, weight ticket, production records, packing lists, codes on inventory, etc.	Generally, the "weigh in" implies a form of official oversight and verification of volumes and species

Source: Authors' own elaboration.

3.6 PROCESSING STATES

The "processing state" concept is not recognized per se in international fisheries law – yet it is the most important state type in terms of country-level traceability solutions. In principle, "processing" means any action that substantially alters an initial product. It can be as simple as transforming a fish from "whole" to "gutted" or "filleted" and includes changes by processes such as cooking, canning, drying and extrusion, or a combination of such processes.

In some cases, "non-transforming" operations, such as grading and packing or storing, are referred to as processing but they have no effect on product or unit weight.

The emergence of important processing states like Thailand, China and Viet Nam in the tuna industry has drawn attention to the data management and traceability in these types of states, where raw materials are imported, processed and then exported.

For robust traceability, processing states must:

- Ensure that no illegal or unsafe raw materials or products enter their territories, whether landed or imported.
- Cover the entire chain of events by means of its *national traceability* system to trace product from landing or importation at ports of arrival through ownership changes and processing exportation, or re-exportation. Traceability systems should cover all critical tracking events between entry and exit "gates" (into and out of the country) so that regulatory controls can establish where anomalies occur and identify those responsible. These controls must cover:
  - Registration and licensing of storage and processing premises to identify value chain operators. In most countries fish storage and processing premises must be licensed and controlled by health and or fisheries authorities, which requires a traceability and record-keeping system.
  - Distribution and transfers between operators' premises: registration of internal movements of declared species and volumes makes them traceable. These require strict adherence to the main KDEs identified for the operators' unique identity and unique seafood material identifiers in Section 3.2.
  - Operations in storage and processing premises involve changes in weight from unprocessed to processed product, providing opportunities for laundering fish from different origins into supply streams. Therefore, fishery authorities must establish controls to:
    - check processing premises and cold stores to verify the accuracy of records and inventories, account for volumes that have been split or mixed and verify the volumes and forms of certified species entering supply chains and subsequently leaving them;
    - verify the reporting and monitoring of yield factors to eliminate fraud; and
    - record products leaving operators' premises, regardless of destination. Regular verification by fishery and sanitary CAs of pre-dispatch checks and consignment loading records will ensure the effectiveness of traceability systems at the level of individual operators.

For any data entry into a regulatory traceability system, the following functions are essential for private sector operators:

- Product entry and creation of a product account link product entry to the premises with the relevant documentation. Scanned supporting documents may be uploaded when creating the

product account and CAs then validate and authorize the product account. All transactions are deducted from this account.

- Product exit, subtraction from the product account and certification for product exit from a supply chain to:
  - another operator in a business to business transaction, with the acquired raw materials in alignment with the details of species, volumes and form;
  - a domestic market for local consumption, logged as above; and
  - exportation, with supporting documentation and details of volume, form and species so that log processing yields and any anomalies can be traced.
- Product account balance is held by any operator, based on logged data and/or verified by inspection.
- Other important functions for private sector users involve mechanisms for queries and error correction.

Authorities must have access and functions to enable them to:

- validate requests submitted by industry operators for product movements, certificates and error correction;
- make queries to obtain an overview of the system and products within it; and
- block or suspend product movement authorizations or certificates submitted for validation.

Overall the system must be capable of:

- automated monitoring of product flows and yield factors throughout national supply chains as product changes form, weight and ownership;
- capturing processing yields on the basis of volume declarations for product in and product out to establish a database; and
- triggering alarms that signal the logging of anomalous data and which in turn trigger investigation.

Processing has been the purview of food safety authorities, for whom traceability is important in terms of consumer safety, information and product origin. Hence, systems involved in tracing product from landing at the port of arrival, importation, ownership changes and processing to domestic markets or exports, are often already in place under specific legislation and/or market access requirements.

Regardless of whether fish are imported or landed, in most countries fish storage and processing premises in the export value chain are licensed and under the control of health and/or fisheries authorities, with particular regulatory conditions that apply according to the type of processing in place. Therefore, fish storage and processing premises involved in the export supply chain need to be licensed and under the control of the fisheries authority.

Non-compliance with license conditions should automatically result in sanctions, enforcement measures and suspension of the license.

In complex national supply chains, which are the norm in advanced processing states, systems must be developed to trace the movement of products from the entry gate to the exit gate so that inspections can establish if compliance has been maintained along the different operators. Without such traceability systems it may be impossible for a CA to establish the nature and cause of any potential problems.

Table 5 summarizes the main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by a processing state.

► TABLE 5

Main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by a processing state

Processing state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Importation	Authorization of imports	Point of importation	Customs pre-clearance	Coordination in between customs and fisheries is fundamental
		Unique operator identifier/ importer	Customs pre-clearance Legal fisheries and business operator are to be registered for existing regulatory frameworks under fisheries, customs, health, tax, etc.	Identifier associated with the operator for the duration of its existence that cannot be re-used by any other operator
		Unique seafood material identifiers Batch/lot number, serial number, or container number *GDST KDE W01, W02*	Unique identifier for item/ SKU/UPC/GTIN *identifier of seafood material to distinguish it within a particular facility, company, or globally* Identifier associated with physical product marking a particular instance of seafood material such as a batch/lot number, serial number, or container number	No single source exists, yet the more standardization, the better
		Verified net volume, forms and species received *GDST KDE W03, W15, W16*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Detailed invoices, certificates, packing lists and bill of landing	Codes for units of measure used in international trade
		Sanitary status of imported products	Sanitary status of exporting country and harvesting vessel (from European Union or Chinese listing)	Proof of sanitary status and control by the CA
Distribution	Product splits (initial and later)	Unique product identifier *GDST KDE W01, W02*	Unique identifier for item/ SKU/UPC/GTIN Batch/lot number, serial number or container number	
		Unique identifier of buyer	Legal fisheries and business operators are to be registered for existing regulatory frameworks under fisheries, health, tax, etc.	
		Verified net volume, forms and species received *GDST KDE W03 W15, W16*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Detailed invoices, certificates, packing lists Lot tracing/product reports/ inventory	Codes for units of measure used in international trade
Receiving, storage and processing	Processing / transformation	Processing establishments unique operator identity	Unique operator identifier *identifier associated with the operator for the duration of its existence that cannot be re-used by any other operator*	Legal fisheries and business operators are to be registered for existing regulatory frameworks under fisheries, health, tax, etc.

(Cont.)

Processing state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Receiving, storage and processing	Processing / transformation	Unique product identifier *GDST KDE W01, W02*	Unique identifier for item/ SKU/UPC/GTIN Batch/lot number, serial number or container number	Linking identifier associated with physical product marking a particular instance of seafood material such as a batch/ lot number, serial number, or container number from reception to exit of the premises is fundamental for these KDEs
		Volumes, form and species acquired *GDST KDE W03, W15, W16*	Detailed invoices, certificates, packing lists, lot allocation/ product reports/inventory	Codes for units of measure used in international trade ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT)
		Volumes, form and species in storage *GDST KDE W03, W15, W16*	Lot tracing/product reports/ inventory	
		Volumes, forms, and species entering processing *GDST KDE W03, W15, W16*	Lot tracing/product reports/ inventory processing orders	
		Volumes, forms and species processed *GDST KDE W03, W15, W16*	Lot tracing/product reports/ inventory processing orders Processing yields	
		Volume, form and species for rendering/fishmeal *GDST KDE W03, W15, W16*	Lot tracing/product reports/ inventory processing orders Processing yields	
		Sanitary status of processing establishment	Proof of sanitary status and control by the CA	Market access condition
Product dispatch / trade	Domestic distribution of finished products	Unique identifier of buyer	Detailed invoices, certificates, packing lists	
		Volume, form and species sold *GDST KDE W03, W15, W16*	Detailed invoices, certificates, packing lists	
	Exportation or re-exportation of semi-finished/ finished products	Name of buyer/foreign consignee	Detailed invoices, certificates, packing lists and bill of landing	
		Volume, form and species, batch number sold *GDST KDE W02, W03, W15, W16*	Detailed invoices, certificates, packing lists and bill of landing Batch/lot number, serial number or container number	
		Sanitary status	Health certificate	Market access condition

Source: Authors' own elaboration.

3.7 END MARKET STATES

End market states are the states where fishery products are sold as consumer goods, albeit they can also be flag, port and processing states simultaneously. This section considers the final importation of fishery products as consumer goods. The main responsibility of end market states is to ensure that imported fishery products do not enter national territories without valid traceability unique identifiers linking to other types of states, CTEs and KDEs.

End market states need various mechanisms to implement their role in traceability.

The first is the involvement of fishery authorities in overseeing importation and legal requirements before border clearance. This is because imported products normally enter countries through commercial ports, which are often outside the purview of fishery authorities.

Fishery authorities must be involved in verification and authorization with customs, health and biosecurity authorities to ensure that only legally sourced and certified products enter a territory.

The authority must have statutory powers to deny entry to non-compliant consignments, which normally requires the development of new regulations.

A system of prior notification and authorization for imports must be in place. Fishery authorities can either undertake their own verifications within a traceability system, or do so in coordination with customs authorities.

In the case of fish fraud, to establish wrong-doing and to know a product's place of origin or the species in a sample or consignment, CAs must rely on other means of investigation, such as genetic analysis.

As in the case of legality, the main responsibility at end market state level is to ensure that imported fishery products do not enter national territories without valid sanitary certification and the traceability associated with the value chain.

Any potential verification of the traceability systems of the providing states (e.g. port or processing) is to be tested in a cooperative manner so as to be trusted by commercial partners.

Table 6 summarizes the main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by an end market state.[8]

► TABLE 6

Main supply chain stops, CTEs and KDEs identified for a standard supply chain overseen by an end market state

End market state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Importation	Authorization of imports	Point of importation	Customs pre-clearance	
		Unique operator identifier/ importer	Customs pre-clearance Legal fisheries and business operator are to be registered for existing regulatory frameworks under fisheries, health, tax, etc.	Identifier associated with the operator for the duration of its existence that cannot be re-used by any other operator
		Unique seafood material identifiers *GDST KDE W01, W02*	Unique identifier for item/ SKU/UPC/GTIN Batch/lot number, serial number or container number	Identifier of seafood material to distinguish it within a particular facility, company, or globally
		Verified net volume, forms and species received *GDST KDE W03, W15, W16*	Detailed invoices, certificates, packing lists and bill of landing	

[8] All co-mingling or mixing, aggregation and disaggregation, or splitting of batches or units must be tracked and all KDEs associated with new units and previous units must be tracked. In addition, changes of legal ownership or physical possession (e.g. a transportation subcontractor) must be tracked. These events are not included in every table, as this could happen throughout supply chains, and even several times under the oversight of one "owner" or during one "event". The GDST Core Normative Standard addresses this topic in more detail.

(Cont.)

End market state				
Supply chain stop	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Importation	Authorization of imports	Sanitary status of imported products	Sanitary status of exporting country and harvesting vessel (from the European Union or Chinese listing)	Proof of sanitary status and control by the CA
Domestic Distribution	Distribution events, by importer Product splits (initial and later)	Unique seafood material identifiers *GDST KDE W01, W02*	Unique identifier for item/ SKU/UPC/GTIN Batch/lot number, serial number or container number	Identifier of seafood material to distinguish it within a particular facility, company, or globally
		Unique identifier of buyer	Legal fisheries and business operator are to be registered for existing regulatory frameworks under fisheries, health, tax, etc.	
		Verified net volume, forms and species received *GDST KDE W03, W15, W16*	Detailed invoices, certificates, packing lists	
	Wholesaler buyer	Verified net volume, forms and species, batch number received *GDST KDE W02, W03, W15, W16*	Detailed invoices, certificates, packing lists	

Source: Authors' own elaboration.

4. CRITICAL TRACKING EVENTS AND KEY DATA ELEMENTS IN AQUACULTURE

4.1 INTRODUCTION

In this section, we refer generally to "aquaculture products" as the culture of finfish, crustaceans and molluscs.

The authorities regulating aquaculture play a crucial role in the development, planning and implementation of production and trading systems. Hence, traceability requirements need to be included from the earliest stages of development and verified all along the value chain.

The increasing complexity of aquaculture value chains is as a result of many requirements being added to the regulatory realm of food safety-related traceability, such as requirements relating to property; or permits for the use of the production areas; license registers; and environmental and labour conditions that are becoming market access issues in aquaculture production. Therefore, the responsible authorities must be able to access the information that allows them to verify compliance.

In general terms, the traceability requirements for aquaculture have been driven by market access conditions for those intending to export their products. Traditionally, this was the realm of the national CA which provides verification against applicable standards (which include specific requirements normally referring to infrastructure, hygiene conditions, HACCP, operations, traceability, labelling, etc.). However, the utility of good traceability has expanded to other regulatory (and private) requirements working in parallel with these food safety aspects.

4.2 FEED PRODUCTION AND DISTRIBUTORS

Feed and fertilizer play an important role in the successful production of fish and other aquatic food for human consumption. They are often a significant cost in aquaculture operations.

In 2010, FAO published comprehensive and practical guidelines to assist producers and stakeholders along the production and distribution chain to comply with the regulatory framework which has or will come into force in response to the Codex Alimentarius Code of Practice on Good Animal Feeding.

Traceability/product tracing of feed and feed ingredients, including additives, should be enabled by proper record keeping for timely and effective withdrawal or recall of products if known or probable adverse effects on consumers' health are identified (FAO and IFIF, 2010).

An increasing number of countries have specific regulatory requirements for animal feed and raw materials used in the production of aquafeed. These requirements are usually met by the registration of the feed formula with the relevant CAs which constitute a positive list of feed authorized to be used. Feed producers are registered and licensed as per their compliance with official controls.

Animal feed and raw materials for the production of aquafeed must meet the minimum requirements in the applicable regulations (e.g. maximum residues of contaminants, microbiological criteria, etc.)

before products are traded. Therefore, traceable management of conformity assessments is critical, in particular when imported products are used. Hence, importers and their imports should have unique operator identifiers and unique materials identifiers and thus keep records of origin, storage and destination of each imported batch.

Table 7 identifies the main supply chain stops, CTEs and KDEs identified for feed production and distribution. The table is designed to suit the production of commercial feed but farms manufacturing their own feed could also use it. In this case, farms have to comply with the national requirements in term of licensing for feed production, when applicable.

► TABLE 7

Main supply chain stops, CTEs and KDEs identified for feed production and distribution

Feed production and distribution				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Feed production	Feed producer details	Name and details of feed manufacturer including in-house sources using a unique operator identifier *GDST KDE A05*	Unique indicator generated by the authorities in the country of operation that gives the licence to operate	A licensing and/or authorization system of feed producers should be implemented
		Location (at least country) of operation, Location ID, address *GDST KDE A07, A08, A09*	Aquaculture business public register, maps, GPS coordinates	Location must be linked with the operation licence, since the place must be approved for installing the facility
	Processing info	Production date, feed expiry date *GDST KDE A19*	Production records Labelling information	Based on implementation of good manufacturing practices and internal minimum traceability system
		Unique seafood material identifier for feed type produced, brand, pellet size GDST KDE A01	Unique identifier for item/ SKU/UPC/GTIN Lot/batch Production records, labelling information	Identifier of food material to distinguish it within a particular facility, company, or globally
		Main ingredients (source of protein) Seafood species name (if applicable) *GDST KDE A14, A04*	Commercial feed formula Feed ingredients list/ certificate of origin/sales order/delivery order	Operators should establish and maintain effective record keeping about the source of ingredients and raw materials used in the production of aquafeed
		Batch volume, weight, quantity of units *GDST KDE A03*	Production records Lot tracing/product reports/ inventory processing orders	This allows the ingredients' mass-balance, especially for fishmeal and fishery-derived ingredients
		Batch number, serial number, or container number *GDST KDE A02*	Production records Lot tracing/product reports/ inventory processing orders	The feed products traded should be identified per traceable unit (either batch of feed sold in bulk or feed bag).
		Selling units, number of units	Invoices, inventory records, delivery bill	
Feed commercialization	Sale info	Selling date	Invoices, inventory records, packing list	
		Name and details of first buyer using a unique operator identifier	Unique indicator generated by the authorities in the country of operation that gives the licence to operate	

(Cont.)

Feed production and distribution				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
		Batch number, serial number, or container number *GDST KDE A01, A02*	Invoice, transport documents, packing list	This allows every batch of feed to be traced to and from the farm
		Batch volume, weight, quantity of units *GDST KDE A03*	Invoice, transport documents, packing list	

Source: Authors' own elaboration.

4.3 HATCHERY/NURSERY/SEED GROWING

Aquaculture has been made possible through the use of hatchery-bred seed. The supply of seed of common aquaculture species has been key to the growth and intensification of the aquaculture sector.

A licensing and/or authorization system of hatcheries/nurseries, with a clear identification of their location, is the basis of most regulatory frameworks for the sector. Hatcheries/nurseries should establish and maintain effective record keeping from the receiving of the broodstock and/or seeds and subsequently cultivating them into seedlings or fish fry on the basis of the internal minimum traceability system.

Hatcheries/nurseries should maintain records internally for all laboratory results certifying the health of the broodstock and seed. Movement of seed may be controlled through movement documents between the hatchery and the growing farm(s) and health certificates.

Hatchery and nursery operations, and in particular the feeding, feed management and the sanitary treatments, should be recorded.

Once harvested, the harvesting record, commercial documents, transport documents and documents of origin should be issued and accompany the seed to the farms/grow out areas. When there are no hatcheries and seed comes from the wild – as in the case of some bivalves and finfish – or in the case of ranching, or for nursery operations receiving seeds from hatcheries, it is necessary to record the collector, permit/licences, species, area, movement, means of transportation, date of collection, date of stocking, amounts, etc. CAs should ensure that the collecting areas have been approved for extraction and a unique code must be assigned to each operator, which allows for identification of the legal origin of the seed.

Table 8 identifies the main supply chain stops, CTEs and KDEs identified for hatchery/nursery/seed growing.

► TABLE 8

Main supply chain stops, CTEs and KDEs identified for hatchery/seed growing

Hatchery/nursery/seed growing				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Hatching area/ nursery/ Seed growing	Hatchery identity and details	Name and details of hatchery using a unique operator identifier *GDST KDE A06*	Unique indicator generated by the authorities in the country of operation that gives the licence to operate	Identifier of operator to distinguish it from others A licensing and/or authorization system of hatcheries should be implemented
	Broodstock info	Unique identifier for broodstock *GDST KDE A01, A02*	Unique identifier for item/SKU /UPC/GTIN lot/batch/tank	Identifier of broodstock to distinguish it within a particular facility, company, or globally High-value species may have unique codes, otherwise code is attached to batch or tank Considerations with exotic species, yet these fall under biosecurity rather than traceability per se
		Broodstock reception date, origin, seller *GDST KDE A11*	Detailed invoices, transport documents, origin certificates Buy or catch records of broodstock, invoices, production records Pre-customs clearance documents	Broodstock are either produced domestically, sourced from the wild, or imported from another country. If imported, then the import documents can be used as data source also In any case, the movement of the animals has to be traceable
		Species name *GDST KDE A04*	ASFIS list of species Sampling records, history of strain development documents (when available)	Species have to be clearly identified for commercial aquaculture History of strain development documents may be added to support the identification of the species Non-authorized species should not be farmed under biosecurity requirements and therefore should not appear in the traceability system
		Sanitary and/or epizootic status	Registers, health certificate, laboratory reports Production records/farm book for sanitary treatments	Proof of animal health status Health certificate issued for the CA, or a CA-authorized laboratory Record of treatments, contaminants, supplements, additives
	Seed source (for nurseries)	Unique fish material identifier for seed GDST KDE A01, A02, A03, A06	Unique identifier for item/ SKU/UPC/GTIN Lot/batch/tank	Identifier of seed material to distinguish it within a particular facility, company, or globally along with its components For input of seed from elsewhere – other hatchery or from the wild Means of verifying origin if from the wild, e.g. proof/document of legal origin; import documents or legal status of catch area; link with requirements on the source of broodstock
	Location	Location (at least country) of operation, location ID, address *GDST KDE A07, A08, A09*	Aquaculture business public register, maps, GPS coordinates	Location must be linked with the operation licence, since the place must be approved for installing the facility

(Cont.)

Hatchery/nursery/seed growing				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Hatching area/ nursery/ Seed growing	Feed info	Name of feed manufacturer Unique identifier of seller *GDST KDE A05*	Detailed invoices, delivery bills	Identifier of supplier to distinguish it from others Hatcheries/nurseries must keep information about their feed suppliers, e.g. distributors and feed producers. Feed labels are often kept as records For imported feed passing through a local distributor, information on the feed producer, such as its unique identifier, may not be available. The minimum information to be recorded should be visible on the feed packaging (bag) and/ or labels
		Feed brand, type, pellet size *GDST KDE A01, A03, A04*	Detailed invoices, production records	When fresh food, such mussels, clams, squids, etc, is used as feed for broodstock, information about the source, species, treatments/contaminants, volume and sanitary status of live, fresh or frozen food must be recorded and kept accordingly
		Feed batch number, feed expiry date *GDST KDE 02*	Feed invoices, certificates, lot tracing/feeding records, feed labels	Identifier associated with the physical product marking a particular instance of seafood material. Relevant information for traceability
		Volume purchased *GDST KDE 03*	Feeding records/inventory records	Numerically quantifiable amount of feed with a standard unit of measure Usually number of bags of commercial feed
	Sanitary treatments	Veterinary drugs and chemicals used	Name of veterinary drugs and chemicals used. Active principle, time, date and dosage (withdrawal period)	Approved list of authorized veterinary drugs and chemicals should be available Information required for market access When controlled substances are used, tests to determine the residue level should be performed according to national/international regulations and standards before processing and selling the harvested product
	Harvest info	Harvesting date *GDST KDE A10*	Harvest records	Date on which fingerlings were transferred to the grow out farm/pond/tank/pen/cage
		Harvested volume/weight/ quantity/age/size or life stage *GDST KDE A03*	Harvest record	Numerically quantifiable amount of seafood with a standard unit of measure In the case of partial harvest, this needs to be mentioned
		Species name *GDST KDE A04*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Harvest record	Species have to be clearly identified since there are some endangered species non-authorized for commercial aquaculture.

(Cont.)

Hatchery/nursery/seed growing				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Hatching area/ nursery/ Seed growing	Harvest info	Unique fish material identifier for seed *GDST KDE A01, A02, A06*	Unique identifier for item/ SKU/UPC/GTIN lot/batch/tank Harvest records, detailed invoice, transport documents, documents of origin	Identifier of seed material to distinguish it within a particular facility, company, or globally along with its components Records should record splitting or combining of lots or sources, etc.
		Species name *GDST KDE A04*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Harvest record	Species have to be clearly identified since there are some endangered species non-authorized for commercial aquaculture.
		Unique fish material identifier for seed *GDST KDE A01, A02, A06*	Unique identifier for item/ SKU/UPC/GTIN lot/batch/tank Harvest records, detailed invoice, transport documents, documents of origin	Identifier of seed material to distinguish it within a particular facility, company, or globally along with its components Records should record splitting or combining of lots or sources, etc.
		Name and details of buying farm for grow-out using a unique operator identifier	Harvest records, detailed invoice, transport documents, documents of origin	The unique indicator generated by the authorities is ideal for the harvest records. When it is unknown to the seller, as much information as possible is required for traceability
		Sanitary and/or epizootic status	Registers, health certificate, laboratory reports	Proof of animal health status Health certificate issued for the CA, or a CA-authorized laboratory Record of treatments, contaminants, supplements, additives Results of controls made in relation to the sanitary and/or epizootic status made by the CAs should be recorded When applicable, a copy of the health certificate required by the processing or market state should be kept

Source: Authors' own elaboration.

4.4 FARMS/GROWING AREAS

Operators involved in farms and growing areas are required to maintain and demonstrate a minimum set of requirements for their traceability systems, such as:

- registration/licensing system that includes mapping of productions units, such as ponds, marine cages and growing areas, which, along with supporting registration and licensing information, form the basis for traceability, in addition to approval of farming operations that reinforce the identification system;
- conformity assessment against national regulations and international standards;
- seafood safety, epizootics and animal welfare requirements;
- the origin, safety and quality of the farm inputs, i.e. seeds, feed and chemicals are to be recorded so that they can be potentially traced in case of non-conformity along the chain; and
- sanitary status of culture areas.

Farms should establish and maintain effective record keeping from the receiving of the seed, to the harvest of the aquaculture products. A traceable unit should be the quantity of products harvested from one production unit with identical production conditions: at the farm, it is usually the harvest from one production unit.

Minimum farming input and parameters should be recorded for each identified unit:

- origin of the seeds, fish seedlings or fish fry;
- feed used and quantities;
- record of any drugs and chemicals; and
- harvest date, quantity and client information.

Movement of aquaculture products may be controlled through movement documents between the growing farm(s) and the collectors and/or processors. This is usually where aquaculture products are split and/or mixed.

Table 9 identifies the main supply chain stops, CTEs and KDEs identified for farms/growing areas.

► TABLE 9

Main supply chain stops, CTEs and KDEs identified for farms/growing areas

Farms/growing areas for bivalves				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Farm/growing area	Growing area/ farm identity and details	Name and details of growing area/farm using a unique operator identifier *GDST KDE A15*	Unique indicator generated by the authorities in the country of operation that gives the licence to operate Location, GPS coordinates, business licence, identifiers for ponds, tanks and pens/ cages	Identifier associated with the operator for the duration of its existence to distinguish it from others A licensing and/or authorization system of farms and growing areas should be implemented Information about location must be declared in the official documents to guarantee the origin of the product in the traceability system Consideration should be given to identification of small producers
		Location (at least the country) of operation, location ID, address *GDST KDE A07, A08, A09*	Aquaculture business public register, maps, GPS coordinates	Location must be linked with the operation licence because the location must be approved for installing the facility
	Stocking information	Species name *GDST KDE 04*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Sampling records	Species have to be clearly identified for commercial aquaculture
		Name of supplier (hatchery that supplied the fry/ fingerlings to farm for grow out, including in-house sourced) *GDST KDE A06*	Unique identifier of the hatchery	If the official unique identifier is unknown, a list of hatcheries/ nurseries supplying the farms should be recorded
		Unique fish material identifier for stocking animals (from hatchery/ nursery) *GDST KDE 01, 02*	Unique identifier for item/ SKU/UPC/GTIN Lot/batch/tank	Identifier of seafood material to distinguish it within a particular facility, company, or globally

(Cont.)

Farms/growing areas for bivalves				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Farm/growing area	Stocking information	Stocking date *GDST KDE A10*	Detailed invoices, delivery documents (from hatcheries/ nurseries), production records	Harvest date of the seeds is important to record as well Age/size/life stage of seeds can be also recorded here The age of the post larvae/seeds can be calculated from the stocking and harvest date at the hatchery
		Pond/cage/tank/pen ID (at the farm)	Unique identifier for pond/ cage/tank/pen	Information detailing farm layout or growing area or company information that allows the identification of the pond/cage/ tank/pen where the animals are grown in a specific time frame
		Stocking quantity	Detailed invoices, delivery documents (from hatcheries/ nurseries), production records	Verifiable number of animals stocked in the production unit Mortality should be taken into consideration because quantity stocked and quantity harvested at the hatchery/nursery may not match
	Feeding information	Name of feed manufacturer including in-house sources *GDST KDE A05*	Detailed invoices, delivery bills	Identifier of supplier to distinguish it from others. Farms must keep information about their feed suppliers, e.g. distributors and feed producers. Feed labels are often kept as records
		Feed brand, type, pellet size *GDST KDE A01*	Detailed invoices, production records	Complete information about feed used for every batch of animals has to be recorded for traceability
		Feed batch number, feed expiry date *GDST KDE A02*	Feed invoices, certificates, lot tracing/feeding records, feed labels	Identifier associated with physical product marking a particular instance of seafood material. Relevant information for traceability
		Volume of feed purchased *GDST KDE A03*	Farm production records, inventory records	Numerically quantifiable amount of seafood with a standard unit of measure
		Additives used	Name of additives used. Active principle, time and dosage	Approved list of authorized additives should be available Information required for market access
	Sanitary treatments	Veterinary drugs and chemicals used Name and details of client (distributor or processing plant) using a unique operator identifier Aggregator name and ID *GDST KDE A21, A22*	Name of veterinary drugs and chemicals used. Active principle, time, date and dosage Production records/farm book	Approved list of authorized chemicals should be available Information required for market access When controlled substances are used, tests to determine the residue levels must be performed before processing and selling the harvested product
	Harvest information	Harvesting date *GDST KDE A16, A10*	Harvest records	Calendar date on which the seafood was harvested from the farm/cultivation area
		Harvested volume/weight/ quantity, batch number, seafood material identifier *GDST KDE A03, A02, A01*	Harvest records, detailed invoice, transport documents, documents of origin	

(Cont.)

Farms/growing areas for bivalves				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Farm/growing area	Harvest information	Harvesting date *GDST KDE A16, A10*	Harvest records	Calendar date on which the seafood was harvested from the farm/cultivation area
		Harvested volume/weight/ quantity, batch number, seafood material identifier *GDST KDE A03, A02, A01*	Harvest records, detailed invoice, transport documents, documents of origin	
		Name and details of client (distributor or processing plant) using a unique operator identifier Aggregator name and ID *GDST KDE A21, A22*	Harvest records, detailed invoices, transport documents, movement documents	The unique indicator generated by the authorities is ideal for the harvest records. When it is unknown to the seller, as much information as possible is required for traceability and market access
		Farming method *GDST KDE A17*	Farming and harvest records	A combination of type of culture, unit, level of intensity, culture species and scale or size of exploitation as defined by FAO

Source: Authors' own elaboration.

4.5 COLLECTOR/DISTRIBUTOR/TRADERS/AGGREGATORS

In many countries, there are intermediaries in between harvest and processing who may be independent, associated with producer organizations, or associated with processors. They can also be a part of the processing plants. For clarity, in this document this role will be called "distributors". The GDST qualifies these intermediaries as "aggregators".

The distributors may be involved with the farm operators during the harvesting process and can split harvest volumes or mix them with products of other farms prior to delivery to the processors. Therefore, it is critical that they are under the structure of the traceability schemes associated with the regulatory requirements in place.

A registration system for distributors needs be in place based on the criteria for unique operator identifiers.

Ideally, the distributors should maintain the granularity of the minimum set of KDEs associated with those of the farms for each lot received and further distributed. However, this is not always practical or possible (e.g. from small-scale farmers or from extensive farmers) and in such cases, the distributors shall record information about what was mixed and how the new mixed lot is now identified.

Distributors' operations normally include the transport of harvested aquaculture products, but can also extend to grading, cleaning and forwarding. Therefore, they should keep records that allow for the unique identification of products and volumes in regard to sources and destinations.

Distributors may receive products from several suppliers, or from the same supplier but in different batches, which they may want to mix. They may also split batches due to size grading. Ideally, in such cases records of what is mixed – and at which step – should be kept and a unique identifier should be given to the new mix.

An alternative solution would be for the distributors to record the names/identifiers of the suppliers delivering aquaculture products over a day or a shorter specific period of time in a day (e.g. a working shift). At the processing stage, daily reception of aquaculture products and distributor names

are recoded. If a trace-back is required, the farms that delivered aquaculture products on a given date can be contacted and the relevant information could be requested and investigated. A traceable unit should be the quantity of products graded and mixed in a lot, with links to the farm(s) of origin.

4.6 PROCESSING

While in most instances farming and processing occur in the same state, the practice of sending raw materials to countries with lower processing costs for value adding is becoming more common in aquaculture (following a similar trend to that seen in fisheries). Therefore, a system needs to cover the entire chain of events by means of a *national traceability* system that traces product from landing, or importation at ports of arrival, through ownership changes and processing exportation or re-exportation. What is needed is for traceability systems to cover events between entry and exit "gates" (into and out of the country) so that regulatory controls can establish where anomalies occur and identify those responsible. These controls must cover:

- Registration and licensing of storage and processing premises to identify value chain operators.
- In most countries, the storage and processing premises of aquaculture products must be licensed and controlled by authorities, which amounts to a traceability and record keeping system that can support traceability.
- Distribution and transfers among operators' premises. Registration of internal movements of declared species and volumes makes them traceable; these require strict adherence to the main KDEs identified for the operator's unique identity and unique seafood material identifiers in Section 3.2.
- Assurance that raw materials/products are coming from farms and distributors identified in the traceability scheme, and that they comply with the minimum traceability requirements.
- The recording of products leaving operators' premises, regardless of destinations. Regular verification by CAs of pre-dispatch checks and consignment loading records will ensure the effectiveness of traceability systems at the level of individual operators.

At the processing stage, combining and splitting batches and production codes depending on the type of products and specific customer requirements must follow the standard practices for these transactions to preserve traceability.[9]

The information provided on the product and content of sales documents (e.g. invoices and health certificates) may contain additional information about the history of the product if required by the buyer or by law. If needed, this information can be used to begin a trace-back or a product recall.

Table 10 identifies the main supply chain stops, CTEs and KDEs identified for the processing of aquaculture products.

[9] All co-mingling or mixing, aggregation, and disaggregation or splitting of batches or units must be tracked and all KDEs associated with new units and previous units must be tracked. In addition, changes of legal ownership or physical possession (e.g. a transportation subcontractor) must be tracked. These events are not included in every table, as this could happen throughout supply chains, and even several times under the oversight of one "owner" or during one "event". The GDST Core Normative Standard addresses this topic in more detail.

► TABLE 10

Main supply chain stops, CTEs and KDEs identified for processing of aquaculture products

Distribution and processing plants				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Distribution	Distribution events Product splits (initial and later)	Name and details of distributor using a unique operator identifier *GDST KDE A21*	Unique indicator generated by the authorities in the country of operation that gives the licence to operate	Identifier associated with the operator for the duration of its existence to distinguish it from others
		Movement date	Harvest records, detailed invoice, transport documents, documents of origin	Date of transportation from the farm or delivery at the distributor facilities
		Transport vehicle identifier	Transport documents For example, registration plate of vehicle or any other means of identification e.g. accreditation number of vehicle with CA, type of vehicle.	Transport vehicle identifier Consideration should be given to small-scale producers
	Product information	Unique seafood material identifier *GDST KDE 01*	Unique identifier for item/ SKU/UPC/GTIN Lot/batch/tank/pen/cage	Identifier of seafood material to distinguish it within a particular facility, company, or globally
		Species name *GDST KDE A04*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Sampling records	
		Verified net volume/weight/ quantity, form, batch number *GDST KDE A03, A02*	Harvest records, transport documents, invoices, movement documents	
		Product form *GDST KDE A18*	Harvest records, detailed invoice, transport documents, documents of origin	Commercial short-hand reference of the degree of transformation of seafood from its original living form
Processing	Processing/ transformation	Name and details of client (distributor or processing plant) using a unique operator identifier registration/ approval number (Food and Drug Administration of the United States of America, European Union, etc.) Processing plant details, product origin *GDST KDE A01, A06, A07, A21, A20*	Unique indicator generated by the authorities in the country of operation that gives the license to operate	Identifier associated with the operator for the duration of its existence to distinguish it from others.
		Reception date	Harvest records, detailed invoice, transport documents, documents of origin	Date of reception at the processing plant should be as soon as possible after the harvest
		Species name *GDST KDE A04*	ASFIS list of species Species, scientific name/FAO 3-Alpha code (e.g. YFT) Sampling records	Species have to be clearly identified because there are some endangered species not authorized for commercial aquaculture
		Verified net volume/weight, forms and species entering processing, batch number, production date *GDST KDE A03, A02, A19*	Reception records, detailed invoices, certificates, packing lists, delivery bill	

(Cont.)

Distribution and processing plants				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Processing	Processing/ transformation	Verified net volume/weight, species for rendering/ fishmeal, batch number *GDST KDE A02, A03, A04*	Processing records	
		Product form *GDST KDE A18*	Harvest records, transport documents, invoices	Commercial short-hand reference of the degree of transformation of seafood from its original living form
	Domestic distribution of finished products	Unique identifier of buyer	Business operators are to be registered for existing regulatory frameworks under health and food safety, tax, etc.	
		Verified net volume, forms and species received, batch number *GDST KDE A02, A03, A04*	Processing records, detailed invoices, certificates, packing lists	
	Exportation or re-exportation of semi-finished/ finished products	Name and details of client (buyer/consignee or processing plant) using a unique operator identifier	Business operators are to be registered for existing regulatory frameworks under health and food safety, tax, etc.	
		Delivery date	Processing records, detailed invoices, certificates, packing lists	
		Verified net volume/weight, form and species sold, batch number *GDST KDE A02, A03, A04, A18*	Processing records, harvest records, detailed invoices, certificates, packing lists, delivery bill, product label, purchase order	
		Unique identifier of first buyers and distributor's name	Last business operator is to be registered for existing regulatory frameworks under health and food safety, tax, etc.	

Source: Authors' own elaboration.

4.7 SPECIAL CONSIDERATIONS FOR BIVALVES

Unlike fish and crustaceans, bivalves are filter feeders that could accumulate certain contaminants present in the culture water and require special attention in terms of sanitary controls. The authorities of the countries in which bivalves are grown, processed and commercialized should pay special attention to traceability aspects related to the growing areas, and incorporate data on water monitoring to control the presence of pathogenic microorganisms, environmental contaminants and biotoxins.

Table 11 identifies the particular chain stops, CTEs and KDEs identified for bivalve aquaculture and wild capture products. While some KDEs in the table align with GDST KDEs, the GDST materials do not identify special considerations for bivalves. Following the processing step in Table 11, the KDEs would be the same as those in Table 10 for distribution and processing.

► TABLE 11

Particular supply chain stops, CTEs and KDEs identified for bivalve aquaculture products

Bivalve				
Supply chain stage	**CTEs**	**Main KDEs**	**Data source**	**Comments**
Hatching area/ seed growing	Name and details of hatchery using a unique operator identifier/ location *GDST KDE A06, A07, A08, A09*	Production area: GPS coordinates of the collecting area that supplied the seed Unique indicator generated by the authorities in the country of operation that gives the licence to operate	Production area maps established by the CA	Location should be identified because water quality has to be monitored. If seed comes from the wild, then operator should have an ID and licence number, and seed should be collected from authorized areas; information has to be traceable
Growing area	Production area Source of stock *GDST KDE A10, A11*	GPS coordinates of the collecting area that supplied the seed Unique indicator generated by the authorities in the country of operation that gives the licence to operate/ classification of the water area	Production area maps established by the CA, laboratory monitoring tests results	Areas should be officially monitored for identified risks so as to maintain its open status
Harvest	Date of harvest *GDST KDE A16*	Calendar date on which the seafood was harvested from the farm/ cultivation area	Harvest records	
Processing	Depuration/clearing/ treatments	Sanitary status of product lot/batch	Monitoring reports	

Note: These apply in addition to previous tables for hatchery, growout and processing and apply to entities involved in shellfish production and handling.

Source: Authors' own elaboration.

In most major markets, importers and distributors help to ensure that only products compliant with local legislation are placed on the market. As they are the intermediaries between producers and retailers, they must have comprehensive knowledge of the legal requirements and make sure that the products they distribute or import meet them. Importers must check that products fulfil all safety, health and environmental protection requirements before placing them on the market. Distributors must handle the product carefully and must not affect the integrity of the packaging so as to avoid contamination, respect the temperature control indications, etc.

The identified KDEs and CTEs for end-market states are the same for wild capture fishery products in Table 6. Generally, the distinction in origin (wild/farmed) is not captured once fish products enter international trade, though some countries do make the distinction in their trade data and are encouraged to do so.

5. DISCUSSION

The many and varied advantages that effective traceability systems provide were summarized by Lewis and Boyle:

> In the last decade, a range of drivers within the seafood sector have incentivized the application of traceability to issues beyond food safety and inventory management. Some of the issues motivating the expanded use of traceability within the global seafood sector include: increased media attention on the legal and social risks within some seafood supply chains, governmental traceability requirements, private-sector sustainability commitments, and others.
>
> (Lewis and Boyle, 2017)

The aim of this guidance document is to support countries by providing technical advice on the CTEs and KDEs required for robust traceability along the seafood value chain, and the identification of supporting verification mechanisms for official assurance. The guidance document also introduces leading private sector-led initiatives across the seafood value chain as the substrate over which electronic traceability-type solutions can work.

There are many intrinsic and extrinsic challenges in implementing successful and cost-effective traceability. These challenges have created some issues for the operators and the CAs in control of food safety, particularly when engaging in transnational trade.

The GDST initiative correctly identified the opportunities that new digital technologies present for making traceability more possible and affordable than ever, but effective and widespread traceability has faced two major obstacles:

i. Inconsistent demands and formats for information coming from regulators, private certifications, and even retailers or other downstream companies. This has led to confusion, higher compliance costs and lower motivation among producers.
ii. Incompatible digital information management systems resulting from the large number of uncoordinated CTEs/KDEs, standards, traceability solutions and solution vendors. This impedes information flow while causing rigidity in business relations and raising barriers to onboarding new suppliers and customers.

By compiling and analysing the CTEs and KDEs from the regulatory realm and incorporating the applicable ones from the non-regulatory realm, this document hopes to facilitate the development of traceability systems that extend over the whole value chain.

The best-case scenario would be that many of the same CTEs and KDEs would be adopted globally for seafood supply chains. If this could be accomplished, many of the challenges relating to traceability – such as inconsistent data formats and interoperability challenges – would be reduced and the resources of companies and governments could be redirected toward verifying the information in the systems and other improvements.

Nevertheless, the authors are very aware that no "one size fits all" solution is possible, and that the views, CTEs and KDEs presented here constitute guidance only, and may not be applicable in their entirety for some products, or even for the same product in different jurisdictions.

Yet, two issues have been identified not only in this guidance document, but also in prior ones (Blaha, Borit and Thompson, 2015) and these remain a non-technical challenge:

- **Different authorities**
  Even if traceability systems are well designed and generally well implemented, they can fail with a lack of implementation at a single step. Therefore, it is vital to ensure coordination between the different operators in the production chain and in the control of traceability systems by the CAs involved.
  For example, the understanding that IUU happens "at sea" is the one CTE where most of the relevant fishing data (KDEs) are recorded. Besides this being the easiest point to perform this activity, it is possible that this situation is due to the traditional view that MCS (including traceability as a tool for MCS) is something that only happens at the vessel and wharf level, and does not concern processing and the risks of laundering illegal fish. While at the same time the sanitary CA (which requires many of the same KDEs) does not extend its oversight to the vessels and wharfs, nor integrates and cross-checks acquired data with the fisheries authorities.

- **National (in country) and across-countries traceability**
  A further topic of importance is the integration of cross-countries (between countries) and national (inside the country) traceability, particularly in the light of many countries with excess processing capacity and low labour costs that import fish and fishery products for further processing and re-export (e.g. China, Viet Nam and Thailand).

National traceability is organized by national administrations and governed by national laws. While many countries require traceability, especially requirements associated with exports to an international market, it is often enforced with varied degrees of effectiveness. Few to no countries provide standardized CTEs and KDEs and electronic traceability systems where specific types of products are electronically traced through the entire national supply chain from point of landing/import to point of export/re-export.

The cross-countries traceability (in between countries) stops at the point of entry into a country and restarts at the point of exit. If a product does not re-emerge as an export following landing or import, it is deemed to have gone into domestic consumption.

This understanding is to be incorporated into the traceability system's design so as to accommodate the reality that in many countries, the largest importers of fish raw materials are not processors but diversified import–export companies. These companies are sometimes servicing a variety of food-related sectors, and often supply to and distribute fish on behalf of, large, and probably small, re-processors. Although this service comes at a price, it may offer essential flexibility in the dynamic channelling of raw material to a network of factories as market conditions change. Although this situation is perfectly legal, the fact that fish may change hands one or more times while in the country has implications for traceability systems.

Finally, interoperability will be always be a challenge to implementing new technology because of the lack of traceability standardization in seafood value chains – both from a technical perspective, where existing traceability systems may not be able to talk to each other, and also from the perspective that there is a need for standardized KDEs to be recorded and shared. This document hopes to contribute to this last point.

6. RECOMMENDATIONS

As demonstrated in this document, establishing a consistent and widely adopted set of KDEs and CTEs is an essential part of functional and integrated traceability systems – both for companies and national CAs.

While technology has enabled many examples of successful implementation and is constantly evolving, implementing advanced technology is secondary to having well-developed traceability along the value chain, not only with accurate and well-defined KDEs and CTEs, but with standards that facilitate integration, management and transmission of data. Hence, prior to deciding which technology is to be used, it is critical to define what data are to be acquired, and to determine the sources and jurisdictions involved at each type of state or entity of the traceability system to be built.

All types of states, entities and operators have essential roles to play in the implementation of traceability mechanisms. Some responsibilities and duties are directly related to the implementation of rigorous traceability mechanisms, whereas others are only loosely related – but together they provide the conditions in which traceability functions can be enforced.

The overall recommendation of this document for countries is to: 1) identify and define standardized KDEs and CTEs for commercial and regulatory traceability; and 2) follow strict due diligence (using a holistic and integrated approach) involving all stakeholders at legal, commercial and operational level prior to commitment.

In order to achieve the two recommendations above, critical forethought needs to be given to the following (not exhaustive) list of considerations:

Use of defined and flexible standards

- Once the identification and definition of the CTEs and KDEs is completed, stakeholders across the supply chain should consider adopting industry-wide use of the standards using globally unique identification of units as a significant step forward for electronic and interoperable seafood traceability.
- An example of such standard is the GDST Standards and Guidelines for Interoperable Seafood Traceability Systems, Version 1.0. These industry-developed standards are designed to improve the reliability of seafood information, reduce the cost of traceability and contribute to supply chain risk reduction and to securing the long-term social and environmental sustainability of the sector.

Traceability and value chain considerations for due diligence

- An exhaustive understanding of all possible is needed - as distinct from desirable - supply-chain events and scenarios under consideration.
- Consideration should be given to small-scale producers supplying domestic markets and potential gaps in national traceability systems where information is challenging to capture.

- Clear identification and definition of the CTEs and KDEs are needed in the value chain under consideration.
- For regulatory purposes, the segments of analysis need to consider the administrative, logistic and legal aspects associated with the types of states, entities and operators that have custody of fishery and aquaculture products as they move through national and international supply chains, from harvesting and processing to the consumer end market.
- A clear understanding of the current operational and logistical advantages and limitations of the traceability system in existence (if any) is needed.

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GUIDANCE DOCUMENT: ADVANCING END-TO-END TRACEABILITY

CRITICAL TRACKING EVENTS AND KEY DATA ELEMENTS ALONG CAPTURE FISHERIES AND AQUACULTURE VALUE CHAINS

Traceability systems, including their associated elements of transparency, represent a crucial concerted effort towards transparent and responsible value chains. They allow a product to be followed from its origin to the end market, informing about compliance with many fisheries regulations. Given the interconnectivity of fisheries and aquaculture value chains, collaboration at all stages is crucial for robust end-to-end traceability. Most current systems are fragmented and internal to individual companies; this creates information gaps throughout the supply chain and loss of operational efficiency. This guidance document provides elements to address these challenges and enable supply chain actors to have a common understanding and language in order to increase interoperability and data sharing for efficient traceability systems at the governmental and private levels.

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