Application of traceability in deterrence of illegal, unreported and unregulated fishing: an analysis model of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS)

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ABSTRACT

Illegal, unreported and unregulated (IUU) fishing is one important concern of fisheries managers and consumers alike all over the world. Recent IUU fishing deterrence strategies consider traceability the most promising indirect method to prevent its occurrence. Two of the three new pillars of the European Union Common Fisheries Policy (EU Regulation 1005/2008; EU Regulation Proposal 2008/0216 (CNS)) were explicitly developed to address this concern. These regulations attempt to introduce market monitoring measures that prevent IUU fish from entering legitimate trade channels in the Community. The leading purpose of this study was twofold: to analyse if the traceability related provisions of these two legal documents are relevant for IUU fishing deterrence, and to test if they fulfil *de lege lata* the traceability requirements of the chain of custody. In order to achieve these aims, a novel analytical tool that was suitable for the dual purposes had to be constructed. Model 1 was conceived to identify the overlapping of the necessary data for identifying IUU components (actors or products) with the traceability data recorded in the documentation imposed by the legal provisions at each critical traceability control point. Model 2 was designed to identify the fulfilment of the chain of custody requirements along the traceability control points. The present findings indicate that the traceability data retained according to the new legal EU norms have little relevance to be used effectively in deterrence of IUU operations. The product data are not constantly recorded at each critical traceability point, and important information to help identify IUU fishing actors and products is not retained. Similarly, the system put into place by both legal documents does not fulfil the requirements of a traceability scheme. Unique identification is not given to trade units, thus hindering their traceability along the supply chain. Furthermore, chain of custody requirements are scant, allowing IUU fish to infiltrate the trade through the exposed links of the chain. Although the two analytical models utilized are preliminary, they can be further developed to improve comprehensiveness and depth of scrutiny. Further, both models are replicable and flexible, as they can be used to analyse any legal text that puts into place a traceability system for the fish supply chain. Model 1 can be applied on single documents required by traceability systems at any critical traceability control point. Model 2 can be used to analyse a self standing traceability system implemented by any company. The models developed and the main findings of the study are of interest to both Community and third-country entities involved in a way or another in IUU fishing deterrence, traceability in fish supply chains or legislation development. Future studies should focus on the design of a traceability system for fishery products that fits the purpose of IUU fishing deterrence under a de *lege ferenda* approach.

Key-words: traceability; IUU fishing; chain of custody; critical control point; EU Regulation 1005/2008; EU Regulation Proposal 2008/0216 (CNS), *de lege lata*.

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ABBREVIATIONS

ACP states - alternately called the Group of African, Caribbean and Pacific countries, are the countries that are signatories of the Lomé Convention with the European Commission (48 African, 16 Caribbean and 15 Pacific countries).

AIS – automatic information system.

CFP - Common Fisheries Policy.

CTCP - critical traceability control point.

EU - European Union.

FAO - Food and Agricultural Organization of the United Nations.

IPOA-IUU - International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

ISO - International Standard Organization.

IUU - illegal, unreported and unregulated .

LU – logistic unit.

MCS – Monitoring, Control and Surveillance.

OECD - Organisation for Economic Co-operation and Development.

RFMO - regional fisheries management organization.

TU – trade unit.

UNCLOS – United Nations Convention on the Law of the Sea.

VDS – vessel detecting system.

VMS – vessel monitoring system.

WWF - World Wildlife Fund for Nature.

1. INTRODUCTION

1.1 Settings

By nature, the extent of un-controlled fishing is difficult to quantify. But, as suggested by the Food and Agricultural Organization of the United Nations (FAO) in 2001, the problem of illegal, unreported and unregulated (IUU) fishing in world fisheries is of serious and increasing concern. Some claim that by the beginning of the 21st Century, almost 30% of the global fish catch could be counted as IUU in its diverse forms, with a total catch value of nearly 1.500 million USD[1]. When confronted with IUU fishing, weak national and regional fisheries management organizations that strive to achieve sound management goals may fail. Possible and logical consequences are the loss of both short and long-term social and economic opportunities, and negative effects on food security and environmental protection. Un-confronted IUU fishing can lead to the collapse of a fishery or seriously impair efforts to rebuild stocks that have already been depleted. Existing international instruments addressing IUU fishing have not been effective due to a lack of political will, priority, capacity and resources to ratify or accede to and implement them[2]. By introducing fish traceability in the fisheries sector, it is believed that it will be possible to check more closely what enters production and what leaves at the other end, confronting thereby IUU fishing, and improving the fisheries management at all levels.

The central notions of the present paper are *IUU fishing* and *traceability*, as defined in the FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (2001), and respectively by the International Standard Organization (ISO) and the European Union (EU).

1.2 Problems to address and research questions

The purpose of this study is to analyse if the traceability related provisions of two new EU legal instruments, the EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS), are relevant and sufficient to prevent and deter IUU fishing and to fulfil the traceability requirements of the chain of custody.

[1] Sumaila, R. (2008).
[2] FAO (2001) 1.

EU Regulation 1005/2008 establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing.

- Type: regulation.
- Date of entry to force: 29.10.2008.
- Date of application: 01.01.2010.
- In what concerns the catch certificate, it applies to all fish to be imported/exported to/from EU.
- It is considered to be one of the most important legal steps in deterring the IUU operations, both inside and outside the Community's waters.

EU Regulation Proposal 2008/0216 (CNS) establishing a Community control system for ensuring compliance with the rules of the Common Fisheries Policy.

- Type: proposal for a regulation.
- Date of entry to force: unknown; it will be the day following its publication in the Official Journal of the EU. Most probably the text will be published in the second semester of 2009.
- Date of application: 01.01.2010. If the norm is not published in the Official Journal of the EU by the end of 2009, its date of application will be postponed.
- It refers to operations related to Community fishing vessels.
- It enforces trade controls that should prevent products obtained through IUU operations from entering the fish supply chain of the EU.

The two legal documents created by the EU were selected for analysis as they constitute the new pillars of the Union's Common Fisheries Policy (CFP). Their impact on the EU relations with third-countries and on the international trade with fishery products is yet not fully assessed. Nevertheless, it is believed that these legal instruments put in place a comprehensive traceability system that will prevent IUU fish entering EU trade, and thus help deterring IUU activities elsewhere, as well.

Related issues such as eco-labelling and genetic traceability are also included in the present analysis, for the sake of relatedness and complementarity.

The following research questions are addressed by this study:

- primary research questions:

- How can a model be developed in order to analyse the connexion between IUU fishing deterrence and the fish traceability put in place by the EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS)?
- What is the law (EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS)) in what concerns traceability issues?
- What are the limitations of the fish traceability put in place by the EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) to deter IUU fishing?

- secondary research questions:

- What is the connexion between eco-labelling and IUU fish traceability?
- What is the connexion between genetic traceability and IUU fishing deterrence?

1.3 Approach

1.3.1 Constraints

Due to the breadth of the topic, the paper will focus only on the theoretical, legal and some operational aspects of the following issues: IUU fishing operations and the relevance of the market/trade management measures; IUU fishing in EU; traceability systems (including eco-labelling and genetic traceability); and the new EU legislation related to deterrence of IUU fishing by means of fish traceability (EU Regulation 1005/2008; EU Regulation Proposal 2008/0216 (CNS)).

It is not an ambition of the present work to address other national or regional policies, legislation or operational initiatives other than those mentioned above. Neither, given the limited scope of the research work, may the paper compare the mentioned EU legislation to other Community traceability related norms, nor assesses its relations to the relevant international law. Moreover, the paper does not describe traceability standards in order to evaluate or improve them, but only to assess if the new EU legal documents meet their requirements. Further, this is a descriptive study and the provision of advice for improvement of the traceability system proposed through the provisions of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) would be out of bounds. Furthermore, the paper does not assess the applicability, the implementation or

enforcement of the regulations. Finally, the paper is not a *de lege ferenda* type of study as it does not provide advice about how the traceability regulations comprised in the two norms should be. What this paper is about, is presenting the law as it is, thus being a *de lege lata* type of study.

1.3.2 Research strategy, theory, hypothesis, objective

The research strategy used is abductive reasoning ("application of traceability entails reduction of IUU fishing") in the context of an interdisciplinary approach that combines data from biology, juridical sciences, forensics, and economics. At the same time, this paper is constructed on the descriptive theory paradigm, therefore it describes and interprets how things are, but not how they should be, starting from the presumption that fish traceability will in the future be the indirect tool of excellence to eliminate IUU fish from the EU trade.

1.3.3 Methodology

In order to achieve the proposed goal, a mixture of qualitative and quantitative methods was used: doctrinal (theoretical) and non-doctrinal (descriptive) legal research; secondary data analysis; qualitative data analysis; case study; informal interviews. In order to achieve the aim of the paper two models were designed. Model 1 was conceived to identify the overlapping of the necessary data for identifying IUU components (actors or products) with the traceability data recorded in the documentation imposed by the legal provisions at each critical traceability control point. Model 2 was designed to identify the fulfilment of the requirements of the chain of custody along the traceability control points. Identifiers of IUU fishing activities were constructed, necessary traceability parameters were included, critical traceability control points were identified along the fishery products chain of custody, and chain of custody standards were designated. All these entries were plotted against the new legal requirements, and the qualitative rating displayed in case-ordered predictor-outcome N-way matrices. The specific methodology followed in order to construct the analytical models is presented in Chapter 4.

1.4 Structure of the paper

Chapter 2 defines IUU fishing, illustrates the actual extension of the problem, and describes its drivers and market/trade counter-measures, all with the purpose of framing the conditions for proper application of traceability schemes.

Chapter 3 defines traceability, circumscribes its drivers, its legal framework, standards, certification schemes, and implications for eco-labelling. The conventional traceability system is described and some analytical methods are exemplified in order to first understand this general concept before finding its application in fisheries management.

Following the presentation of general issues related to IUU operations and traceability, an attempt to intersect the two and define their common grounds within the framework of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) is made in *Chapter 4*. The analysis and discussion sections identify how the new legal provisions deal with traceability in connexion with IUU fishing deterrence, and if they fit the purpose they were designed for. A comprehensive model that summarizes the findings displayed in matrices is designed. Finally, the findings of the two Models, the connexions between eco-labelling and IUU fish traceability, and genetic traceability and IUU fishing deterrence are addressed in *Chapter 5*.

2. ILLEGAL, UNREPORTED AND UNREGULATED FISHING

2.1 Background

2.1.1 Definitions

Commonly referred to as "pirate fishing", the illegal, unreported and unregulated (IUU) fishing comprises a broad range of activities[3], and a more specific characterization of the term is called upon. Domestically, fishing without a licence, out of season, or prohibited species, using banned types of fishing gear, catching more fish than is allowed, and not reporting or misreporting catch weights are all examples of deceitful behaviour and IUU activities. Internationally, fishing contrary to the fisheries conservation and management measures of a regional fisheries management organization (RFMO), or fishing in a State's jurisdictional waters without authorization, are more examples of IUU fishing.

The only internationally agreed definition of IUU fishing is found in the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), a voluntary binding instrument adopted by the Food and Agricultural Organisation of the United Nations (FAO) in 2001. This followed from the framework set by the FAO Code of Conduct for Responsible Fisheries (1995). Later, in 2008, the European Union (EU) agreed upon a similar definition of IUU fishing, which was included in the Council Regulation 1005/2008[4] establishing a Community system to prevent, deter and eliminate IUU fishing.

According to the provisions of Article 3 IPOA-IUU[5], the following fishing activities are considered as illegal: fishing "conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations; fishing conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or in violation

[3] EJF (2005), page 2.
[4] Council Regulation (EC) No 1005/2008 of 29.10.2008 establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing, amending Regulations (EEC) No 2847/93, (EC) No 1936/2001 and (EC) No 601/2004 and repealing Regulations (EC) No 1093/94 and (EC) No 1447/1999, published in on 29.10.2008 in the Official Journal of the European Union L 286/1.
[5] FAO (2001) 1.

of national laws or international obligations, including those undertaken by co-operating States to a relevant regional fisheries management organization."

Fishing activities "which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization" are defined as unreported.

According to the same provisions, fishing activities "in the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization" are considered unregulated. Likewise are considered fishing activities "in areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law".

Taking a step forward, the EU Regulation 1005/2008 widens in Article 3(1) the concept of fishing vessel engaged in IUU fishing, by presuming that a fishing vessel is carrying out this kind of activities if it is proved that:

- it has falsified or concealed its markings, identity or registration;
- concealed, tampered with or disposed of evidence relating to an investigation;
- obstructed the work of inspectors checking compliance with applicable conservation and management measures;
- transhipped or landed undersized fish;
- transhipped from, supported ore re-supplied other fishing vessels identified as having engaged in IUU fishing.

Figure 1 is an illustration of types of IUU fishing based on the above definitions. Within an EEZ, there may be unlicensed fishing (poaching), under- or non-reported, or unauthorised fishing by area, season, gear, quota or species. Outside EEZs there may be non-compliance with an RFMO, or there may be unregulated fishing outside the area of an RFMO. Many RFMOs also cover adjoining EEZ waters, but the primary jurisdiction in these cases remains that of the coastal state so the RFMO was drawn as bounding on EEZ waters.[6]

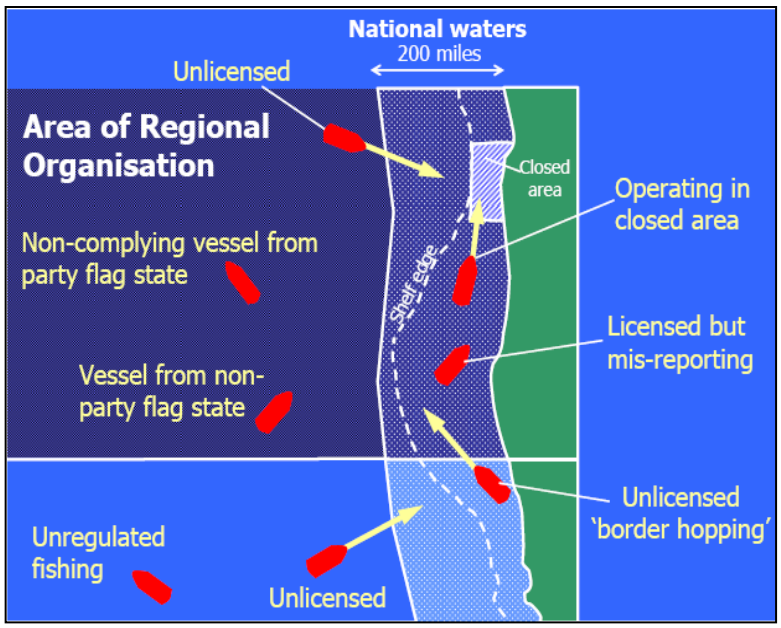


Figure 1[7]**:** Illustration of types of IUU fishing activities.

Although the seriousness of infraction may vary from fishery to fishery, the extent of IUU fishing is not insignificant: it has been estimated that almost 25% of the fish landed in 2004 was caught in a manner that can be defined as IUU fishing[8] (Figure 2).

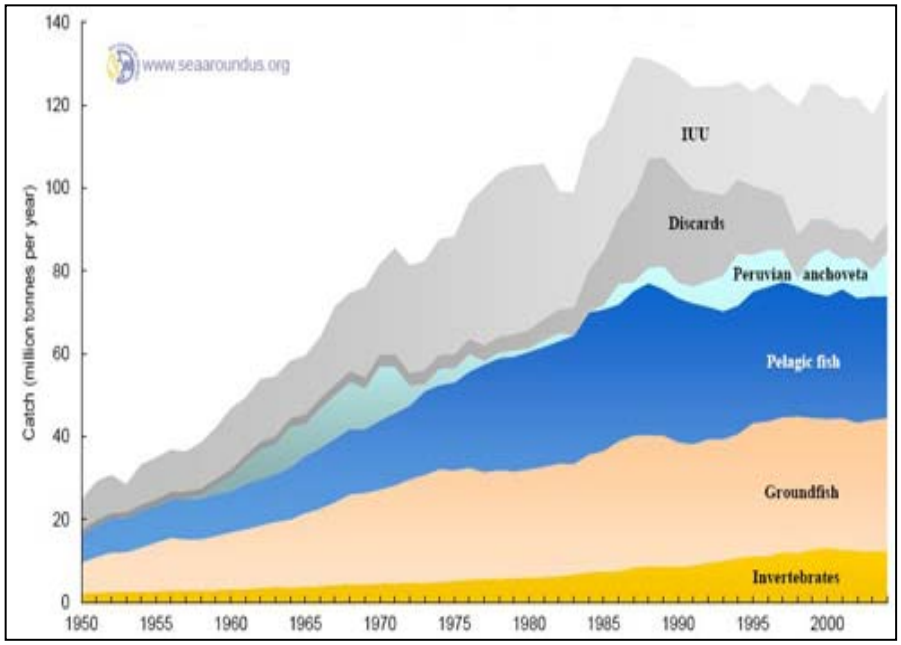


Figure 2[9]**:** Estimated global fish landings 1950-2004, including estimates of different types of IUU fishing.

[6] MRAG (2005), page 11.
[7] MRAG (2005), page 11.
[8] MRAG & University of British Columbia (2008), page 17.
[9] Sumaila, R. (2008), page 5.

2.1.2 State of art in IUU fishing[10]

In its broadest sense, IUU fishing is a worldwide issue, affecting both domestic waters and high seas, all types of fishing vessels, regardless of their size or type of gear, and a multitude of species, with global (*e.g.* tuna and tuna-like species) or local (*e.g.* Patagonian toothfish) impact (Figure 3). As underlined by FAO already in 2001[11], IUU fishing undermines efforts to conserve and manage fish stocks in many regulated fisheries. When confronted with this problem, national and regional fisheries management organizations can fail to achieve management goals, the situation ultimately leading to the collapse of a fishery, or seriously impairing efforts to rebuild depleted stocks. In addition, IUU fishing activities may have negative impacts on the marine ecosystem, through their direct or indirect effects on the populations of seabirds, marine mammals, sea turtles and bio-diversity as a whole (discards, by-catch).

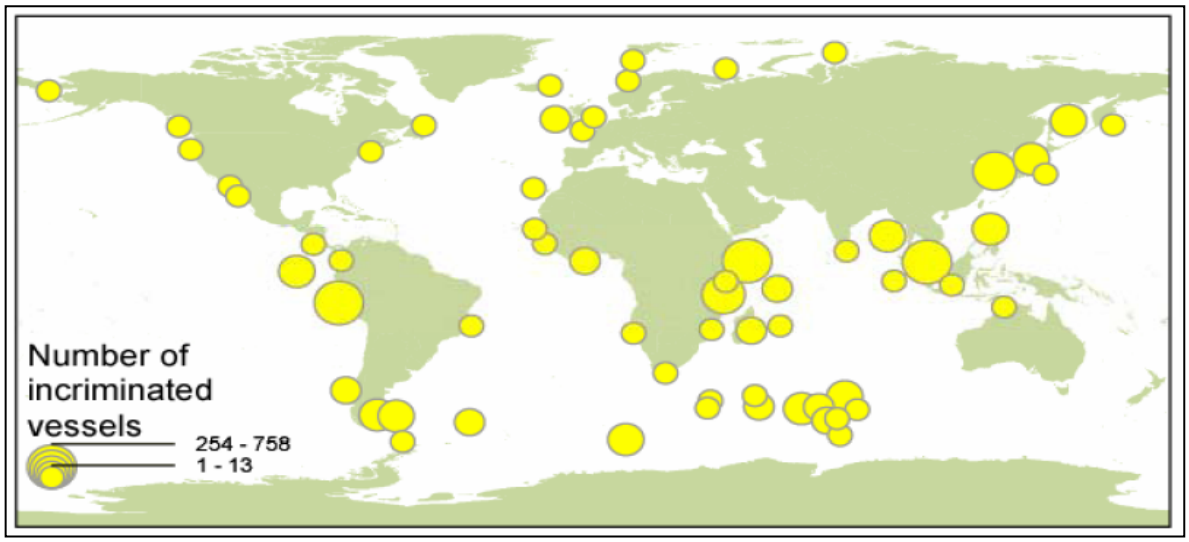


Figure 3[12]: Global incidence of illegal fishing (based on data from 1980-2003).

Moreover, IUU fishing may alter competition and put at risk the economic survival of those who fish in accordance with the law and in compliance with relevant conservation and management measures. Therefore, IUU fishing may bear important social costs, affecting the food-security and livelihoods of fishing-dependent countries and communities. Because many of the crewmembers on IUU fishing vessels are themselves from poor and underdeveloped regions, often working in inadequate social and safety

[10] Based on OECD (2004), pages 11-12.
[11] FAO (2001) 1.
[12] Sumaila, R. (2008), page 8.

conditions, the socio-economic problem is two-sided and complex. For an overview of the most important indicators and shocks borne of IUU fishing activities, see Appendix 1.

One conclusion reached by the Organisation for Economic Co-operation and Development (OECD) Workshop on IUU fishing activities (2004) is that IUU fishing is a dynamic and multi-faceted problem, and that no single strategy is sufficient to eliminate or reduce it. Therefore, a concerted and multi-divided approach is required nationally, regionally and internationally, and by type of fishery. In order to find viable solutions to the IUU fishing problem, all actors should be involved in the process: governments, communities, NGOs, and the private sector.

The FAO IPOA-IUU contains tools to tackle the IUU fishing issue, but the question is to find better ways to implement these tools and to make all countries (developed or developing) responsible in complying with their duties as flag states, port states, coastal states, states of vessel owners and trading nations.

2.1.3 The extent of IUU fishing in EU

Marine fishing and associated processing and commerce are important industries for a number of coastal communities in the EU. IUU fishing, in various forms, is a significant threat to achieving biologically sustainable fisheries and a serious management problem for a large number of the fisheries on which these industries and coastal communities depend. As shown in Figure 4, the IUU fishing activities bear a high social, economical and environmental cost, as the percentage of fish caught in activities defined as IUU fishing is considerably high (Figure 5).

The volume of illegal fisheries products imported each year into the EU has been assessed to amount approximately 500.000 tons for a value of 1,1 billion euro[13] regardless if the place of capture was inside or outside the Community's waters.

[13] http://www.eubusiness.com/Fisheries/iuu-fishing-eu/ (accessed: 07.05.2009).

Figure 4[14]: Summary of estimated IUU fishing costs of all EU Member States for the IUU activities carried in EU's waters.

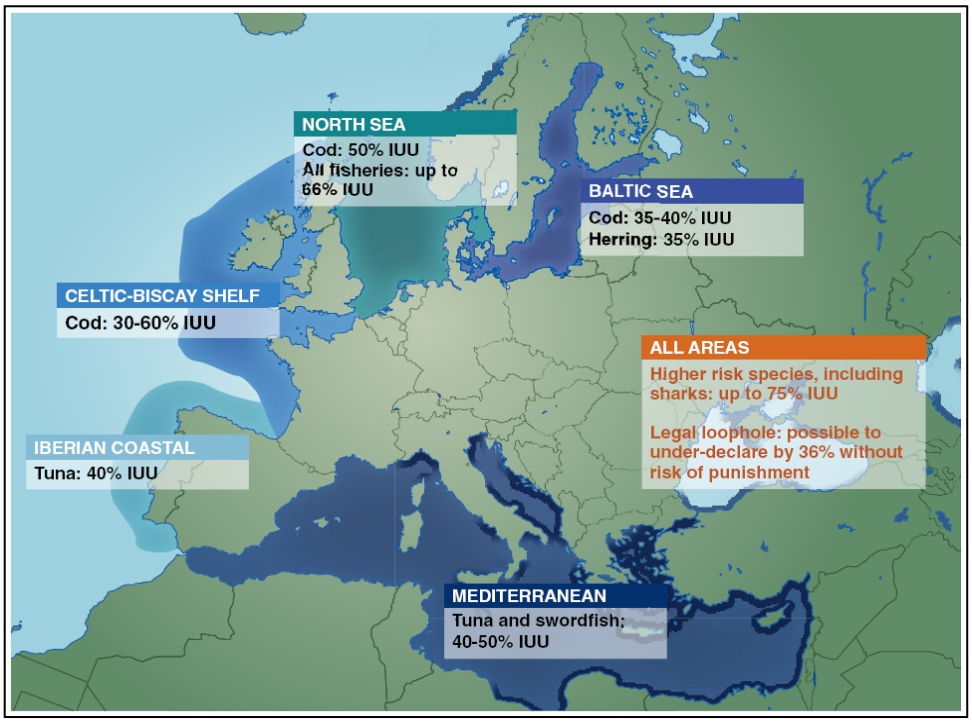


Figure 5[15]: The Large Marine Ecosystems adjacent to the coastlines of EU Member States and the amount of IUU fishing activities done by EU and non-EU vessels inside EU's EEZs (IUU rates are expressed as a percentage of a fishery's total catch).

[14] EFTEC (2008), page 69. The study reviews evidence on the rates of IUU fishing in European waters, and on the costs associated with IUU fishing activities. The study develops a simulation model for fisheries at the Large Marine Ecosystem (LME) scale, using a surplus production model applied at the level of key commercial groups (cod-likes, perch-likes, herring-likes, tuna and billfishes) in each LME, representing 46% of the value of European fishing.

[15] EFTEC (2008), page 9.

2.2 Drivers of IUU fishing activities

Attempts have been made to identify and address the drivers of IUU fishing, with particular regard to its illegal and unreported (IU) components. Starting from the precept that "expected profits from IUU fishing = expected benefits from IUU - expected costs of IUU", in 2005, the OECD's Committee for Fisheries identified groups of important economic and social drivers of IUU fishing activities (Appendix 2). Among these, the market value of the IUU fish can be considered the decisive one, as without it most of the others would be annihilated.

Responses in the global survey demonstrate the significant economic gains available through IUU fishing. Demand for fish as a healthy, wholesome food is increasing in all parts of the world and, in a paradoxal way, the more legal fishing is constrained by catch and effort limits – as the overall state of global fish stocks requires in many cases – the greater the motivation for and gains from IUU fishing.[16]

Since there are strong economic drivers for IUU fishing, and it occurs in situations of poor fisheries management and control, one might expect that the level of illegal fishing should be related mostly to fish price, governance and indicators of the control problem, such as the area of a country's EEZ and the number of patrol vessels at its disposal. In fact, in a study conducted in 2008[17] with respect to illegal and unreported fishing, no significant relationship was found between these activities and the price of fish or the size of the EEZ or of the fishery. Nevertheless, a significant relationship between the IU fishing and the World Bank governance indicators could be established for all fisheries across Africa, Asia and Europe (Figure 6).

The result does not imply that developing countries with poor governance records are necessarily to blame for IU fishing, but that they are more vulnerable to this kind of activities, conducted by both their own fishermen and vessels from distant water fishing nations (*e.g.* fishing vessels from China, EU or Russia conducting IU activities in African states waters). This represents a failure of control on behalf of the flag state as well as the coastal state.

[16] Bray, K (2000), page 1.
[17] Agnew, DJ; Pearce, J.; Pramod, G.; Peatman, T; Watson, R. et al. (2009).

Furthermore, many vessels engaged in both illegal and unreported activities on one hand, and unregulated on the other, are registered under "flags of convenience" states. While these states are in most cases developing countries, the vessels themselves are usually owned and operated by developed countries companies.

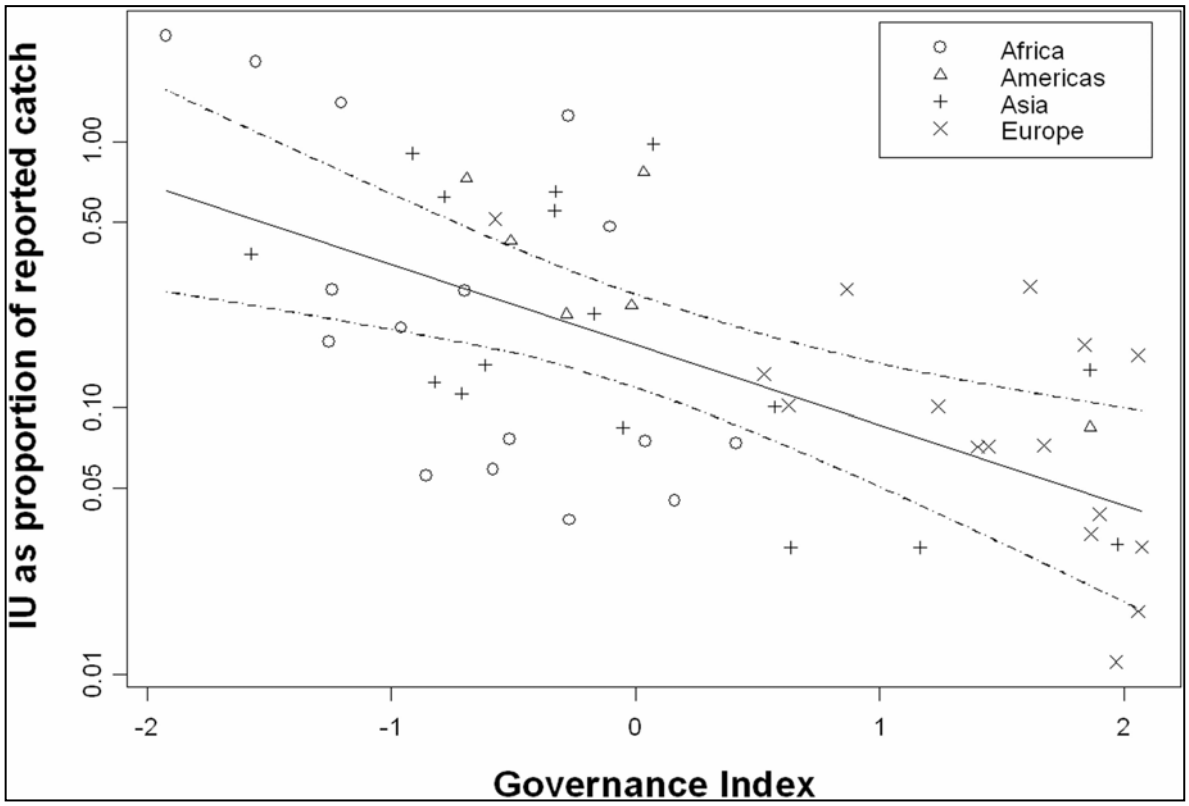


Figure 6[18]: Relationship between the amount of illegal and un-reported fishing (expressed as a proportion of the reported catch that is additionally taken as illegal and unreported catch) and an average of four World Bank indices of governance (Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption), measured in 2003.

2.3 Management measures in place against IUU fishing

Even though the high seas are open to all states, the freedom to fish is limited by the basic conditions set out in the UN Convention on the Law of the Sea (UNCLOS) (1982). In addition to UNCLOS, the current international instruments related to high seas fisheries are the FAO Compliance Agreement (1993), the UN Fish Stock Agreement (1995), the FAO Code of Conduct for Responsible Fisheries (1995), and the FAO IPOA - IUU (2001). While the first two are legally binding international instruments containing requirements

[18] Agnew, DJ; Pearce, J.; Pramod, G.; Peatman, T; Watson, R. et al. (2009).

relating to flag State responsibilities, compliance and enforcement, the last two are voluntary and management-oriented instruments.

Analysing the structure of an IUU operation (Figure 7), one can break down this kind of process into three segments[19], and each of them can be targeted by measures specially designed for it:

- first, *fishing vessel activity* segment, from vessel registration to landing of fish at a port. This is the "at sea" segment, which corresponds largely to what is understood by "IUU fishing".
- second, the *logistical* aspect of an IUU operation addresses the organisation of supplies and services (re-fuelling, transhipment, change of crew etc.).
- third, the *catch/product* in trade and market segment. This is where income-flows occur and net incomes are generated, and this is the main purpose and driving force for IUU operations.

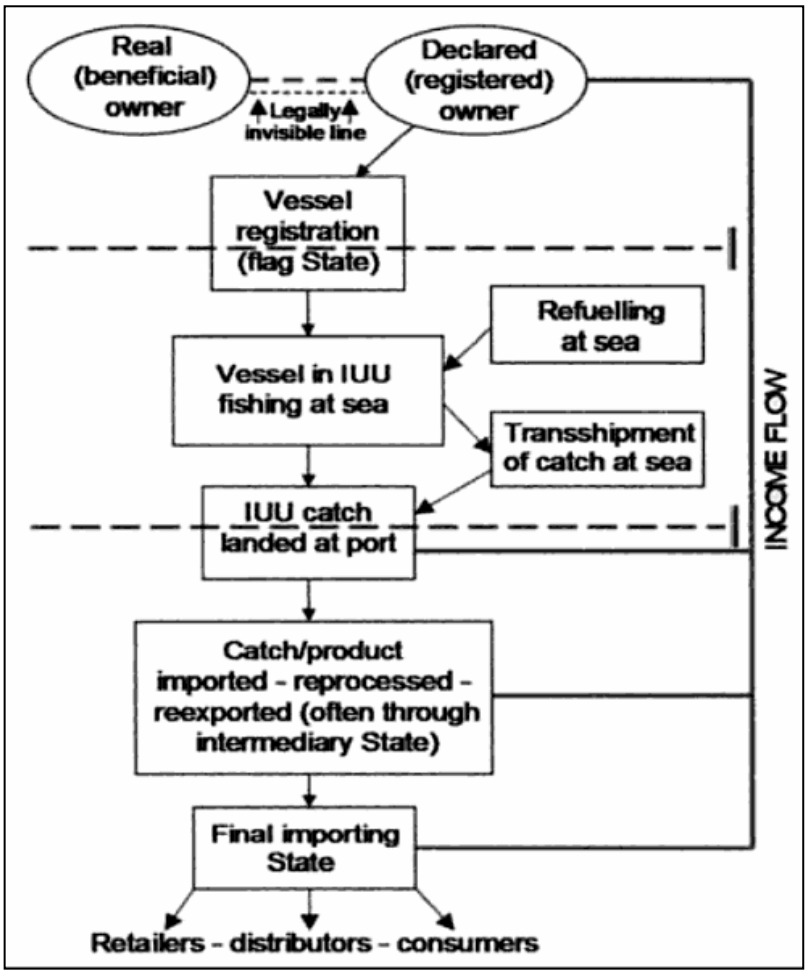


Figure 7[20]. The chain of IUU fishing operations.

A management measure configured to address an IUU operation effectively would need to deal with all three segments of the phenomenon, and would have to exploit potentials to cut across these segments. Appendix 3 provides an overview of the most important tools against IUU operations based on FAO Code of Conduct and FAO IPOA-IUU.

[19] OECD (2004), page 22.
[20] OECD (2004), page 21.

Among these tools, the market and trade related measures have a clear potential to address all the three aspects of the IUU operation. For example, by improvement of the transparency of the markets in order to allow the traceability of fish and fish products, IUU fish can be stopped form entering the trade (segment 3). At the same time, important information about IUU actors (vessel owners, beneficial ownership, importers, buyers, consumers, bankers, insurers, transhippers, equipment suppliers; IUU ports, IUU vessels) can be retrieved in order to eliminate them from fishing operations (segments 1 and 2).
The traceability of fish and fish products can be enhanced by introducing mandatory controls of importation and exportation of goods (catch certification and trade documentation requirements), and import and export restrictions and prohibitions whose violation could be tracked. Eco-labelling could also be one cross-cut measure, as the certification of a fishery guarantees the absence of IUU activities at sea (segments 1 and 2), and the product chain of custody certification ensures that only non-IUU fishing products enter the trade (segment 3).

2.4 Compliance with FAO Code of Conduct for Responsible Fisheries requirements with respect to IU fishing[21]

The FAO Code of Conduct, together with the FAO IPOA-IUU, is considered one of the most important instrument containing tools to address IUU fishing. In 2005, WWF and the University of British Columbia Fisheries Centre initiated a project to assess the Code's implementation, applying a consistent assessment protocol to data for 2003-2005 to 53 countries, representing over 95% of the world's wild fisheries catch.

The conclusion of the report is that none of the 53 countries achieves what was considered a "good" score of 70% or more (Figure 7). Only six countries (11%) have overall compliance scores whose confidence limits overlap 60% (Norway, USA, Canada, Australia, Iceland, Namibia). This means that, ten years after the Code of Conduct was agreed, there was a lot of space for improvement of governance and compliance even among those countries at the top end of the rankings. At the lower end, the alarming finding is that 28 countries (53%) had "fail grades" of less than 40% (Peru, Poland, India, Ghana, Taiwan, Latvia, Philippines, Brazil, Argentina, Morocco, Pakistan, Russia, Senegal, Ecuador, Indonesia, Iran, Thailand, Ukraine, Sri Lanka, Viet Nam, Turkey,

[21] Based on Pitcher, T. J.; Kalikoski, D.; Pramod, G. and Short, K. (2008).

Bangladesh, Egypt, Yemen, Nigeria, Angola, Myanmar, North Korea). In the middle range, disappointing scores were obtained by most developed European nations with the undoubted resources and know-how to implement the Code. This reinforces the impression of the low political priority given to improving fisheries management internationally. Some developing countries score as fairly in the implementation of the Code as a developed European country, indicating that elements of good fishery management can be achieved even with limited resources. A negative relationship with a marine biodiversity index suggests that management is weakest in the most species rich jurisdictions. Although it is expected that the biodiversity index would be confounded with both economic and governance indicators ("poor countries are richer in biodiversity"), this fact suggests that implementation of good practices is easier where fisheries target intensively a lower number of species.

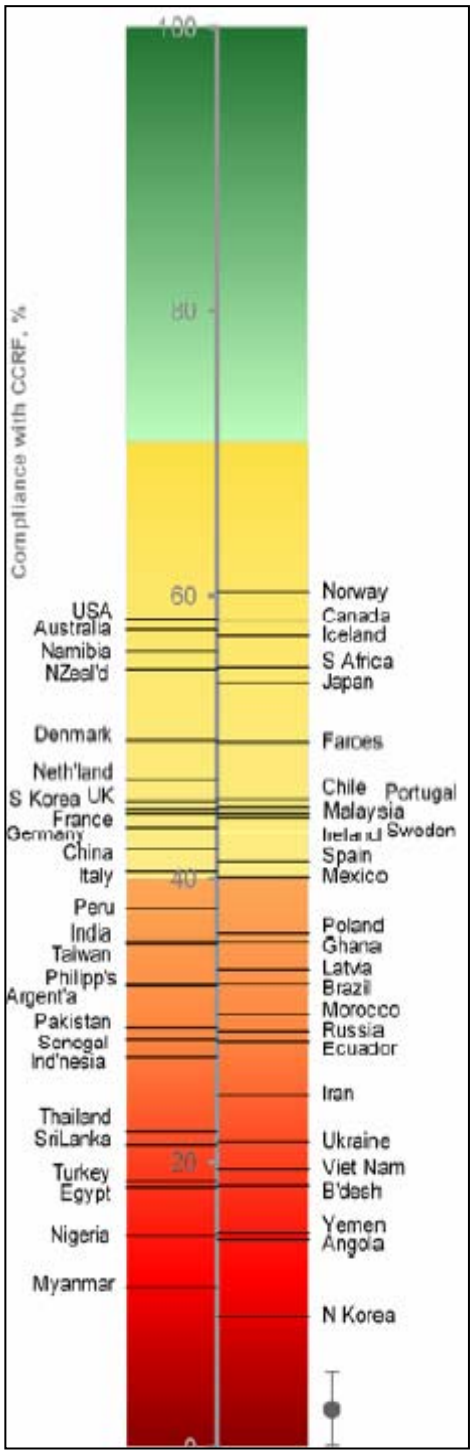


Figure 8[22]. "Codeometer" showing estimated overall compliance of the top 53 marine fishing countries FAO Code of Conduct for Responsible Fisheries. Colours indicate good scores (70% and over), fail scores (40% and below) and intermediate values.

In what concerns the compliance with the Code in terms of measures to be taken for deterring IUU fishing, the same report estimates that only 26% of the countries deal reasonably with illegal fishing activities, while most countries (60%) address the problem unsatisfactorily (Figure 9). It is worth to note that among the countries rated to effectively tackle illegal fishing there are only three EU states (out of 11 included in the study), and two EEA states.

[22] Pitcher, T. J.; Kalikoski, D.; Pramod, G. and Short, K. (2008), page 8.

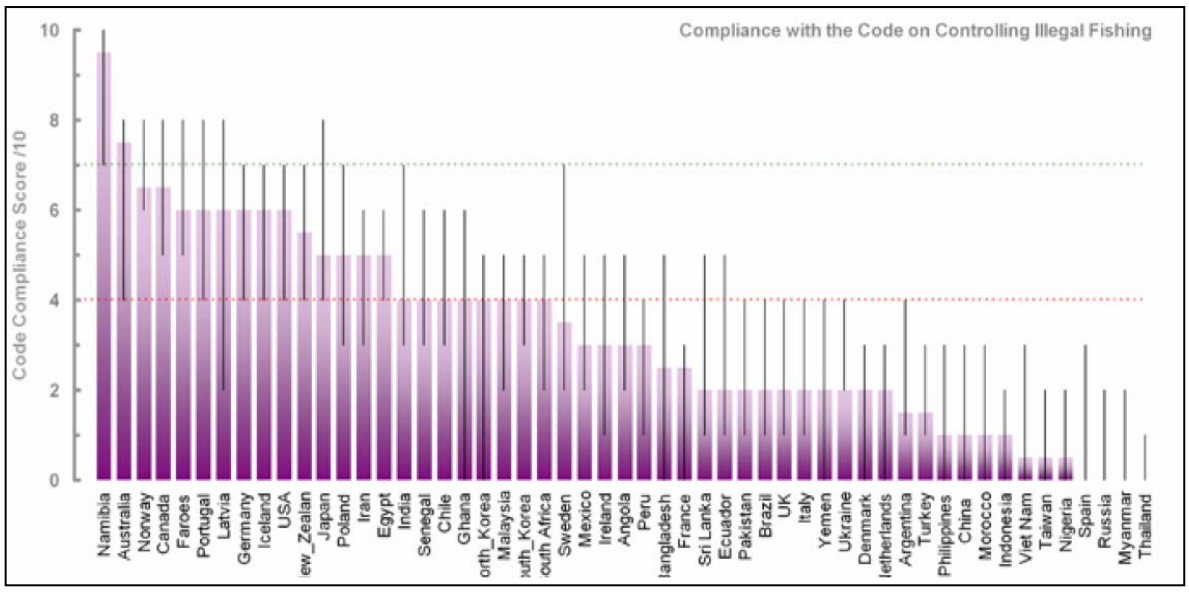


Figure 9[23]. Bar chart showing compliance with the Code of Conduct in controlling illegal fishing for the 53 top fishing countries. Broken lines: green denotes "good" compliance rating; red denotes "fail" rating. Note that even though the chart refers to illegal fishing, the study analyses it in terms of IUU fishing. There is sometimes confusion in the terminology, and issues are often confounded, but this should not detract from the generality of the results of the study cited.

The results obtained by this study with respect to EU member states can be correlated with the ones found by another 2008 study[24] that focused only on IUU fishing activities carried out inside Community's waters. As shown in Figure 10, a high proportion of illegal activities[25] take part in EU Member States. This goes together with a relatively poor score by EU Member States for their ability to control illegal fishing (Figure 11), substantially worse than the scores for Iceland and Norway (EEA countries), and similar or little better than for Morocco (developing country) and Turkey (intermediate country).

[23] Pitcher, T. J.; Kalikoski, D.; Pramod, G. and Short, K. (2008), page 13.
[24] EFTEC (2008). The study refers in this particular case of relating EU Member States fishing activities with IUU fishing to the Pitcher T, Kalikoski, D and Pramod, G (2008) "Evaluations of Compliance with the FAO (UN)
Code of Conduct for Responsible Fisheries" study available at www.fisheries.ubc.ca/publications/reports/report14_2.php. This later one used 44 questions for each country in which scoring was based on the assessment of 2332 separate analyses including: national legislation, international treaties, country synopses from FAO, country reports to FAO and by NGOs, websites of national fisheries agencies, NGO websites, literature, and information from fisheries experts.
[25] One should bear in mind that even though the figures relate only to illegal fishing, the study refers to them as connected to IUU fishing. As in the previous case, there is sometimes confusion in the terminology, and issues are often confounded, but this should not detract from the generality of the results of the study cited.

When analysing the figures, one should not pay attention to the exact scoring (*e.g.* score 10 for Spain in Figure 10 would imply that 100% of the Spanish fishing fleet is undertaking illegal activities inside the Community's waters), but to its overall significance (*e.g.* in Figure 10 the important issue is that too many of EU vessels are engaged in illegal operations inside the Community's waters).

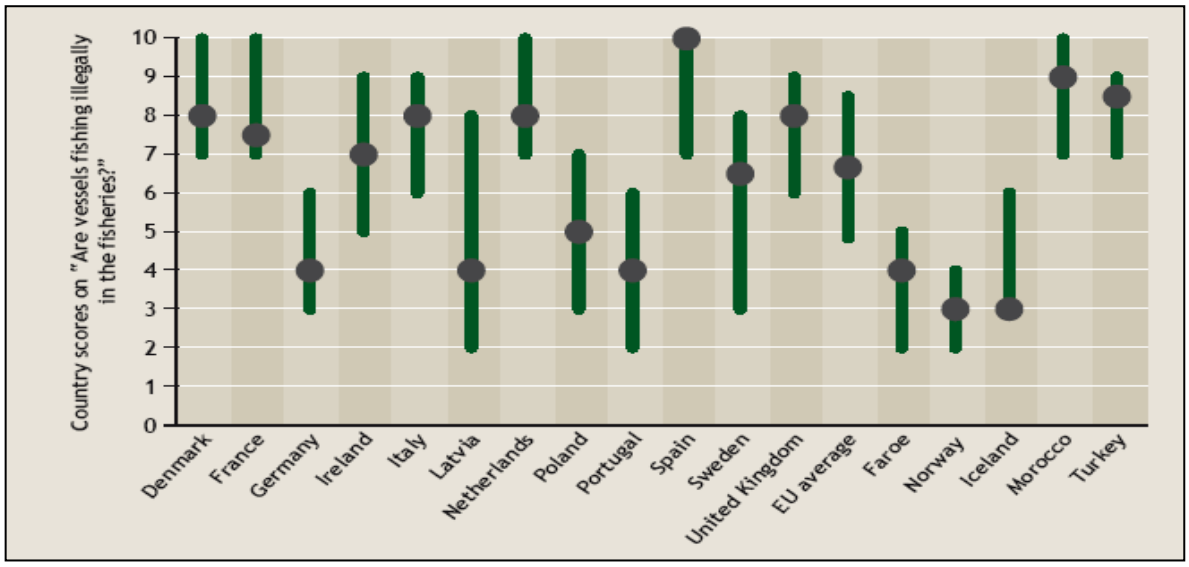


Figure 10[26]. Country scores on "Are vessels fishing illegally in the fisheries?" Bars indicate ranges of scores in the study.

Member States' scores for the effectiveness of observer schemes, catch inspections, and vessel monitoring are 5.8, 4.5 and 4.8 respectively out of 10 (Figure 12), reflecting a poor standard of enforcement within the EU as compared to those enforced by the neighbouring EEA fishing countries in their home waters. As underlined in the report, the EU low to moderate standards of enforcement and follow-up influence the risk of detection of IUU activity and the expected penalties, which in turn lower the expected costs of engaging in IUU fishing.

[26] EFTEC (2008), page 18.

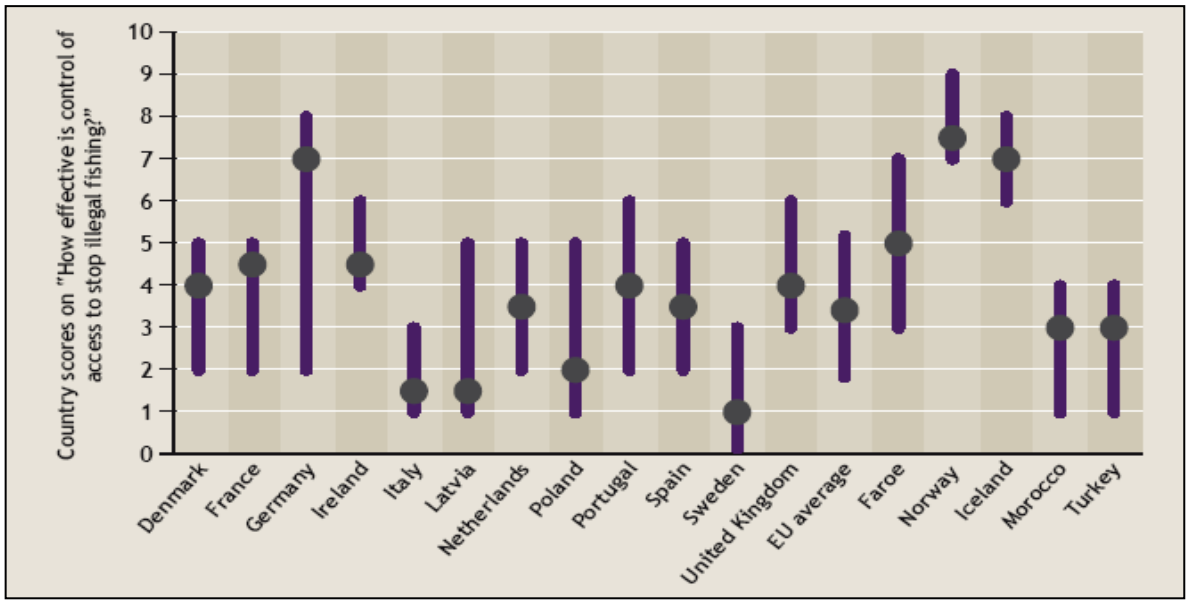


Figure 11[27]: Countries scores on "How effective is control of access to stop illegal fishing?"

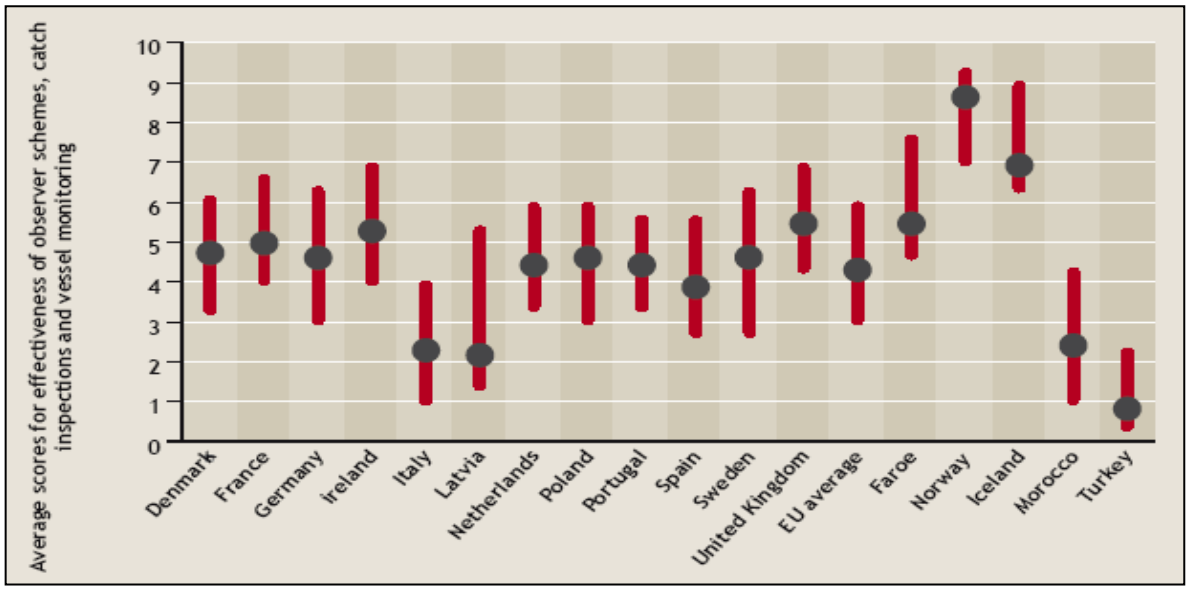


Figure 12[28]. Average scores for effectiveness of observer schemes, catch inspections and vessel monitoring.

All these results should be read critically, as the severity of the infractions is not clearly defined in such an aggregated presentation of findings. However, in a cross-sectional perspective (across countries), the contrasting trend between illegal fishing (and by extension, of other forms of IUU) and the level of control and surveillance is clear.

[27] EFTEC (2008), page 18.
[28] EFTEC (2008), page 15.

In summary, at the core of the IUU fishing issue lays a number of drivers that Member States and the Community must seriously address. In the EU context, this encompasses such known problems as over-capacity, tradition and lack of alternatives to fishing by some, and a high demand for fish products by a generally wealthy population. The later also creates a drive to the import of IUU international fish commodities along food supply chains. It is also becoming increasingly evident that adequate control and surveillance, including aspects related to traceability, have a complementary role to play in the deterrence and prevention of irresponsible fishing.

3. TRACEABILITY

3.1 Definitions of traceability, categories and drivers

3.1.1 Definitions

Even though the concept of traceability is relatively new, its acception changed in time. Therefore, different institutions with authority in this domain are still trying to thoroughly circumscribe it, as specialists in traceability are not really in full agreement with what traceability is and what is not.[29]

a. International Organization of Standardization (ISO)

One of the first definitions of traceability, a very practical one and often used, is found in the international standard ISO 8402:1994 Quality management and quality assurance – Vocabulary: traceability is "the ability to trace the history, application or location *of an entity by means of recorded identifications*" (my italics). In 2000, the International Organisation for Standardization withdrew this standard, replacing it with ISO 9000:2000 Quality management systems - Guidelines for performance improvements, where traceability is defined in a less specific way as being "the ability to trace the history, application or location *of that which is under consideration*" (my italics). Both standards include an additional clause which states that when relating to products, traceability specifically entails "the origin of materials and parts, the processing history, and the distribution and location of the product after delivery". The difference between the two definitions is that in the newer one "recorded identifications" are no longer mentioned. According to ISO 8402, objective methods or instruments that give immediate values for entity properties (for instance, devices that measure fat, water content, alcohol content, colour, salinity etc. in food items) did not provide traceability. In contrast, according to the new definition of ISO 9000, they offer traceability. Therefore, sometimes, the objective methods and instruments are considered to provide traceability control mechanisms rather than traceability as such. For example, they are used to verify the claims made in the recorded identifications.[30]

[29] Discussions during Workshop "Harmonizing methods for food traceability process mapping and cost/benefit calculations related to implementation of electronic traceability systems", NOFIMA, Tromsø, Norway, 25-26.02.2009.
[30] http://www.tracefood.org/index.php/ (accessed: 18.04.2008).

b. European Union

Resembling more with the newer ISO standard, the European Community Regulation 178/2002 General principles and requirements of food law defines traceability in Article 3(15) as "the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution".[31]

c. FAO/WHO Codex Alimentarius

Citing the Procedural Manual developed by the Codex Alimentarius Commission, the CAC/GL 60-2006 standard developed by FAO/WHO defines traceability/product tracing as "the ability to follow the movement of a food through specified stage(s) of production, processing and distribution"[32], thus being closer to the newer ISO standard.

3.1.2 Categories

Traceability can be distinguished into two interrelated categories: internal traceability and external or chain traceability[33], graphically depicted in Figure 13.

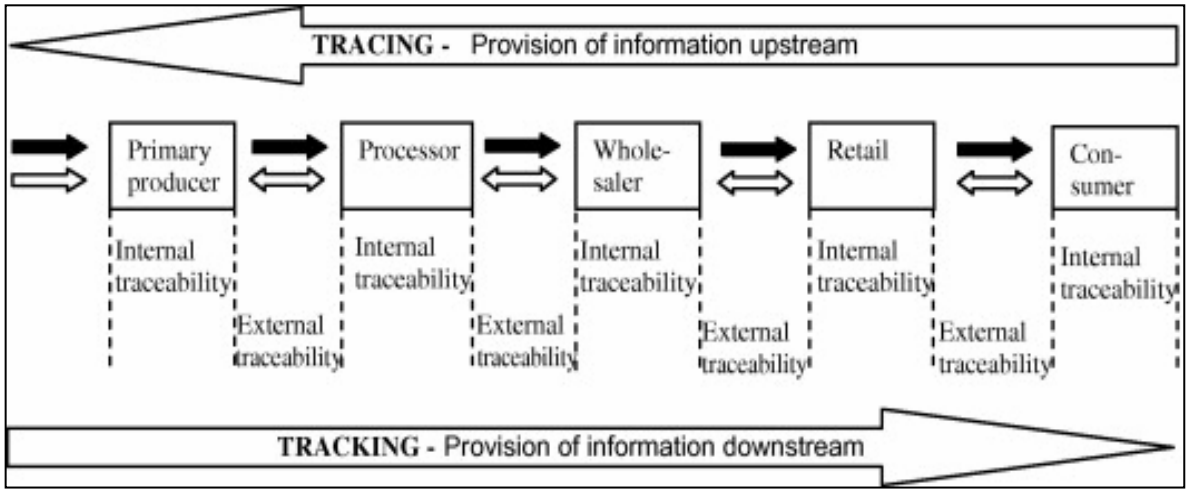


Figure 13.[34] Traceability along the food supply chain. Filled arrows show the product flow; open arrows show the information flow.

[31] OJ L31/1/ 2002, page 8.
[32] CAC/GL 60-2006, page 1, at http://www.codexalimentarius.net/web/standard_list.do?lang=en (accessed: 18.04.2009), and FAO/WHO (2008), page 20.
[33] http://www.tracefood.org/index.php/ (accessed: 18.04.2008).
[34] Randrup, M. et al. (2008), page 1065.

Internal traceability refers to the ability to keep track of what happens to a product, its ingredients and packaging within a company or production facility. For example, when a company receives a box of mackerel, and uses the fish to produce flavoured smoked mackerel, it has to keep records from whom the fish was received, if the fish was divided in batches or mixed with other received raw material, what smoking process was used (cold or warm smoking), what ingredients were used and where did they come from, where the finished product packing came from, where the finished product goes. External traceability refers to the ability to keep track of what happens to a product, its ingredients and packaging in the entire or part of a supply chain[35]. For example, if a customer in a supermarket wants to know if the purchased fish was caught by trawl or long line, it should be possible to find this information with an external traceability system.

Using a metaphor[36], the concept of traceability can be compared with a train track that crosses all the points of the supply chain (harvesting - primary processor - secondary processor - retailer), while the train carriages are the information retained at each of these points by means of internal traceability. Traceability downstream (back) can be called "tracing" and upstream (forward) "tracking"[37].

In practice, the term traceability can be used in distinct contexts, each with a different implied sense[38]:

1. *Product*; it may relate materials, their origin, processing history, and their distribution and location after delivery.
2. *Data*; it relates calculations and data generated throughout the quality loop, sometimes back to the requirements for quality; it relates to transformation information (identification+transformation relations) and product information (origin+processing history+location).[39]
3. *IT and programming*; it relates design and implementation back to the requirements for a system.

[35] The *supply chain* can be defined as "the entire chain the product travels through from raw materials to consumption" (http://www.bordbiavantage.ie/bordbia/preview.asp?pid=3&mid=11&cid=37&id=37; accessed: 18.04.2009).
[36] Olsen, P. (2009) 1, page 8.
[37] Aarnisalo, K.; Heiskanen, S.; Jaakkola, K.; Landor, E. and Raaska, L. (2007), page 8.
[38] Moe, T. (1998), page 211.
[39] Karlsen, K.M.; Olsen, P. and Storøy, J. (2006), page 19.

Figure 14 shows the integrant components of traceability, and their relations.

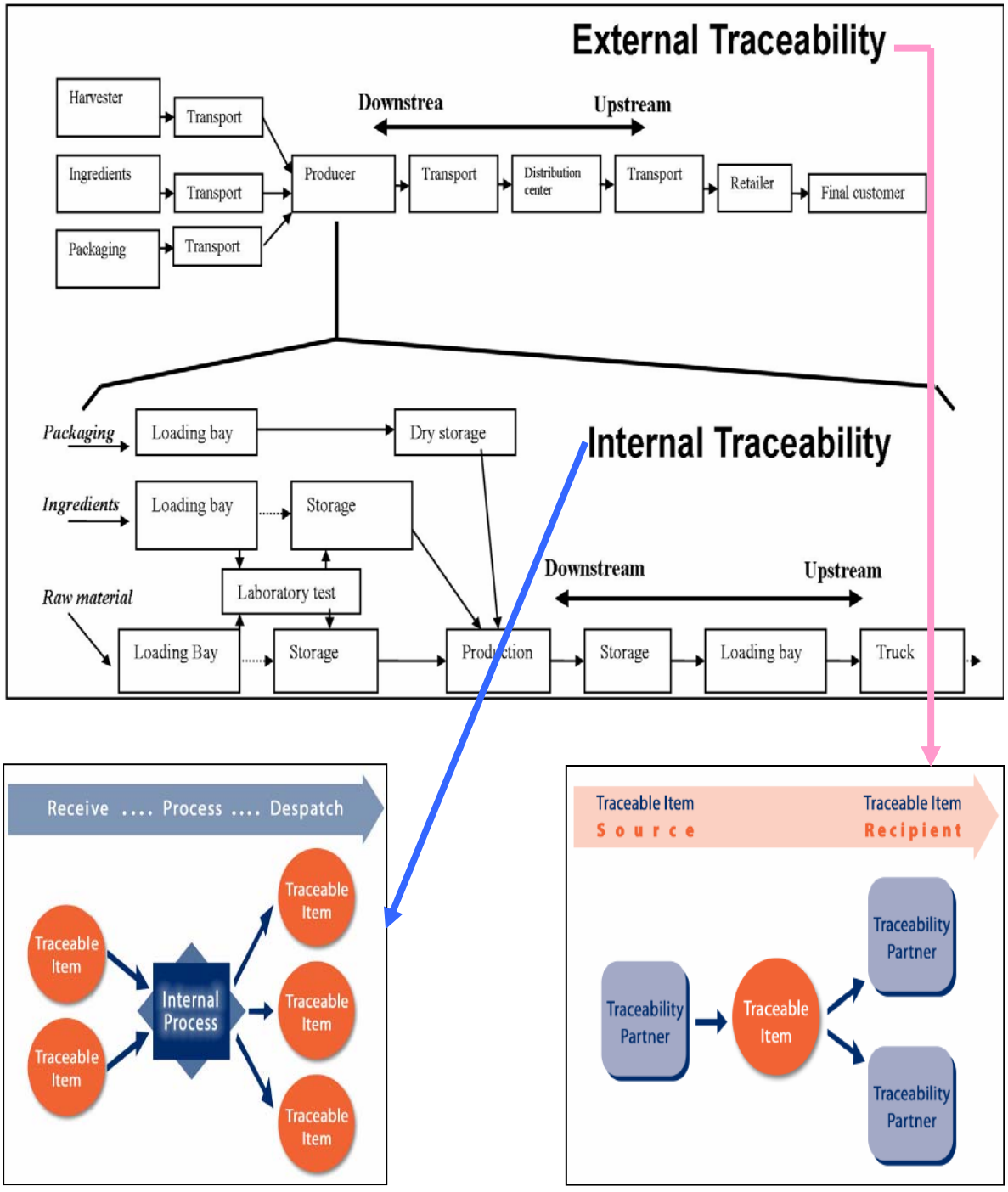


Figure 14.[40] External and internal traceability, downstream and upstream.

[40] Adapted from http://www.sporfori.fo/InEnglish/Ontraceability/InternalExternalTraceability/tabid/109/Default.aspx (accessed: 18.04.2009) and GS1 - *The GS1 Traceability Standard: What you need to know*, at www.gs1.org (accessed: 18.04.2009).

3.1.3 Drivers

There are different drivers for traceability in food supply chains, including fish and fish products ones. These drivers circumscribe the requirements for the identification and information systems.[41] Figure 15 shows these drivers and their inter-relations.

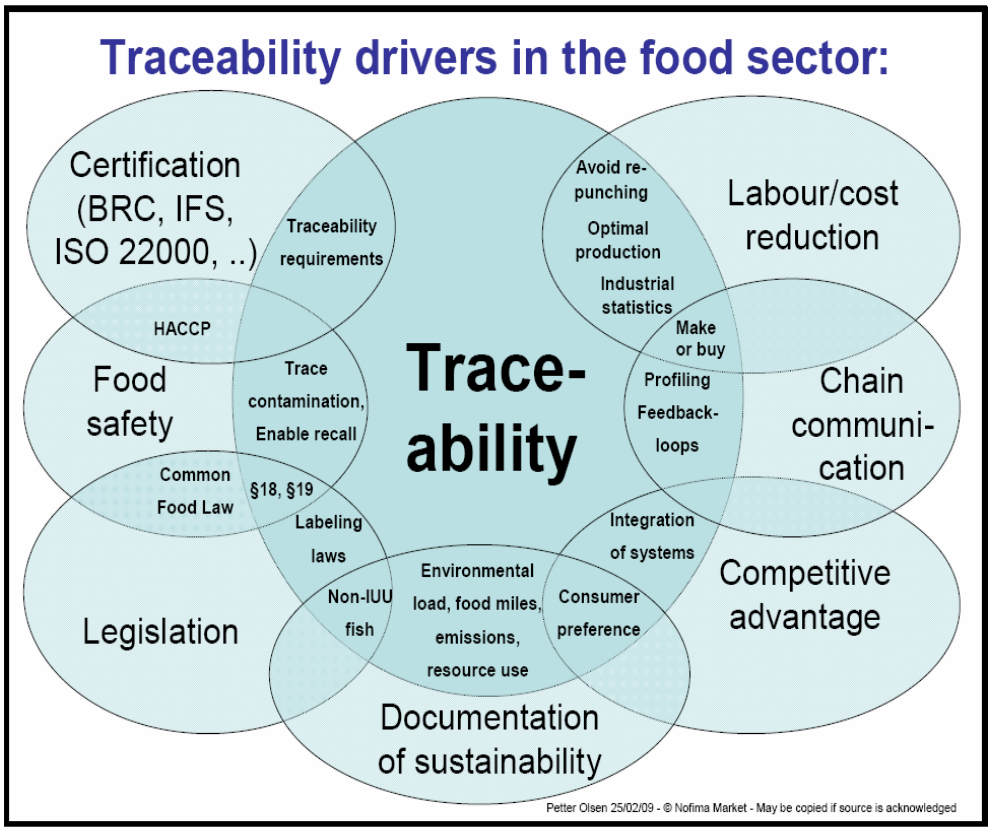


Figure 15.[42] Traceability drivers in the food sector.

Risk avoidance drivers (the left side of the diagrams) and economic development drivers (the right side of the diagrams) are considered old, traditional ones, while the documentation of sustainability driver is a new one, which emerged in the last few years from the growing global concern about natural resources and environment.

3.2 Legislation, standardisation, certification and eco-labelling

3.2.1 Legislation

At this moment, at Community level, the EU Regulation 178/2002 General principles and requirements of food law is the most relevant piece of legislation in the area of food traceability. In the area of fish, fish and fishery products traceability, the EU Regulation 1005/2008 and the EU Regulation Proposal CNS/2008/0216 are the most important legal documents.

[41] Bollen, A.F.; Riden, C.P. and Opara, L.U. (2006), page 94.
[42] Olsen, P. (2009) 1, page 8.

a. EU Regulation 178/2002[43]

From 2005 the European Commission set into force a new food law (Common food law), and established the European Food Safety Authority. The general principles and requirements of this law are specified in EU Regulation 178/2002. As an instrument to deal with food crises and a rapid increasingly global trade, this regulation has a strong focus on food safety, reduction of food induced health risks, protection of consumers and building up confidence in food and food production. The ability to carry out recalls of contaminated products is considered as an important functionality in a future food safety regime. This requirement is partly built into Regulation 178/2002 by the so called "one-up/forward, one-down/backward approach", where all producers have to document from whom they have received food stuffs and to whom they have sent their products.[44]

In connexion with the same problematic addressed by this Regulation, EU developed other legal documents that deal in a more or less specific way with traceability of food in general or of fish and fish products in particular. For an overview of the most relevant of them, see Appendix 4.

b. EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS)[45]

Both EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS), try to implement within the Community Member States the traceability requirement for the fish and fishery products, by introducing different recorded documents along the custody chain. It is important to specify that these two legal norms are of regulation type, which requires direct implementation in the Member States.

When deciding if the new legislation should take the form of the Code of Conduct or a regulatory instrument in the form of a new binding regulation, the European Commission adopted the later option.[46] This choice was taken in order to consolidate and simplify the existing legislation, develop a new, harmonised approach to inspection and control (covering all aspects from “net to plate”), to develop a common culture of compliance and to ensure the effective application of Common Fisheries Policy rules.

[43] EU Official Journal L31/1 (2002);
[44] http://www.tracefood.org/index.php/Traceability:Legislation (accessed: 19.04.2009).
[45] Together with EU Regulation Proposal CNS/2007/0114 concerning authorisations for fishing activities of Community fishing vessels outside Community waters and the access of third country vessels to Community waters, they form the new pillars of the EU Common Fisheries Policy.
[46] European Commission (2008).

Therefore, EU Member States have to transpose into their national legislation both new documents as such, one of the outcomes having to be a global and integrated control system to deter IUU fishing.

3.2.2 Standardisation

It is generally accepted that there are three types of standards[47]:

- *First-party standards* – developed by a company for application within the company. They are used by the company, but they are open to important criticism concerning conflict of interest.
- *Second-party standards* – developed by an industry organisation for application to the entire industry sector. In their case, the common criticisms are conflict of interest and playing to lowest common denominator.[48]
- *Third-party standards* – developed by organisations independent of the industry to which the standards apply. They are often seen as the preferred choice in supporting the dissemination of environmental information to consumers as they have the appearance of independence and objectivity. Nevertheless, the true objectivity of these standards is dependent on the range of input provided during the standard development process. Therefore, including a wide range of stakeholders could assure the objectiveness and independence of the standard. All standards presented hereunder are third-party type.

ISO introduced in the last five years three new standards[49] that define the requirements for a traceability system within a food safety management system and the data that needs to be retained (ISO 22000:2005 Food safety management systems – requirements; ISO 22519 traceability system in the agriculture food chain general principles for design and development; ISO 22005:2007 Traceability in the feed and food chain - General principles and basic requirements for system design and implementation).[50]

[47] Philips, B.; Ward, T.; Chaffee, C. (2003), pages 5-6;

[48] Industry associations are usually in the position of having to protect all members equally, so creating standards that allow for significant differentiation among members is often against the charter of the association, unless the express wishes of its paying members.

[49] An ISO standard is a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose. (http://www.iso.org/iso/iso_catalogue/faq_standards_2.htm, accessed: 19.04.2009).

[50] Aarnisalo, K.; Heiskanen, S.; Jaakkola, K.; Landor, E. and Raaska, L. (2007), page 13; and http://www.iso.org/iso/catalogue_detail?csnumber=36297 (accessed: 19.04.2009).

In the fish and fish products traceability area, ISO is developing now a new technical standard, ISO TC234 Traceability of fish products – Specification on the information to be recorded in captured fish distribution chains, which is for the moment still in the draft stage.

Besides ISO, both the international organisation Codex Alimentarius and the European Committee for Standardization (CEN) have also dealt with questions on traceability during the last years, establishing the following standards:
- Alimentarius CAC/GL 60-2006 Principles for Traceability/Product Tracing as a Tool within a Food Inspection and Certification System;
- CEN/CWA 14659:2003 - Traceability of fishery products: Specification of the information to be recorded in farmed fish distribution chains;
- CEN/CWA 14660:2003 - Traceability of fishery products: Specification on the information to be recorded in captured fish distribution chains (it constitutes the starting point for ISO TC234);
- CEN/SS C01-Food Products prEN ISO 22005 Traceability in the feed and food chain: General principles and basic requirements for system design and implementation (ISO/FDIS 22005:2007).[51]

There are many other traceability standards developed by different institutions, but it is important to state that except CEN/CWA 14660:2003 and ISO TC234 standards, all the other standards that deal with information needed in captured fish distribution chains do not standardize on parameter level.[52] Therefore, recorded data is not measurable, stopping only at a surface level of quantifiable recording (*e.g.* parameter level: register transport vehicle number; non-parameter level: register only type of transport-truck, vessel, plane, train).

3.2.3 Certification

Certification is the procedure by which a certification body gives written or equivalent assurance that a product, process or service conforms to certain standards.[53]

[51] Aarnisalo, K.; Heiskanen, S.; Jaakkola, K.; Landor, E. and Raaska, L. (2007), page 13.
[52] Olsen, P. (2009) 2, page 16.
[53] FAO (2009), page 15.

As in the case of standards, there are three types of certification:

- *First-party certification* – by which a single company or stakeholder group develops its own standards, analyzes its own performance, and reports on its compliance.
- *Second-party certification* – where an industry or trade association or NGO develops standards, analyzes the performance of involved parties, and reports on compliance.
- *Third party certification* – where an accredited external, independent, certification body, which is not involved in standards setting or has any other conflict of interest, analyzes the performance of involved parties, and reports on compliance.

3.2.4 Eco-labelling[54]

Eco-labelling schemes, which are a marked based private sector mechanism to manage the sustainable use of natural resources, can be categorized as follows[55]:

- *First party labelling schemes*: established by individual companies, based on their own product standards, with "self declared" compliance.
- *Second party labelling schemes:* established by industry associations for their member's products; compliance is verified through internal audit procedures or by employing external companies as auditors (*e.g.* Bureau Veritas).
- *Third party labelling schemes*: developed by a body independent of procedures, distributors and sellers of the labelled products. The label is licensed to a producer. The "chain of custody" is tracked to ensure that the labelled product it is in fact derived form the certified one. Audit is conducted by independent, third-party certifier.

The eco-labelling certification process has two distinct stages:

1. *fishery certification* (three phases: pre-pre assessment, pre-assessment and full assessment);

[54] One should not mistake eco-labelling for a certification scheme, as eco-labelling schemes use certification ones as processes within their own procedure.
[55] FAO (2001) 2, page 11.

2. *chain of custody certification*. This refers to the set of measures which makes sure that a certified product originates from a certified production chain and is not mixed with non-certified products. Chain of custody verification measures track/trace the product throughout the production, processing, distribution and marketing chain, with corresponding documentation[56], as showed in Figure 16.

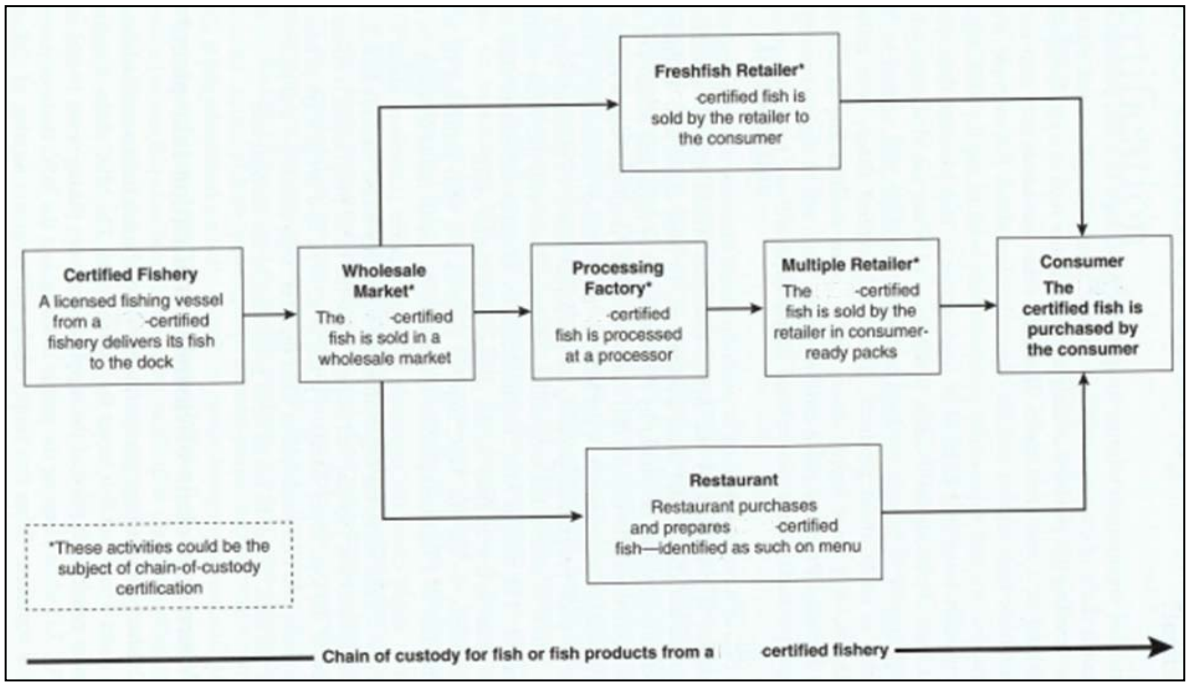


Figure 16.[57] Summary of chain of custody from a certified fishery throughout to consumer.

The client who is under assessment can decide to stop the process after the first stage, in this case only the fishery being awarded the eco-label certification (*e.g.* after passing this step under MSC standards, the USA Alaska salmon fishery claims that is MSC certified), or it can decide to complete the second stage, in which case the products derived from the fishery being allowed to carry the eco-label. During the certification process, the burden of proof is reversed, which means that the client has to demonstrate the certification body that it meets the certification scheme standards.

[56] FAO (2009), page 15.
[57] Modified from Philips, B.; Ward, T.; Chaffee, C. (2003), page 88.

As shown in Appendix 5, there are quite a number of standards, certification schemes and labels in fisheries and aquaculture. This situation can be confusing for all parties, and there is an obvious need for comparison of practices - the benchmarking[58] issue. While in aquaculture a benchmarking study was undertaken by WWF in 2007[59], in capture fisheries this comparability study is lacking. There are strong indications that this kind of study is more than needed in the industry, as voiced by the stakeholders during the Round Table on eco-labelling and certification in fisheries sector, held in The Hague in April 2009.

3.3 Traceability systems

3.3.1 Types of systems

Not all traceability systems are equivalent and/or interchangeable, nor can they necessarily be consolidated. Different purposes and systems also trigger different expectations in producers and consumers that do not always correspond to the traceability system in use (regulatory, contractual or voluntary). This partially explains the current uncertainty related to traceability requirements and to the possible implications of traceability regulations. Table 1A presents the most fish and fish products common traceability systems, as identified by FAO/Globefish in 2006.[60]

Table 1A. Traceability systems: purpose, objective, attributes, standards and examples.

Purpose	Objective	Attributes	Standard	Example
Safety	Consumer protection (through recall and withdrawal)	Specified in food & fish safety regulations	Mandatory	EU regulation
			Voluntary (1)	USA regulation
Security	Prevention of criminal actions (through verifiable identification and deterrence)	Specified in security regulations	Regulatory (2)	USA Prevention of Bio-terrorism, regulation
		Verification of selected attributes on package and/or food	Voluntary (no common standard)	Brand & product protection
Regulatory Quality	Consumer assurance (through recall and withdrawal)	Specific attributes included in regulations	Regulatory (3)	EC labelling, mandatory consumer information.

[58] Benchmarking is the process of comparing the cost, cycle time, productivity, or quality of a specific process or method to another that is widely considered to be an industry standard or best practice. (www.wikipedia.com, accessed: 27.04.2009).
[59] See *Benchmarking Study on International Aquaculture Certification Programmes*. World Wildlife Fund (WWF), Switzerland and Norway, Zurich and Oslo 2007.
[60] Lupin, H. (2006).

Non-regulatory quality & Marketing	Creation and maintenance of credence attributes	Specific attributes included in public standards	Voluntary (common standard) (4)	Public Quality seals (*e.g.* Label Rouge, France) Organic fish, Eco-labelling
Food chain trade & logistics management	Food chain uniformity & improved logistics	Specific attributes required to food and services suppliers by contract	Private standards (4)	Own traceability systems (*e.g.* Wal-Mart)
			Public standards for encoding information	GS 128 (5) (*e.g.* with TRACEFISH (6) standard) SSCC (7)
Plant Management	Productivity improvement and costs reduction	Internal logistics and link to specific attributes	Voluntary (internal traceability; own or public standards)	From simple to complex IT systems.

(1) Recall and withdrawal can become compulsory if a responsible company does not take action.
(2) Includes the possibility of mandatory disposal, recall and withdrawal, legal and police actions but primary purpose is prevention.
(3) Includes the possibility of mandatory disposal, recall and withdrawal and administrative actions, but primary purpose is consumer assurance.
(4) Could include voluntary (contractual) recall and withdrawal and agreed (contractual) sanctions.
(5) GS1 System standardizes bar codes (www.GS1.com)
(6) TRACEFISH, "Traceability of Fish Products" (EC funded project) http://www.tracefish.org/
(7) SSCC : Serial Shipping Container Code (UCC)

In order to adapt Table 1A to the realities of the traceability drivers as defined in Chapter 3.1.3, it is here purposed that one more row be added:

Table 1 B. Supplement to traceability systems: purpose, objective, attributes, standards and examples.

Purpose	Objective	Attributes	Standard	Example
Documentation of sustainability	Natural resource sustainability	Specified in environment protection regulations	Mandatory	EU Regulation Proposal CNS/2008/0216
			Voluntary	FAO IPOA-IUU

3.3.2 Components

Traceability systems are constructions which enable traceability. There are several essential elements of traceability constituting an integrated food supply chain traceability system.[61] These elements are:

1. *Product traceability* - defines the physical location of a product at any stage in the supply chain.

2. *Process traceability* - ascertains the type of activities that have affected the product during the growing and post harvest operations (what, where and when).

[61] Opara, L.U. (2003), pages 102-103.

3. *Genetic traceability* - determines the genetic composition of the product and includes information on the type and origin (source, supplier).

4. *Inputs traceability* - determines type and origin (source, supplier) of inputs, *e.g.* fertilizers, additives used for preservation or transformation of the raw materials into processed products.

5. *Disease and pest traceability* - traces the epidemiology of microbiological hazards and pests, which may contaminate food products.

6. *Measurement traceability* - relates individual measurement results through calibrations to reference standards and assures the quality of measurements by observing various factors which may have impact on results (such as environmental factors, operator etc.).

3.3.3 Characteristics

A good identification system for a product must fulfil the legal requirements, must be unique, legible, resistant to damage, easy to capture for records, tamper-proof (resistant to interference), able to avoid fraud and incapable of reuse.[62] Effective traceability is the result of structured data acquisition and clarity of reporting. The acquired data should be easily accessible and scrutinable, quickly searchable, and descriptions of production flows should be understandable.

Products and activities are core entities of a traceability system, and they are defined by a set of essential descriptors that must be included in order to secure the system (Figure 17).

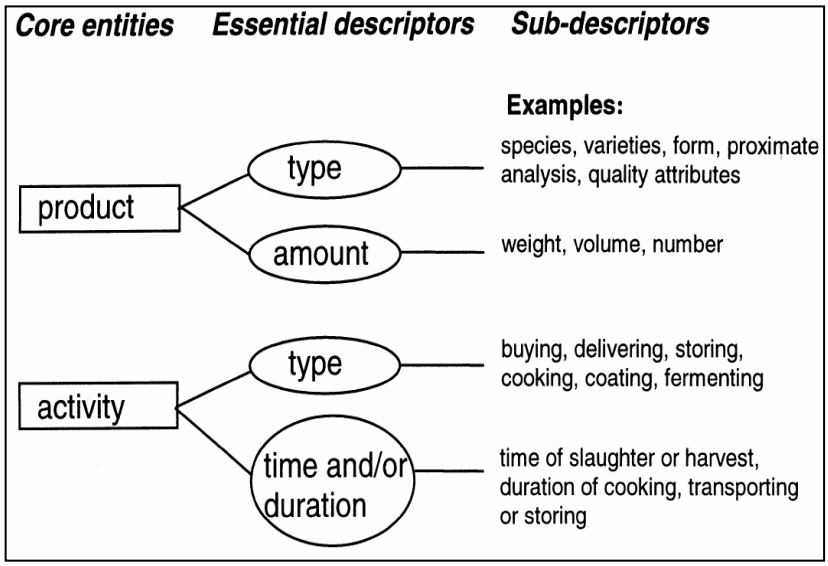


Figure 17.[63] Fundamental structure of a traceability system.

[62] Aarnisalo, K.; Heiskanen, S.; Jaakkola, K.; Landor, E. and Raaska, L. (2007), page 15.
[63] Moe, T. (1998), page 212.

Traceability can be achieved using either paper based records, a bar/scanner system combined with a computerised central database, or an integrated IT traceability system that implies among other radio frequency identification (RFID) tags.

3.3.4 Traceable units

The concept of traceable units is a key aspect in traceability. A traceable unit must be uniquely identifiable and linked to the relevant records: it can be one fish (*e.g.* one big halibut), one catch, one day's catch or one week's catch. It has been the prerogative of the industry to define the appropriate unit[64]. Trade units, logistic units and batches are traceable units, defined as in Table 2.

Table 2[65]. Traceable units: trade unit, logistic unit, batch.

- **Trade Unit (TU)** - any item upon which there is a need to retrieve predefined information and that may be priced, or ordered, or invoiced at any point in any supply chain. In practice it often refers to the smallest traceable unit that is exchanged between two parties in the supply chain. A crate of fish is often a TU. (image from http://www.fotobank.ru/img/SF15-4519.jpg?size=l)	
- **Logistic Unit (LU)** - an item of any composition established for transport and/or storage that needs to be managed through the supply chain. In practice it is made up by one or more separate TUs. In some cases, the trade unit and the logistic unit are the same. A LU is often a pallet of fish being distributed from one producer to a receiver. (image from www.promensfoodpackaging.com/page.asp?pageid=402)	

[64] Frederiksen, M. (2006),
[65] http://www.tracefood.org/index.php/GTP:Defining_traceable_units (accessed 01.05.2009).

- **A production batch** - has to be referred to when dealing with internal traceability. A production batch is the traceable unit that raw materials and ingredients go into before they are transformed into products placed in new TUs and LUs.	Example batch code: - Supplier code/Reception date code/Species code - A/050208/Hd - Haddock supplied by company A on 05.02.2008.

As depicted in Figure 18, batches relate to internal traceability, while TUs/LUs relate to external traceability. This distinction is important because globally unique identifiers have to be given to traceable units involved in external traceability (since a production batch is an internal matter, it does not need to have a globally unique identifier).

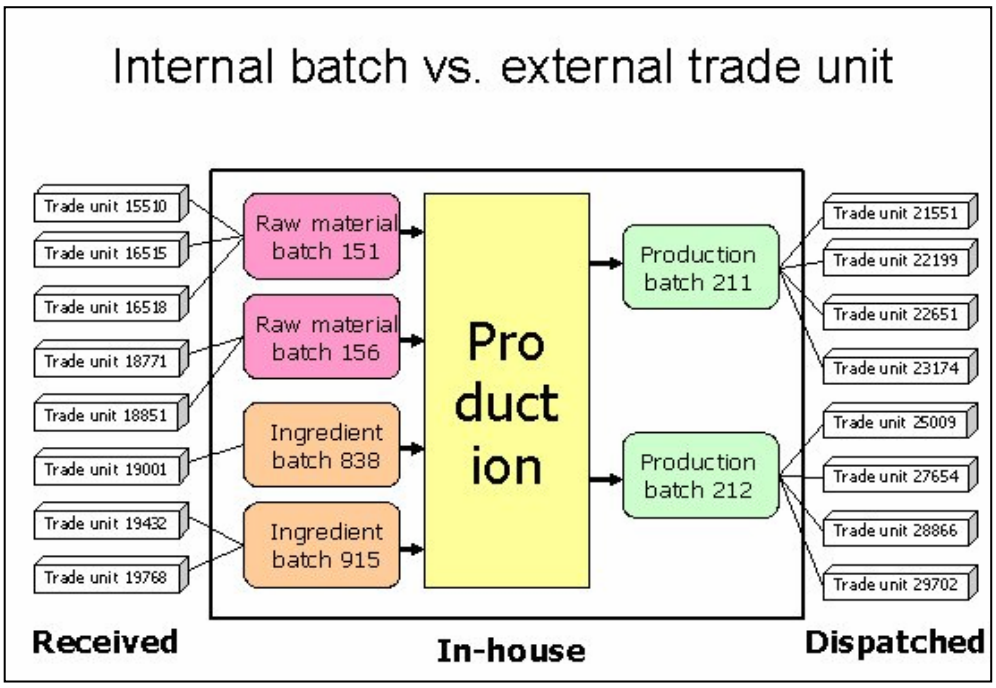


Figure 18.[66] Relation between internal batch and external trade unit.

3.3.5 Data recording of unique ID-codes starting from lowest unit

To be able to trace both backwards to find origin and forward to find all related units it is vital to record all transformations the lowest TU is subject to. The four steps below specify how to keep track of transformations.[67]

[66] http://www.tracefood.org/index.php/GTP:Defining_traceable_units (accessed 01.05.2009).
[67] http://www.tracefood.org/index.php/GTP:Transformations (accessed: 01.05-2009)

1. Define the TU in the business under examination (*e.g.* a 20 kg crate with herring).

2. Record IDs of received TUs (raw materials and/or ingredients). Here are two alternatives: a) if the received TU has a unique ID, record it; b) if the received TU does not have a unique ID, allocate one to it. For an allocation system of unique identification of traceable units see Appendix 6. (*e.g.* the 20 kg crate with herring was received with the unique ID-code or was given the unique ID-code (01)07038010000065(8008)040915125603).

3. Record the ID of the TUs that go into the production, and give all produced TUs a unique ID. In practice, the ID of TUs that goes into production will at that stage be linked to a production batch (cf. Batch number). Every produced TU must be allocated a unique number. In this way the ID of received TUs will be linked with the ID of produced TUs. This practice ensures forward traceability inside the business. Where possible and relevant, it is also recommended to record the fraction (%) and/or the net weight of each TU that goes into production. (*e.g.* the 1 kg net fish weight barrels with marinated herring produced from the received crate of 20 kg of herring will be given an ID-code similar to and related with the crate's ID-code)

4. Record the ID of all TUs dispatched. Fulfilment of requirements in step 2-4 provides both a link between received and dispatched TUs (and the other way around), via the production process (internal traceability), and a link to previous and next food business operator (external traceability).

Figure 19 shows how relations are linked both ways through a business. For example, entire TU 11 is input factor in TU 21, while TU 21 is also made up by TU 12. Both fractions (%) and net weight are indicated. In this figure the production step is removed and only relation between received and dispatched TUs is shown.

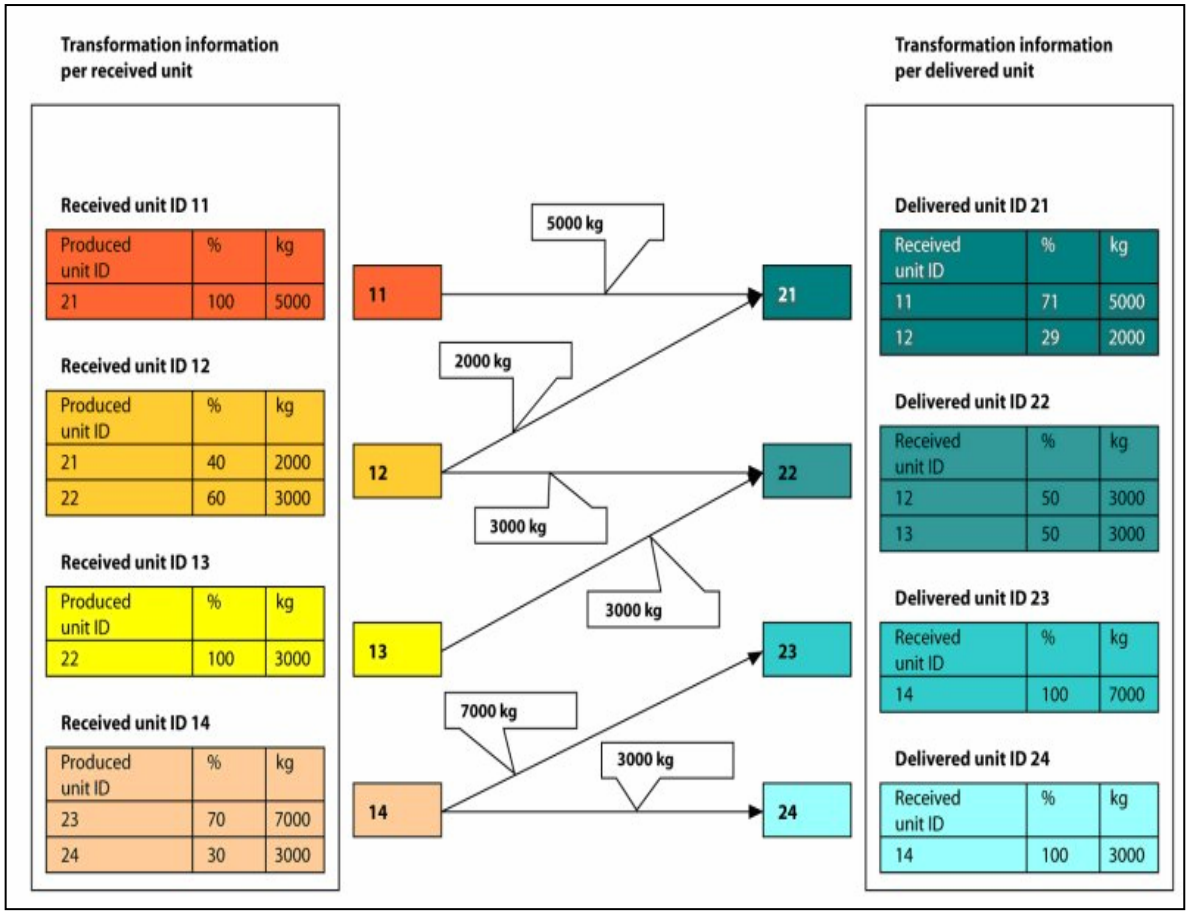


Figure 19.[68] Trade units flow.

3.3.6 The importance of weighing

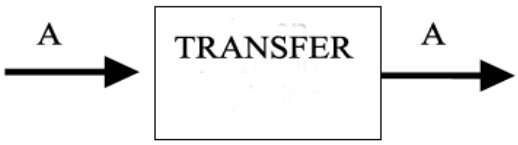
Weight accountability is a very important aspect in a fish traceability system, as it prevents the infiltration of fish from untraceable provenance, usually from IUU activities. In Figure19, the fish net weight received is equivalent with the fish net weight delivered, and this was recorded in a data sheet. For example, a tuna canning factory receives 5.000 kg of uniquely identified tuna fish crates, but delivers cans that contain 7.000 kg of net weight of tuna fish. The question that rises is where do the additional 2.000 kg of tuna fish come from? If no recorded evidence can be found according to applicable legal provisions in order to identify the provenance of the 2.000 kg extra of tuna (no unique ID-codes, no catch certificates etc.), then it is clear that the fish has an illegitimate origin.

[68] http://www.tracefood.org/index.php/GTP:Transformations (accessed: 01.05-2009).

3.3.7 Transformations/operations

As referred above, at each point of the supply chain, the traceable units go through different types of operations/transformations. In order to achieve a good traceability of the product, the information that is linked to that product must undergo a parallel operation, so the product and the information will remain linked. There are 6 main types of operations/transformations connected to traceable units and their linked data. Some of them are more or less exposed and susceptible to infiltration of IUU fishery products, or can facilitate for it, as exemplified in Table 3. For structuring Table 3, available information from other authors[69] was reviewed, amended and organised from the new perspective. For examples of the other transformations/operations see Appendix 7.

Table 3. Operations/transformations and their exposure to infiltration with IUU fishery products.

1. Transfer (no joining or splitting of the unit). It is essential that product ID-code is transferred with the product during operation. Example: A truck transports 10 pallets with ID-codes of fresh mackerel from the harbour to the processing unit. The pallets are not changed under transport. IUU fish infiltration: The first buyer after an IUU vessel lands its catch gives his own ID-codes to the fish which will be sold further on as such, without any processing, further on. If at the upper links of the supply chain the product seems perfectly traceable, a deeper investigation to the origin of product will reveal the illegality.	

[69] Karlsen, K.M.; Olsen, P. and Storøy, J. (2006), pages 11-12, & Derrick, S.; Dillon, M. (2004), pages13-14.

2. Joining (mixing). During this operation, one process step combines several traceable units, which should have each an unique ID-code. A new ID-code should be established for the new combined TU, and the records should clearly indicate the ID-codes of all the component TUs. Example: One processor, who receives fish from more than one fishing vessels, mixes the cod from the different vessels (one motive might be that the processor does not have sufficient raw material from only one source). The fish received from each vessel should have its own ID-code, also the mixed one, while the records of the processor should indicate the ID-codes of all the fish that formed the new product with a new ID-code. IUU fish infiltration: Only the fish received from one vessel has ID-codes, while the one from the other boats is derived from IUU activities, and does not have ID-codes. The processor mixes the fish from all the vessels and gives the new product (the mixed fish) a new ID-code that relates only to the one form the legitimate fishing vessel. In this case, checking the weight of the received fish and the delivered one would indicate irregularities, and a further investigation will discover the IUU fish.	
3. Splitting. During this transformation, one traceable unit is split for use in different processes or products. New ID-codes should be given to each of the split units, while the records should indicate the ID-code of the origin product. Example: One supplier of cod transports the whole day's catch with the fishing vessel to the slaughterhouse where the fish is pumped in 3 different basins. Facilitating for IUU fish infiltration: The supplier of cod gives non-unique ID-code to its catch before this is pumped into 3 out of 4 basins, and the raw	

material from the basins is given again non-unique ID-codes. The IUU fish pumped by an IUU vessel in the 4th basin receives the same non-unique ID-code as the legitimate fish from basin 3. During the inspection at the landing site, the fish from basin 4 is assumed to be legitimate while having the same ID-code as the one in basin 3.	

Note that not giving unique ID-codes to any of the trade units in any kind of operation/transformation can immediately and permanently compromise the traceability system, as the units can not be either tracked or traced correctly along the custody chain.

3.3.8 Critical traceability control points

If the infiltration of IUU fish in the supply chain is seen as a hazard which can be prevented by means of traceability, then all the points along the custody chain where the possibility of appearance of the hazard is high can be defined as critical traceability control points. The fish and fish products can enter a legitimate fish supply chain through three different points: at sea, at landing and at onshore distribution chain, as suggested in Figure 20. This distinction is important as different critical traceability control points can be identified at each IUU fish entrance point.

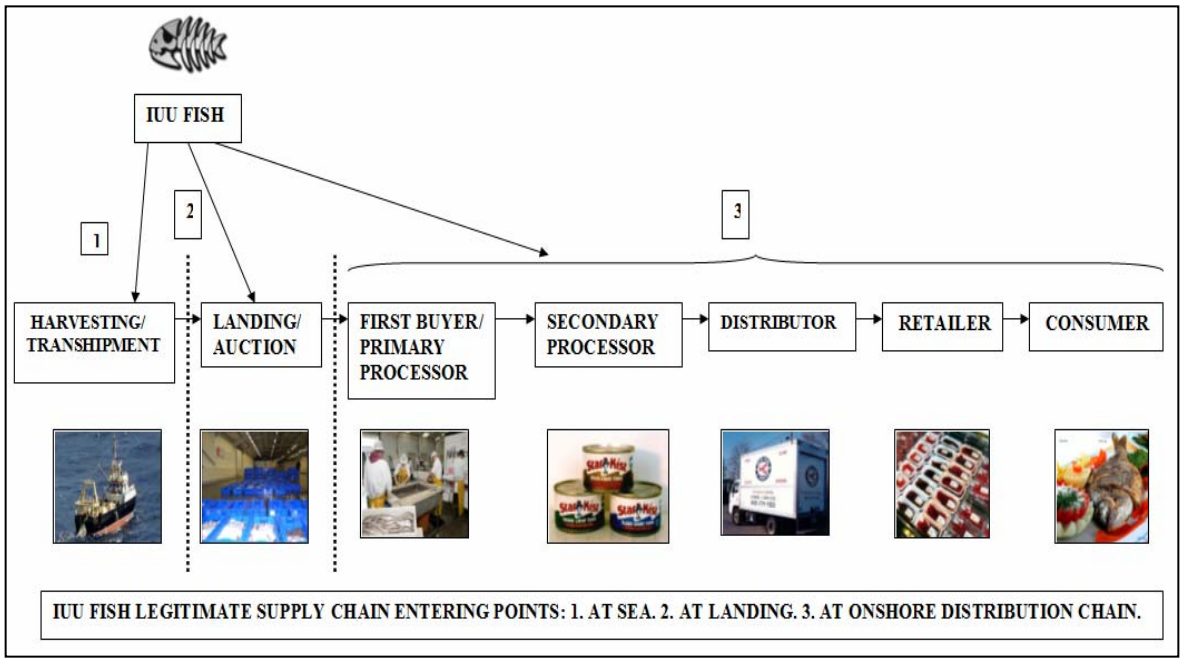


Figure 20. IUU fish entering points into the legitimate fish supply chain.

The *critical traceability control point (CTCP)* can be defined as a step at which the control of traceability can be applied and it is essential to prevent, eliminate or reduce the entrance of IUU fish in the legitimate fish supply chain.

In order to identify the CTCP, this study proposes the following steps suggested in Figure 21. These steps were designed following the decision tree modelling method.[70] In this context, *step* is defined as an operation (*e.g.* harvesting, landing) or transformation (*e.g.* splitting, joining, grouping) in the fish supply chain, from primary production to final consumption, the point in the chain where exists the possibility for mixing of non-IUU fish and IUU fish. Each of the points identified will need traceability controls to ensure that mixing does not occur. Among the CTCP identified after this method there are, for example: 1. at sea: fishing, harvesting or transhipment operations; 2. at landing: pumping fish from the fishing vessel into basins; 3. at onshore distribution chain: packing crates with fish brought by different fishing vessels or even fish from the same vessel but from a different catch.

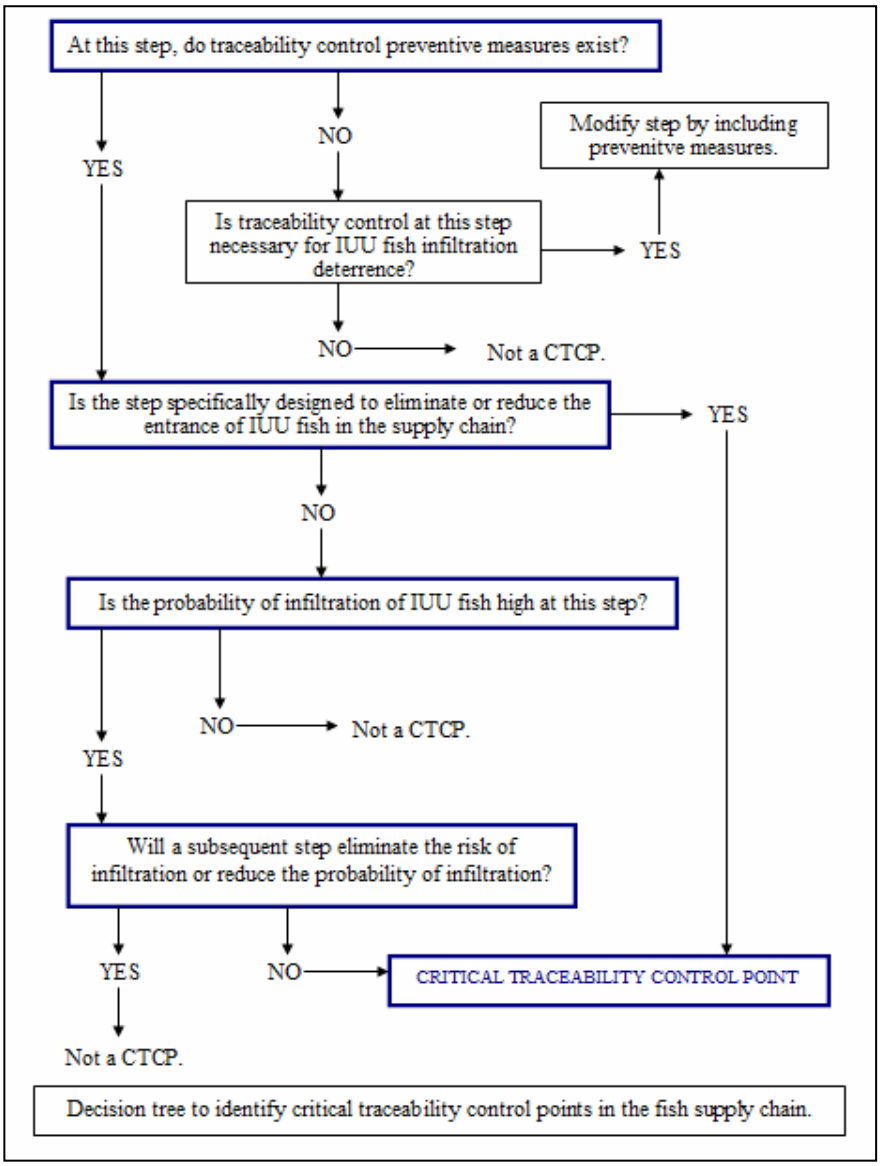


Figure 21. Decision tree to identify critical traceability points in the fish supply chain.

[70] Miles, M.B.; Huberman, A.M. (1994), page 185.

The identification of CTCP along the fish supply chain is important as it indicates the weakest links of the custody chain; the points where the entrance of IUU fish in the legitimate trade could be stopped or reduced by means of traceability.

3.4 Analytical methods used in fish traceability investigations

Traceability documentation is the paper trail that must accompany a product and contain all pertinent data to trace its origin and life-history. It includes species, ingredients, origins, manufacturing processes, temperature logs, etc.[71] Full traceability will help to follow up honestly produced and handled products, but because they are honestly produced and treated it is not to be expected that they will also be correctly labelled. For example, more than one-third of all the fish from the US market is mislabelled, for different reasons: hiding IUU fish, selling under-utilised fish with a bad image at a higher price, profiting on account of legitimate eco-labelled products[72]. Sometimes the products appear to be perfectly traceable, but they are in fact fraudulent, in which case fisheries forensics has to be applied.

In traceability investigations, the target could be finding the geographical origin of the food/food product (geographical traceability) or to correctly identify the individual animal, breed or species (genetic traceability). Analyses performed on a sample to assess whether the product is indeed what the label says are called authentication analyses. The methods used in these analyses can be categorized into: physicochemical techniques (using the variation of the radioactive isotope content of the product, spectroscopy, pyrolysis or electronic nose), biological techniques (using the analysis of total bacterial flora through many techniques such as Denaturing Gradient Gel Electrophoresis (DGGE) or DNA chips), biochemical techniques (such as API galleries, analysis of antibiotic resistance and ELISA tests) and molecular biological techniques (such as DGGE or Single Strand Conformation of Polymorphism (SSCP)).[73] All these methods need the construction of databases with authentic material so that unknown samples can be analysed under the same conditions as the reference material. The results are then statistically analysed to see whether the unknown matches the authentic sample, or samples suitable as substitutes, or

[71] Martinez, I., James, D., Loréal, H. (2005), page 28.
[72] Jacquet, J. L.; Pauly, D. (2008).
[73] Aarnisalo, K.; Heiskanen, S.; Jaakkola, K.; Landor, E. and Raaska, L. (2007), page 34.

whether it does not match any of the material included in the database (if a new species is used). In order to reduce the likelihood of not identifying the samples it is useful to have as large a database of known reference material as possible.[74]

Genetic traceability is based on the identification of both animals and their products through the study of DNA, using the four most important features of the DNA molecule: enormous variability among individuals; inalterability during animal life; stability to the different treatments of processed food; it is present in every cell of the organism.

Once the DNA is extracted from the chosen matrix (it can either be fish tissue, blood, muscle, skin, or even a processed food such as fish fingers or canned tuna) it is analyzed by molecular markers to obtain a fingerprint or specific allelic frequencies allowing for individual, breed or species identification. Since the introduction of the polymerase chain reaction (PCR) in 1989, many different markers have been discovered and studied. At present the most widely used are microsatellites also known as short tandem repeats (STR), and single nucleotide polymorphism (SNP). The use of these technologies in fish and their products is just an extension of techniques already in use for human testing and routinely applied in forensic casework.[75]

[74] Martinez, I., James, D., Loréal, H. (2005), page 37.
[75] Dalvit, C.; De Marchi, M. and Cassandro, M. (2007), page 445.

4. TRACEABILITY AND IUU FISHING DETERRENCE, ANALYSIS OF LINKS

4.1 Introduction

In order to analyse if the traceability related provisions of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) are both relevant for IUU fishing deterrence and fulfilling the chain of custody traceability requirements, two models were designed. Model 1 was conceived to identify the overlapping of the necessary data for identifying IUU components (actors or products) with the traceability data recorded in the documentation imposed by the legal documents at each critical traceability control point. Model 2 was designed to identify the fulfilment of the chain of custody requirements along the traceability control points. Using the earlier train metaphor, the first model analysed if the data stored in the carriages are sufficient/adequate for stopping IUU fish to enter the EU market, while the second model analysed if the train track is properly designed to carry the carriages. In both examples, the train was attaching new carriages only in the critical traceability control points.

As related issues, eco-labelling and genetic traceability aspects were included after the discussion of the models' results.

4.2 Method: description, materials, premises, limitations, suggestions

4.2.1 General methodology and materials

Due to the complex nature of this research, a mixed methods data analysis was used in order to comprise the qualitative data in a quantitative manner.[76] The study followed the usual steps of mixed data analysis (data reduction, data display and data transformation), where the second step involved the most troublesome decision of choosing a proper graphical display for the designed model.

The models passed through subsequent stages of partially ordered cross-case matrices and case-ordered descriptive matrices until they had reached the final form of *case-ordered predictor-outcome N-way matrices*. *Predictor-outcome matrices* align cases on a main *outcome* or criterion variable, and provide data for each case on the main *predictor*

[76] Onwuegbuzie, A.J.; Dickinson, W.B. (2008), page 205.

variables thought to be the most important contributors to the outcome.[77] This kind of matrices is deemed useful when the analysis has some sort of inferential and explanatory aim, rather than just visualization and recognition of patterns. The purpose of this study was not only to barely present the available data comprised in the trade documents, and to find a pattern between document cases, but to predict if the information will fit a certain purpose. The N-way matrices were, thus, chosen due to their power to handle the complexity of the clustered predictors and cases included.

The legal material used was the text of EU Regulation 1005/2008), as found in the Official Journal of the European Union, and EU Regulation Proposal 2008/0216 (CNS) as found in the Procedure file[78] (the original text was corroborated with the Parliament legislative resolution).

4.2.2 Model 1: Acquisition of IUU fishing identification data by means of traceability

a. Description and materials

The N-way model designed for the identification of overlap of IUU components (actors or products) and traceability data, as recorded in the documentation imposed by the Regulations at each critical traceability control point, is based on the following series of steps. In order to improve readability some simple examples are given.

1. *Identification of the IUU fish entrance points in the legitimate fish supply chain, of the associated critical traceability control points and of their linked legally assigned documents.* The last item (legally assigned documents) will be displayed in the results matrix, in columns clustered according to the IUU fish entrance point. The requirements of these documents form the first set of data that is assessed against the one defined at step 2 of the method (IUU operations *identifiers*).

> Example: At the IUU fish entrance point "at sea", one of the critical traceability control points is "the operation of transhipment", while the operation linked document assigned by EU Regulation Proposal 2008/0216 (CNS) is "the transhipment declaration". The term "transhipment declaration" will be displayed in the results matrix, and its data requirements will be assessed in connection with the IUU fishing identifiers.

[77] Mile, M.B.; Huberman, A.M. (1994), page 213.
[78] http://www.europarl.europa.eu/oeil/file.jsp?id=5715242 (accessed: 12.05.2009).

As the display form of the model is a case-ordered predictor-outcome N-way matrix, the following steps (2 to 7) define the *predictors,* which are displayed in rows, clustered according to their prediction value: IUU fishing deterrence data, traceability, law jurisdiction and miscellaneous.

2. *Designation of the identifiers of the different necessary information for finding IUU operations components.* These identifiers are circumscribed by descriptors (the generic class) and parameters (the specific class). These identifiers are derived from fisheries management measures[79] , and the definitions of IUU fishing[80] and IUU fishing vessel[81].

Example **A.** Identify the management measure: area X is closed for fishing all year round. Identify the illegal fishing activity: fishing at any time in area X. The *identifier* is, thus, a combination of a *descriptor* (right or wrong place) and a *parameter* (area of catch). During the control of any of the documents required in the chain of custody it can be scrutinized whether or not the area of catch is right, and whether or not the catch is from area X.

Example **B.** Identify the management measure: IUU fishing vessel owners should be excluded from trade. An appropriate *descriptor* for such *identifier* could be: bad will vessel owner. Specific *parameters* for such *identifier* could be: name of the vessel owner + address of the vessel owner. When a certain vessel is identified as engaged in IUU operations, by finding the name of its owner the competent authority of the Member State/third-country involved can exercise its control over nationals engaged in IUU fishing.

3. *Inclusion of the unique identification and weighing traceability requirements*, as definitive components of a properly designed traceability system for fishery products. Each legal document is scrutinized for occurrence of general or specific requirement of assigning unique ID-codes to fish trade units. Further, each legal document is scrutinized for adequate inclusion of information on whether the fish has to be weighed on scales approved by competent authorities before entering distribution chain onshore.

[79] FAO (2003) and FAO (1997).
[80] FAO (2001).
[81] EU Regulation 1005/2008, Article 3.

4. *Inclusion of the validation of documents parameter*. The validation of documents by a competent authority was assimilated by this study to a second-party certification, as defined in Chapter 3.2.3 of this paper. This type of validation grants credibility to the data included in the document.

5. *Inclusion of the exemption parameter*. Sometimes, granting exemptions from legal requirements leads to non-unitary application of the law. If the law is not applicable to all kinds of fishing vessels, catch, operators and others, it may create a loophole that can be exploited by IUU operators. The exact identification of the exemption, of the loophole, and of how this can be abused by IUU operators falls outside the scope of this study.

> Example: If the requirement for filling in a transport document has an exemption in a certain case, IUU operators may concentrate their transport activities to comply with this exemption.

6. *Inclusion of the cross-reference documents parameter.* The study will search if the legislation requires that each document issued at any link of the custody chain has to contain a reference to the next document up or down the chain. This requirement it is not essential for traceability, but it can facilitate it.

> Example: If the sales note specifies the number of the catch certificate, it will be easier to trace the product.

7. *Inclusion of the type of fishing vessel: community vessel (as defined in EU Regulation 1005/2008 Article 2(6): flying the flag of a Member State and registered in the Community); vessels flying the flag of a member state other than Community fishing vessels; third country vessels.* This parameter is relevant in order to assess if the legislation applies in a unitary way to all fishing vessels engaged in trade with the Community, and to determine the jurisdiction of the norm.

8. *Analysis of the link between N- predictors (the IUU operations information identifiers, traceability requirements restricted for the purpose of this model to unique identifiers and weighing, jurisdiction of the law and miscellaneous) and the requirements for product data imposed for each document by the Regulations.* The rating system simple states: "NA" = not applicable; "x"=existent; "\"=non-existent.

> Examples: If during the analysis it is found that the requirement to state the name of the buyer in the sales note exists in EU Regulation Proposal 2008/0216 (CNS), then the parameter "operator up" will be rated as "x" (existent) in the box where the "sales note" column intersects the "operator up" row. If it is found that the requirement to give unique identification to trade units does not exist in the catch

certificate, the parameter “unique identification” will be rated as “\” (non-existent) in the box where the “catch certificate” column intersects the “unique identification” row. As the existence of VMS on board of a shipping vessel is not related to the cross-reference parameter, the later will be rated “NA” in the box where the “advance identification technology” column intersects the “cross-reference to other documents” row.

The model described above was run two times, once for the EU Regulation 1005/2008 and once for the EU Regulation Proposal 2008/0216 (CNS), and the relevant Article number is displayed in a N-way matrix.

b. Premises

When running the model and interpreting the results, some premises related to the interpretation of the legal text should be borne in mind:

- in the case of EU Regulation Proposal 2008/0216 (CNS), as indicated by Article 48(4) Principles of monitoring of marketing, the provisions of Article 50 Traceability were corroborated with the ones of Articles 14 Logbooks, 19 Transhipment declaration, 21 Landing declaration, 54 Sales notes, 57 Take-over declarations, and 58 Transport document. Therefore, the traceability requirements listed in Article 50 were included in the data requirements for each document.
- the specific, but not the general, requirements of both Regulations were taken into consideration, as the two legal texts are of regulatory type, rather than guidelines of conduct, meant to be fully implemented among the Member States.

Example: In order to assess if a comprehensive traceability system was introduced by the EU Regulation Proposal 2008/0216 (CNS), the general requirement of Article 48(2) that reads “All lots of fishery and aquaculture products shall be traceable and the operators shall be able to identify the origin and destination of lots from catching or harvesting to final consumer” was not taken at face value. Instead, the specific requirements for traceability systems disseminated along the entire document were assessed for consistency.

4.2.3 Model 2: Assurance of chain of custody by means of traceability

The model designed to define the fulfilment of the chain of custody requirements along the traceability control points is based on the following steps, which bear resemblances to the methodology used in Model 1.

As the display form of the model is a *case-ordered predictor-outcome N-way matrix*, step 1 defines the *predictors.* These are displayed in rows, clustered according to their prediction value: control/management system in place, confirmation of inputs, secure product labelling etc.

1. *Identification of the chain of custody requirements.* These requirements are circumscribed by *descriptors* (the generic class) and *parameters* (the specific class). They were derived from chain of custody documentation used in practice[82].

2. *Identification of the general critical traceability control points* for each of the legal document: at sea, at landing, and along the onshore distribution chain. Procedures are identical for the two legal texts analyzed.

3. *Analysis of the link between the chain of custody requirements and the correspondent legal provision assurance at each general critical traceability control point. The rating system utilized to classify the entries was:* "NA" = not applicable; "x"=existent; and "\"=non-existent. If at least for one of the links of the custody chain, clustered in accordance to critical traceability control points, the parameter requirement was deemed fulfilled, the requirement was considered as "existent" for the entire cluster.

> Example: If it was found that the requirement of a label is fulfilled at the transhipment link, the parameter "presence of label" was rated "x" (existent) in the box where the "1. at sea/ EU Regulation Proposal 2008/0216 (CNS)" column intersects the "presence of label" row, even though the label might not be required to be present at other links from the same group (catching, harvesting).

The model was run simultaneously for both EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS).

[82] www.us.sgs.com/rd12.pdf (accessed: 05.05.2009); www.msc.org (accessed: 05.05.2009); Olsen, P. (2009) 2.

4.3 Results

4.3.1 Output

The output matrices obtained for Model 1: Acquiring IUU fishing identification data by means of traceability are displayed in Tables 4 and 5. The output matrix for Model 2: Assurance of chain of custody by means of traceability is given in Table 6.

Table 4. Output of Model 1: Acquisition of IUU fishing identification data by means of traceability. Analysis of EU Regulation Proposal 2008/0216 (CNS).

	IUU operations identifiers		EU Regulation Proposal 2008/0216 (CNS)						
	Descriptor	Parameter	1. at sea	1. at sea	1. at sea	2. at landing	2. at landing	2. at landing	2. at landing
			ID technology	Logbook	Transhipment declaration	Landing declaration	Sales note	Take-over declaration	Transport document
1. Type of fishing activity			Art. 9,10,11	Art. 14, 50	Art. 19, 50	Art. 21, 50	Art. 54, 50	Art. 57, 50	Art. 58, 50
A. Illegal (1 to 16) B. Unreported (9, 10, 11, 12) C. Unregulated (10, 12, 13, 16)	1. genuine species/ population identification	1.1 species composition by common name	NA	x	x	x	x	x	x
		1.2 species composition by scietific name	NA	x	x	x	x	x	x
		1.3 product code	NA	\	\	\	x	x	x
	2. catch on/off season	2.1 date of catch	NA	x	x	x	x	x	x
	3. time effort limit	3.1 times of harvesting	NA	x	x	\	x	x	x
	4. right or wrong place	4.1. area of catch	NA	x	x	x	x	x	x
	5. licenced or not	5.1 licence number	NA	\	\	\	\	\	\
		5. 2 valid to	NA	\	\	\	\	\	\
	6. appropiate gear	6.1 gear type	NA	x	x	x	x	x	x
		6.2 by-catch avoidance/reduction devices	NA	\	\	\	\	\	\
		6.3 technical specifications	NA	\	\	\	\	\	\
	7. catch limit	7.1 weight of catch per each species	NA	x	x	x	x	x	x
	8. catch size	8.1 minimum fish size	NA	\	\	\	\	\	\
	9. discards	9.1 volume of discards	NA	x	NA	NA	NA	NA	NA
	10. bad will vessel owner	10.1 registered vessel owner name	NA	\	\	\	x	x	X
		10.2 registered vessel owner address	NA	\	\	\	\	\	\
	11. IUU vessel or not	11.1 vessel name	NA	x	x	x	x	x	x
		11.2 vessel flag	NA	x	\	\	\	\	\
		11.3. vessel call sign	NA	x	\	\	\	\	\
		11.4 vessel EU/IMO/Loyd's number	NA	x	\	\	x	x	x
		11.5 types of processing authorised on board	NA	\	\	\	\	\	\
	12. advance technological identification	12.1 VMS	x	NA	NA	NA	NA	NA	NA
		12.2 AIS	x	NA	NA	NA	NA	NA	NA
		12.3 VDS	x	NA	NA	NA	NA	NA	NA
	13. IUU port	13.1 port name	NA	NA	x	\	x	x	\
		13.2 destination port	NA	NA	x	NA	NA	NA	NA
		13.3 date of landing	NA	NA	NA	NA	x	x	\
	14. bad will operators	14. 1 name of operator up	NA	NA	x	\	x	x	x
		14.2 name of operator down	NA	NA	x	x	x	\	\
	15. operation date	15.1 operation date	NA	\	\	\	x	x	x
	16.conformity with management measures	16.1 references of applicable conservation and management measures	NA	\	\	\	\	\	\
3. Weighing of product at all stages			NA	x	x	x	x	x	x
2. Unique identification		1.1 unique lot number	NA	\	\	\	\	\	\
4. Validation			NA	C	C	C	C	C	C
5. Exemptions			x	x	x	x	x	x	x
6. Cross-reference to other documents			NA	\	\	\	x	x	\
7. Vessels	1. community fishing vessels		x	x	x	x	x	x	x
	2. vessels flying the flag of a member state other than community fishing vessels		\	\	\	\	\	\	\
	3. third country fishing vessels		x	x	\	\	\	\	\

VMS=Vessel Monitorin System; AIS= Automatic Identification System; VDS=Vessel Detection System.
NA = not applicable; X = existent; \ = not existent; C = computerised

Table 5. Output of Model 1: Acquiring IUU fishing identification data by means of traceability. Analysis of EU Regulation 1005/2008.

	IUU operations identifiers		EU Regulation 1005/2008						
	Descriptor	Parameter	1. at sea	1. at sea	1. at sea	2 . at landing	2 . at landing	2 . at landing	3. onshore distribution chain
1. Type of fishing activity			ID technology	Logbook	Transhipment transport doc.	Catch certificate	Re-export certificate	Transport document	Processing plant certificate
			\	*	Art. 14, 19 (4)	Art. 14	Art. 21	Art. 14 (1)	Art. 14 (2)
A. Illegal (1 to 17) B. Unreported (9, 10, 11, 12) C. Unregulated (10, 12, 13, 16)	1. genuine species/ population identification	1.1 species composition by common name	NA	*	\	?	?	\	\
		1.2 species composition by scietific name	NA	*	\	?	?	\	\
		1.3 product code	NA	*	x	x	x	\	\
	2. catch on/off season	2.1 date of catch	NA	*	\	x	\	\	\
	3. time effort limit	3.1 times of harvesting	NA	*	\	\	\	\	\
	4. right or wrong place	4.1. area of catch	NA	*	\	x	\	\	\
	5. licenced or not	5.1 licence number	NA	*	\	x	\	\	\
		5.2 valid to	NA	*	\	x	\	\	\
	6. appropiate gear	6.1 gear type	NA	*	\	\	\	\	\
		6.2 by-catch avoidance/reduction devices	NA	*	\	\	\	\	\
		6.3 technical specifications	NA	*	\	\	\	\	\
	7. catch limit	7.1 weight of catch per each species	NA	*	x	x	x	\	x (total catch, catch processed processed fishery product)
	8. catch size	8.1 minimum fish size	NA	*	\	\	\	\	\
	9. discards	9.1 volume of discards	NA	*	\	\	NA	NA	NA
	10. bad will vessel owner	10.1 registered vessel owner name	NA	*	x	\	\	\	\
		10.2 registered vessel owner address	NA	*	\	\	\	\	\
	11. IUU vessel or not	11.1 vessel name	NA	*	x	x	\	\	x
		11.2 vessel flag	NA	*	\	x	\	\	x
		11.3. vessel call sign	NA	*	x	x	\	\	\
		11.4 vessel EU/IMO/Loyd's number	NA	*	x	x	\	\	\
		11.5 transport vessel name	NA	*	x	x	\	x	NA
		11.6 types of processing authorised on board	NA	*	\	x	\	\	\
	12. advance technological identification	12.1 VMS	\	*	NA	NA	NA	NA	NA
		12.2 AIS	\	*	NA	NA	NA	NA	NA
		12.3 VDS	\	*	NA	NA	NA	NA	NA
	13. IUU port	13.1 port name	NA	*	x	\	NA	\	\
		13.2 destination port	NA	*	x	x	NA	\	NA
		13.3 date of landing/transhipment	NA	*	x	\	NA	\	NA
		13.4 transhipment port name	NA	*	x	x	NA	\	NA
	14. bad will operators	14. 1 name of operator up	NA	*	x	x	\	\	x
		14.2 name of operator down	NA	*	x	x	x	x	x
	15. operation date	15.1 operation date	NA	*	\	x	x	\	x
	16.conformity with management measures	16.1 references of applicable conservation and management measures	NA	*	\	x	\	NA	NA
	17. nature of fishery product	?	NA	*	x	\	\	\	\
3. Weighing of product at all stages			NA	*	\	x	\	\	\
2. Unique identification		1.1 unique lot number	NA	*	\	\	\	\	\
4. Validation			NA	*	\	x	x	\	x
5. Exemptions			NA	*	\	x	x	\	\
6. Cross-reference to other documents			NA	*	\	x	x	\	x
7. Vessels	1. community fishing vessels		x	*	x	x	x	x	x
	2. vessels flying the flag of a member state other than community fishing vessels		\	\	\	\	\	\	\
	3. third country fishing vessels		x	*	x	x	x	x	x

VMS=Vessel Monitorin System; AIS= Automatic Identification System; VDS=Vessel Detection System.
NA = not applicable; X = existent; \ = not existent; * = not existent here but the requirment is dealt with in EU Regulation Proposal 2008/0216 (CNS).

Table 6. Output of Model 2: Assurance of chain of custody by means of traceability. Analysis of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) .

Chain of Custody Requirements		Critical Traceability Control Points					
(Descriptor & Parameter)		1 at sea		2 at landing		3. onshore distribution chain	
(x & x.1)		EU P	EU R	EU P	EU R	EU P	EU R
1. Control/management system in place	1.1 Description of formal document control systems	\	\	\	\	\	\
	1.2 Physical evidence of document control system	x	x	x	x	x	x
	1.3 Designation of responsible authority	x	x	x	x	x	x
	1.4 Training support to control	\	\	\	\	\	\
2. Confirmation of inputs	2.1 Evidence of weighed uniquely identified inputs	\	\	\	\	\	\
	2.2 Evidence of accompanying documents	x	x	x	x	x	x
3. Separation and/or demarcation of uniquely identified inputs and non-uniquely identified ones	3.1 Methods for identifying uniquely identified material throughout the production/storage chain, especially in the presence of non-uniquely identified material	\	\	\	\	\	\
	3.2 Physical and/or temporal separation of uniquely identified and non-uniquely identified production runs	\	\	\	\	\	\
	3.3 Ability to record and recall the input/output weights of different batch runs of uniquely identified material	\	\	\	\	\	\
4. Secure product labelling	4.1 Presence of a label	x	\	x	\	x	\
	4.2 Security of label production	\	\	\	\	\	\
	4.3 Uniqueness of the label	\	\	\	\	\	\
	4.4 Adhesion of the label	\	\	\	\	\	\
	4.5 Legibility of the label	\	\	\	\	\	\
	4.6 Resistance to damage of the label	\	\	\	\	\	\
	4.7 Facility to capture for record of the label	\	\	\	\	\	\
	4.8 Tamper-proof label	\	\	\	\	\	\
	4.9 Label incapable of reuse	\	\	\	\	\	\
	4.10 Incorporation of actor information on label	\	\	\	\	\	\
5 Unique identification of outputs	5.1 Unique identification of weighed outputs through labels (see parameters 4.1-4.10)	\	\	\	\	\	\
	5.2 Passing forward documents able to link to uniquely identified products and batches	\	\	\	\	\	\
	5.3 Passing forward documents have to include at least:						
	5.3.1 description of product	x	x	x	x	x	x
	5.3.2 record of volume/quantity	x	x	x	x	x	x
	5.3.3 unique identifier	\	\	\	\	\	\
	5.3.4 expiry date (adapted to each critical control point)	x	x	x	x	x	x
6. Record keeping	6.1 System for recalling entire 'chain of custody' information (species, operation data, volumes etc.) from product outputs (batch numbers or other production identifiers) back to uniquely identified inputs	\	\	\	\	\	\
	6.2 System records kept for a minimum of X years.	x	x	x	x	x	x

NA = not applicable; X = existent; \ = not existent; EU P = EU Regulation Proposal 2008/0216 (CNS); EU R = EU Regulation 1005/2008.

4.3.2 Criteria for assessment of Model 1: Acquisition of IUU fishing identification data by means of traceability results

The ratings displayed in Table 4 and 5 can be grouped into five different themes, depending on the questions that are addressed in the analyses. This is further highlighted in the Tables by the utilization of different shade codes for the different themes.

1. The IUU operations identification data – do they cover or not all the critical control points? (Or, re-visiting the metaphor: does the train stop or not at each station to attach carriages?)

2. The IUU operations identification data – do they exist or not? (The data relevant for IUU operations identification: are they stored in the carriages or not). These are the ratings in the white cells.

3. The IUU operations identification data – are they traceable or not? These are the ratings in the light grey cells;

4. Miscellaneous data related to traceability – do they exist or not? These are the ratings in the medium grey cells.

5. The IUU operations identification data – are they retrieved for all the fishing vessels or not (covering jurisdiction of the norm)? These are the ratings in the dark grey/white font cells.

Acquisition of IUU fishing identification data by means of traceability. Analysis of EU Regulation Proposal 2008/0216 (CNS). Model 1: Table 4.

1. *The IUU operations identification data – do they cover all the critical control points or not?* The legal text covers all the critical traceability control points at sea and at landing, but it covers none of the items at the onshore distribution chain. This exposes the onshore segment to possible infiltration of IUU fish.

2. *The IUU operations identification data – do they exist or not?* Data are recorded with respect to catch identification (species, time, area, weight of the catch), and are, thus, relevant for the identification of the IUU fish (wrong species, time, area). However, there are no recorded data that might help assessing if the minimum fish size requirements were violated. This could be inferred (but still not totally proved) if technical specifications of the gear (*e.g.* hook or mesh size) would have been provided. The provisions of Article

48(3) were considered irrelevant from this point of view: by knowing only the area of catch no one can say if the fish was of a certain size without assuming that everybody complies with the rules in that area, which may not be the case. In addition, the fishing licence number is not recorded in any of the documents, and this may raise problems in the rapid identification of operators and quotas. Further, the recorded data for vessel identification is not consistent throughout the documents, and this may cause a problem when the vessel changes its registration name in a manner that facilitates IUU operations. Another weakness is the absence of recorded data with respect to conformity with management and conservation measures. Hence the legal provision is irrelevant with regard to especially unregulated fishing. In addition, the data required for identification of operator backwards and downwards are not consistently recorded, nor is the operation date. The ability to retrieve related data at each point becomes, thus, restricted.

3. *The IUU operations identification data – are they traceable or not?* There are no requirements in place for a unique identification number of the fishery product lots. This absence immediately and permanently hinders the traceability of products.

4. *Miscellaneous data related to traceability – do they exist or not?* Both the requirement to weigh the products on approved scales at all the critical control points covered by the legal text, and the requirement for a computerised validation system are in place. However, there are many openings for exemptions from all the requirements considered until now, by all parameters, and at all the control points covered by the norm, hampering thereby the unitary application of the law. Cross-references to other documents are poor, preventing the traceability system to work at its maximum.

5. *The IUU operations identification data – are they retrieved or not for all the fishing vessels (covering jurisdiction of the norm)*? The legal norm covers entirely the community vessels and partly the third country vessels (the later ones are subject to specific provisions in EU Regulation 1005/2008). However, it provides no coverage to vessels flying the flag of a Member State other than Community fishing vessels. Hence, no data can be retrieved from this kind of vessels under this regulation. If these vessels are engaged in IUU operations, the only way to stop them is by the Member state ensuring the control over its nationals; it is therefore important to retrieve the name of the owners of any vessels and to compare it against the existent black lists of IUU operations.

It is worth noting, even though it is not related to the model, that while analysing the legal provisions of this text it was realized that the allowable margin of error tolerance in the logbook with regard to volume of fish stored on board was raised from the 5% originally proposed (the European Commission Draft) to 10% (stated in the European Parliament legislative Resolution with respect to the Commission Draft).[83] This decision indicates a higher tolerance towards catch that could be otherwise registered as illegal or unreported.

Acquisition of IUU fishing identification data by means of traceability. Analysis of EU Regulation 1005/2008. Model 1: Table 5.

1. *The IUU operations identification data – do they cover or not all the critical control points?* The legal text covers all the critical traceability control points at sea and at landing, but it covers only one such point at the onshore distribution chain. This exposes this last segment to possible infiltration of IUU fish.

2. *The IUU operations identification data – do they exist or not (the data relevant for IUU operations identification is it stored in the carriages or not)?* The requirements for data retrieval are inconsistent along the critical control points with respect to all parameters other than the weight of the product. This can hinder the traceability of data and products. There are just not enough data linked to the product to assess its non-IUU origin.

3. *The IUU operations identification data – are they traceable or no?* No single requirement is in place for a unique identification number of the fishery products. This hinders immediately and permanently the traceability of products.

4. *Miscellaneous data related to traceability – do they exist or not?* The weighing requirement is existent, but in an inconsistent manner, facilitating, thus, IUU fish infiltration. Further, the validation requirements exist only in two cases, and the credibility of the operations becomes questionable. Cross-references to other documents are scant, preventing the traceability system to work at its best level. On the other hand, the law does not provide many exemptions, ensuring therefore a more unitary application.

5. *The IUU operations identification data – are they retrieved or not for* all the fishing vessels *(covering jurisdiction of the norm)?* The legal norm covers entirely the Community vessels and the third country vessels. But again, it fails to cover the vessels flying the flag of a Member State other than Community's fishing vessels.

[83] European Parliament legislative resolution of 22 April 2009 (T6-0255/2009), at http://www.europarl.europa.eu/oeil/file.jsp?id=5715242 (accessed: 09.05.2009).

4.3.3 Model 2: Assurance of chain of custody by means of traceability results

The results displayed in Table 6 can be interpreted from one perspective: are any chain of custody requirements included in EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS)? The overall outcome is that, with some few exceptions, there are no such requirements incorporated in the legal text. As a consequence "black fish" has the possibility to infiltrate into the legitimate trade. The analysis reveals that there are some rules in both legal texts that lay a certain basis for a chain of custody (*e.g.* the designation of the responsible authority; the keeping of records for a minimum of X years), but they are only isolated cases. Moreover, the EU Regulation Proposal 2008/0216 (CNS) is a step ahead of EU Regulation 1005/2008, by imposing the existence of a label requirement.

5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

5.1.1 The Models

Though designed to address various purposes of the new Common Fisheries Policy, the aim of the Regulations was, allegedly, the ambition to put up a comprehensive traceability system as a management tool to deter IUU fishing activities. Both EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) are regulatory type norms, to be obligatorily incorporated into in the legal system of all member states. Therefore, their provisions have to be clear and specific.

The aim of this study was to assess if the legal requirements fit the purpose of the law, that is if the evidence found in the texts indicates a comprehensive traceability system or not. This is a novel approach to both EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) from a dual perspective: IUU fishing deterrence and traceability. So far, extensive studies have been carried out to assess the impact of the first norm on EU trade with third parties, particularly developing countries (*e.g.* Tsamenyi, M. et al. (2009) – *Fairer Fishing? The Impact on developing countries of the European Community Regulation on IUU Fisheries*; Tsamenyi, M. et al. (2008) – *Development impact of the Council Regulation establishing a European Community system to prevent IUU fishing on Commonwealth ACP Member countries*). Within the EU some research is also being done with respect to the operational implementation of the same norm (*e.g.* Larsen, E.P. (2009) – *Traceability in the Danish fish sector*). The question of the applicability of the laws still stands, as little or no research seems to be published on this subject. Nevertheless, the clarification of this particular issue was not an objective that the present study set out to analyse.

The two models suggested here are preliminary, and both may need further refinement. Model 1 “Acquisition of IUU fishing identification data by means of traceability” could be made more comprehensive. For this purpose the analysis of the catch documents proposed by RFMOs could be included, as Article 13 Regulation 1005/2008 assimilates them to the catch certificates defined in Article 12. To gain profoundness, more IUU fishing data identifiers could be specified. Moreover, identifiers could be divided into several

categories: technical identifiers, trade operators' identifiers, vessel identifiers, or others, in order to improve detail. Model 2 "Assurance of chain of custody by means of traceability" could gain resolution if each group of general critical traceability points was broken down into more specific components, like "at sea: catching, transhipment". This would improve clarity and accuracy. The chain of custody parameters could also be disaggregated into sub-components in order to improve depth of analysis.

In spite of their limitations, both Model 1 and 2 could be used to analyse, and rate accordingly, any legal text that puts into place a traceability system for the fish supply chain. Moreover, Model 1 could be used not only for analysing a legal norm, but also be applied to any singular document required at critical traceability control points. In a similar way, Model 2 could be used to analyse a self-standing traceability system implemented by any company. Because the rating system is straightforward, as existence and non-existence are not matters of interpretation but of strict identification, both models are replicable. Thus, anyone following the named method should achieve identical results, provided that the same predictors are used and identical requirements of the chain of custody are adopted.

The comprehensive display and the multitude of inferences that can be made are probably the strongest assets of the models used. Nevertheless, at some point their wideness and depth could be also the weakest asset, as the multiple-entry format may seem intricate to some. However, being a three fold study (IUU fishing, traceability, EU law), the chosen method seems to be appropriate, as it enables the integration of all the data in a readable, predictable and parsimonious manner.

Based on the results of Model 1, this study reveals that the data necessary for identification of the IUU fish and operators is not constantly recorded at each critical traceability point by the documents required by EU Regulation Proposal 2008/0216 (CNS) and EU Regulation 1005/2008. Thus, the data traceability scheme can only deficiently, if hardly, be used in the deterrence of IUU operations. Moreover, the unique identification requirement does exist neither in EU Regulation Proposal 2008/0216 (CNS), nor in EU Regulation 1005/2008. Thus, the system fails to fulfil the mandatory requirement of a traceability scheme.

Based on the results of Model 2, this study reveals that the traceability system put in place by EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) does not fulfil the chain of custody requirements. It is, thus, also deemed weak and useless for deterrence of IUU fishing.

5.1.2 Eco-labelling and IUU fish traceability

As presented in Chapter 3.2.4 of this paper, the eco-labelling certification process consists of two steps: fishery certification and chain of custody certification of all individual companies that will use the eco-label logo on their products. During the first step, the certification body assures *inter alia* that the fishery and actors are not engaged in IUU operations. Therefore, an eco-labelled certified fishery is to be assumed exempt of IUU fishing, and products originating from it are deemed non-IUU commodities. The information gathered during the pre-pre-assessment and pre-assessment phases of this step could be used by public authorities to define their strategies with respect to IUU fishing[84].

During the second step, the certification body verifies that a certified product originates from a certified fishery and is not mixed with non-certified products. This will ensure that "black fish" will not be mixed with the "white" one, at any point of the custody chain. In the end, the consumer buying an eco-labelled product is to remain assured that the purchased fish is not coming from IUU operations.

Most of the eco-labelling schemes have chain of custody certification requirements, but they are either weak or too general, with the exception of the Marine Stewardship Council (MSC) scheme.[85] This scheme defines parameters to be checked by the certification body, and only if the requirements of these parameters are fulfilled at all individual companies along the chain of custody the certification is awarded. In practice, the representative of the certification body should visit on site all the individual companies along the custody chain, not only their head quarters, and check all the requirements of the chain of custody certification.

In this context, the most important challenges for eco-labels schemes to ensure the traceability of the chain of custody, and helping deter IUU fishing, would be:

[84] Carleton, C. (2009), pages 12-13.
[85] Olsen, P. (2009) 2, page 17.

- Developing measurable standards for chain of custody certification. In this respect, there are examples of efficient and non-efficient practice. For instance, the standards of "Friend of the sea" are non-measurable – *e.g.* "The Organization guarantees that a specific traceability system is in place in order to demonstrate that the product audited respects all requirements of this Standard and there is no possibility of mix with other products not under certification."[86] On the contrary, the standards of MSC seem measurable – *e.g.* "Sales invoice able to be linked to certified products and batches".[87]
- Make sure that the certification body assesses all the involved individual companies on site.

5.1.3 Authentication/genetic traceability and IUU fishing deterrence

Identifying the species to which a fish sample or product belongs is maybe the first application of genetic traceability. Often used to discover mislabelled products, the species authentication combined with conventional traceability can actually indicate the IUU fish. For example, if the product is labelled as swordfish but is identified to be mako shark, this is a case of mislabelling. If the investigation checks the documents that followed the product along the custody chain, it may be discovered that in the catch area it is legal to catch swordfish, but not mako sharks. In this case, the genetic trace would be necessary, together with conventional traceability, to identify IUU fish.

With regard to fish stocks (exploited populations of a commercial species) and identification[88] of their geographic origin, even the most advanced techniques of genetic analysis may not always provide unequivocal evidence. Genetic variation among populations reflects levels of gene exchange among spawning stocks, and in principle it is possible to allocate fish to the right stock of origin, even if only in a probabilistic sense. A complication may arise, however, when fish form *e.g.* feeding aggregations. These may be composed of multiple evolutionary populations, a mixture that is often found. Consequently, molecular markers may be used to trace an individual salmon to the specific river drainage where it hatched, but not to where it was caught. Therefore, the method can

[86] Friend of the Sea fishery check list at http://host1.bondware.com/~fos/news.php?viewStory=74 (accessed: 09.05.2009).
[87] Application form for MSC "Chain of Custody" Certification, developed by MacAlister Elliott and Partners Ltd (http://www.macalister-elliott.com/msc_certification/; accessed: 09.05.2009).
[88] Ogden, R. (2008), page 466.

hardly be used to detect IUU provenience with regard to area of catch, gear used, time of catch, and other controls. Vary often genetic identification techniques can simply not reveal these data. An additional flaw of genetic analysis is that it is sometimes difficult to resolve "true" independent stock units. This is the case when even small amounts of gene flow between stocks blur their genetic make-up.[89] This is not infrequent, even for stocks that were positively identified as possessing separated spawning populations by means of other classical methods. In this case, it may be difficult to prove both the area of catch and the stock origin.

On the other hand, genetic traceability[90] at any point in the food supply chain is restricted to demonstrating product receipt from one stage up in the chain and product provision to one stage down in the chain. This logic removes the requirement for molecular genetic markers to identify samples; instead they can be employed to exclude samples. Exclusion is simpler than identification, as it does not require the same level of comparative population data or statistical interpretation. By screening a batch of fish at any point in the supply chain, subsequent adulteration can be detected by resampling. This can help uncover genetic material that was not present in the original batch. Dense supply chain sampling allows identification of the exact point at which illegal fish entered the chain. From a practical fisheries perspective, such methods would not use DNA markers for tracing individual fish, but instead use markers that characterize the genetic variation found within approved fisheries. For example, microsatellite panels currently used to identify farmed salmon broodstock from different suppliers could also be used to demonstrate changes in the genetic composition of a batch of fish as it becomes infiltrated with IUU products along the supply chain. The scale of sampling required would then be restricted to that typically used to provide a comprehensive estimate of allele frequencies in a population genetic study. In addition to enabling enforcement authorities to investigate IUU activity, genetic tracing also provides a method that can be employed by the fisheries industry, or independent certification schemes, to demonstrate the source of specific products.

[89] ICES WGAGFM (2009), page 11.
[90] Ogden, R. (2008), page 468.

The EU Regulation Proposal 2008/0216 (CNS) took into consideration all these aspects. But, owing to the cost entailed by traceability tools such as genetic analysis, it was decided for the moment to only carry out pilot projects that broaden the research and information base for future measures (Article 13 New Technologies).

5.1.4 Facilitating the traceability of fishery products

In order to facilitate the usage of traceability as a management tool in deterrence of IUU operations, some measures could be implemented, including:

- The introduction of internationally coordinated customs codes.[91] Where a species subject to international trade is threatened by IUU fishing, the introduction of this kind of codes would enable a more accurate assessment of the trade. Also, improved coordination of product-specific codes between countries engaged in the trade of a species would greatly assist in reducing the errors in converting processed weights to live weight.
- The development of clear, parameterised international standards of fish/fishery traceability (an example of such standard developed at EU level is CEN/CWA 14660:2003-Traceability of fishery products: Specification on the information to be recorded in captured fish distribution chains).
- Wherever possible, the conventional traceability system should be backed up by authentication/genetic traceability.
- The problem of transhipment must be addressed seriously and actively because it is a very weal link in the chain of custody. Port States should be more demanding with regard to accountability of landings. Where fish being landed, or trafficked, lacks full accountability by internationally recognized standards, the whole operation should be treated as suspicious. Even if the fish unaccounted for represents just a part of the total volume.
- Real time update of IUU fishing black/white lists.
- Monitoring systems should be improved, for example by ensuring that devices cannot be disabled, or the data tampered with.[92]
- Catch documentation schemes should be implemented more widely, together with trade documentation schemes. It should be ensured that documentation accompany the fish in

[91] OECD (2004), page 73.
[92] OECD (2004), page 391.

trade, starting from the point it is caught, all the way through the time it reaches the consumer. These systems should be implemented with priority in important markets (Japan, Chinese Taipei) and ports, especially ports of convenience (Las Palmas, Spain; Port Louis, Mauritius).[93]

5.2 Conclusions

Primary analyses:

- Novel and comprehensive methods were developed to analyse the connexion between IUU fishing deterrence and the fish traceability scheme put in place by the EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS), using the case-ordered predictor-outcome N-way matrix method.
- Although replicable, the models developed are preliminary, and further refinement can improve their applicability.
- Neither EU Regulation 1005/2008 nor EU Regulation Proposal 2008/0216 (CNS) has the power to effectively use traceability to deter IUU fishing:
    - the traceability system set up is not viable, as it lacks the unique-identification requirement;
    - the product data required by law is either insufficient or irrelevant to scrutinize IUU fishing actors or products;
    - the law does not assure the chain of custody traceability.
- Further studies can improve the suggested model under a de *lege ferenda* approach, *i.e.* designing a traceability system that can effectively be used in deterrence of IUU operations.
- Eco-labelling of fish products is a viable way of deterring IUU fishing through its fishery certification and chain of custody components, provided that measurable standards for chain of custody certification are developed and the certification body assesses all the involved individual companies on site.
- Genetic traceability/authentication alone, although promising, still has moderate applicability in the deterrence of IUU operations. To improve effectiveness it must be used complementarily with the conventional traceability systems.

[93] OECD (2004), page 392.

- genetic traceability of the species/stocks is the easiest and clear application of this tool in IUU fishing deterrence;
- fish stock and geographic origin identification by means of genetic traceability are not conclusive for identification of IUU fish;
- genetic traceability at any point in the food supply chain may be an application that facilitates IUU fish identification, provided that a genetic database of reference exists;
- the EU Regulation Proposal 2008/0216 (CNS) takes into account the new genetic technologies, but owing to their cost these are still not operational.

Related findings:

- The provisions EU Regulation Proposal 2008/0216 (CNS) regarding the logbook are insufficient to deal with unreported fishing.
- The provisions of EU Regulation 1005/2008 and EU Regulation Proposal 2008/0216 (CNS) leave outside their jurisdiction fishing vessels flying a flag of a Member State other than Community vessels.
- The multitude of exemptions offered by both legal texts may easily lead to a non-unitary application of the law.
- The introduction of internationally coordinated customs codes and the development of clear, parameterised international standards of fish/fishery traceability are just a few examples of fishery management measures that can be taken to facilitate the traceability of fisheries products.

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APPENDIX 1.[94] Potential impacts of IUU fishing.

PARAMETER	INDICATORS	IMPACTS
Contribution of fishing to GDP/GNP	Value added; value of landings	IUU fishing will reduce the contribution of EEZ or high seas fisheries to the national economy and lead to a loss of potential resource rent.
Employment	Employment in the fishing, fish processing and related sectors	IUU fishing will reduce the potential employment that local and locally based fleets may make to employment creation.
Export revenues	Annual export earnings	IUU fishing by reducing local landings and non payment of access dues will reduce actual and potential export earnings. This will, of course have potentially serious implications for surveillance activities, where these are supported wholly or partly by export revenues (or port revenues, see below).
Port revenues	Transhipment fees; port dues; vessel maintenance; bunkering	IUU fishing will reduce the potential for local landings and value added.
Service revenues and taxes from legitimate operations	Licence fees, revenue of companies providing VMS, observer etc facilities, exchequer revenue from company taxes.	IUU fishing will reduce the resource which in turn will reduce the other revenues that would accrue from companies providing legitimate fishing services. This includes company taxes
Multiplier effects	Multiplier impacts on investment and employment	The direct and indirect multipliers linked to fishing and fishing associated activities will be reduced with the loss of potential activities through IUU fishing.
Expenditure on MCS	Annual expenditure on MCS linked to IUU fishing.	The existence of IUU fishing will put budget pressures on MCS/fisheries management[34]
Destruction of ecosystems	Reduction in catches and biodiversity of coastal areas	Loss of value from coastal areas e.g. inshore prawn fishing areas and from mangrove areas that might be damaged by IUU fishing. Reduction in income for coastal fishing communities.
Conflicts with local artisanal fleets	Incidences recorded of conflict between IUU fishing vessels and local fishing fleets.	Reduction in the value of catches for local fishing fleets. Possible increased health and safety risks because of conflicts between the artisanal and industrial fleets.
Food security	Availability of fish for local consumption (food and protein balance sheets)	The reduction in fish availability on local markets may reduce protein availability and national food security. This may increase the risk of malnutrition in some communities.

PARAMETER	INDICATORS	IMPACTS
Employment	Employment rates in marine fishing communities	IUU fishing may lead to lower employment if it has a negative impact on stocks and the activities of artisanal and local coastal fishing activities. Less opportunities for new generations of fishers to participate in fishing
Household incomes	Gross and net household incomes	IUU fishing through conflicts with local fishing fleets and by over exploitation of certain species may lead to reduction in household incomes and therefore exacerbate poverty. Possible negative impacts on income distribution.
Gender issues	Employment of women in fishing and fish marketing	IUU fishing may have a negative impact on shore fishing by women and on the marketing opportunities for women who in many societies have an important role in basic fish processing and marketing.
Nutrition and food security	Availability of fish on local markets at affordable prices.	In some cases IUU fishing through its negative impact on fish stocks and availability may have a detrimental impact on the availability of fish, an important source of protein in some countries.

[94] OECD (2004), pages 197 and 199.

APPENDIX 2.[95]

Groups of important economic and social drivers of IUU fishing activities:

a. overcapacity in the global fishing fleet. Among developing countries, there is a growing concern that the overcapacity problems of developed countries will spill over into IUU fishing activities. Not offering scrapping incentives can also drive vessels-owners into IUU fishing.

b. degree of MCS operations and their effect. The high cost of an efficient MCS system can hinder coastal states, especially the developing countries, to ensure the legal compliance in their EEZs.

c. level of sanctions against IUU fishing. Limited enforcement and the absence of severe penalties can transform IUU fishing in a very profitable activity. The forfeiture of vessels and catch could sometimes be more of an impediment to IUU fishing than fines.

d. management regimes. Countries with weak fisheries management regimes are more often a source of vessels for IUU operations than the ones with strong fisheries management.

e. weak international legal framework. Voluntary binding soft international legislation or the lack of any legal provisions (*e.g.* safety and personnel requirements for fishing vessels etc.), tax havens, open vessels registries, all these are incentives for IUU fishing activities.

f. unsatisfactory economical and social conditions of fishers. Poor livelihood conditions, particularly in developing countries, influence fishers to engage in IUU activities.

g. market and value of the IUU fish. Most of the species targeted by IUU activities have a very high market value; therefore, the economic gains from IUU fishing are often substantial.

[95] OECD (2005), pages 37-40.

APPENDIX 3[96]

Available measures against IUU fishing activities	
All countries	- States should ratify international legal instruments related to fisheries. - Countries whose vessels take part in fisheries regulated by RFMOs should become members of those organizations, or make their vessels fish in such a way that they do not undermine the rules created by those organizations. - Each country should review its own fishing laws and practices to see if they enable the use of all relevant tools in the IPOA-IUU. - Countries should improve their MCS capacity and participate in the International Network for the Cooperation and Coordination of Fisheries-Related Monitoring, Control and Surveillance Activities. - Governments can encourage fishers to comply with fishing rules through positive actions (community education and other outreach to fishers; ensuring that stakeholders participate in the development of fishery rules; fostering peer pressure in favour of compliance; creating systems for collecting information that are easy for fishers to use). - Countries should eliminate subsidies and other economic support, which contribute to the build-up of excess fishing capacity. - States have to take measures or cooperate to ensure that their nationals do not support or engage in IUU fishing.
Flag countries (countries that register fishing vessels and authorize vessels to fly their flags)	- The State has responsibility under international law to control the fishing activities of both fishing vessels and fishing support vessels (such as transport vessels that receive the catch of fishing vessels and supply vessels that bring fuel and provisions to fishing vessels), no matter where the vessel operates. - The State should ensure, before it registers a fishing vessel that it can exercise its responsibility to control that the vessel does not engage in IUU fishing. - The States should ensure that there is a strong link between the process by which they register fishing vessels and the process by which they grant authorizations to fish. - The States should register as many fishing vessels as possible, preferably all of them, and to enter all of them on its record of fishing vessels. - The States should require all chartering arrangements to be fully transparent. - The State should issue an authorization to fish only to a vessel properly registered in its territory and entered in its record of fishing vessels. - The States should prohibit their vessels from engaging in trans-shipment of fish at sea without prior authorization issued by the flag State.
Coastal countries (countries that border ocean areas)	- The State should: keep a record of foreign vessels authorized to fish in its waters; require foreign vessels to use VMS, such that the coastal country has real-time or near real-time access to vessel positions and receives regular data reports by VMS; require foreign vessels, or a certain percentage of them, to carry independent observers.

[96] Based on FAO (2002) 1 and FAO (2002) 2.

	- The coastal State should request the flag State to guarantee that its vessels being licensed do not have a history of IUU fishing before licenses are issued by the coastal State. - Coastal countries should consider requiring that all trans-shipments take place in port or, at a minimum, require that trans-shipment at sea ought to be done in accordance with proper controls and at locations where inspectors can be present to check the details of the fish being trans-shipped. - A coastal State must work closely with other States and RFMOs on different levels. - The state should improve its MCS efforts.
Port countries (countries to whose ports fishing vessels come)	- A port State should require foreign fishing vessels seeking port access to provide at a minimum: reasonable advance notice of their entry into port; a copy of their authorization to fish; details of their fishing trip and quantities of fish on board. - If a port country has reasonable grounds for suspecting that a vessel in its port has engaged in IUU fishing, the port country should: not allow the vessel to land or trans-ship fish in its port; immediately report the matter to the flag country, and if the suspected IUU fishing may have taken place in another country's waters or in waters regulated by a regional fishery organization, immediately report the matter to that country or organization.
Regional Fishery Management Organizations	Among things that regional fishery organizations can do are to: - collect and disseminate information relating to IUU fishing; - identify vessels that are engaging in IUU fishing and coordinate measures against them; - identify countries whose vessels are engaging in IUU fishing and can urge identified countries to correct such behaviour; - call on their members to take action against vessels without nationality that are fishing in the relevant region; - adopt rules to ensure that vessel chartering arrangements do not lead to IUU fishing; - adopt port inspection schemes, restrictions on trans-shipment at sea and schemes creating a presumption that fish harvested by non-member vessels in the relevant region should not be permitted to be landed in ports of members; - adopt catch certification and/or trade documentation schemes; - adopt other market-related measures to combat IUU fishing.
National Plans of Action	The IPOA-IUU calls upon all countries to develop and adopt national plans of action to further achieve the objectives of the IPOA-IUU. Each country's national plan of action should at least consider how each of the basic tools could be put to use in the fisheries in which it is involved.
Market/Trade measures	- Market-related measures cover several types of controls on the importation and exportation of goods, including: catch certification and trade documentation requirements; import and export restrictions and prohibitions; improvement of the transparency of their markets to allow the traceability of fish or fish products; eco-labelling.

APPENDIX 4. Relevant EU legislation for fish supply chain (the list is not exhaustive).

Regulation 1829/2003/EU	Genetically modified foods and feeds
Regulation 1830/2003/EU	Traceability and labelling of food products made from genetically modified organisms
Directive 2001/18/EU	Deliberate release of genetically modified organisms into the environment
Directive 2001/95/EC	General product safety
Directive 93/43/EEC	Hygiene of foodstuffs
Directive 91/493/EEC	Health conditions for the production and the placing on the market of fishery products
Directive 89/396/EEC	Indications or marks identifying the lot a foodstuff belongs to
Directive 2003/89/EC	Amending Directive 2000/13/EC as regards indication of the ingredients present in foodstuffs
Regulation 2847/93/EEC	Establishing a control system applicable to the Common Fisheries Policy
Regulation 2371/2002/EEC	On the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy
Regulation 104/2000/EC	On the common organisation of the markets in fishery and aquaculture products
Regulation 2092/91/EEC	On organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs

APPENDIX 5[97]. Standards, certification schemes and labels operating in fisheries and aquaculture (the enumeration is not exhaustive). [98]

			Market access issues addressed				
Standard (S), Code (C), guidelines (G), label (L) or certification scheme (SC)	Type	Main Market orientation	Food Safety	Animal Health	Environment	Social/Ethical	Food Quality
Codex alimentarius	S, C, G	Global	√	-	-	-	√
OIE	S, C, G	Global	√	√	-	-	-
GlobalGAP	S, CS	Europe	√	√	√	-	√
GAA/ACC	CS, L	USA	√	-	√	√	-
Naturland	CS, L	Europe	√	-	√	√	√
Friend of the Sea	C,S	Global	-	-	√	-	-
Seafood Watch	C, L	USA	-	-	√	-	-
ATJ	C, L	Japan	-	-	√	√	?
FEAP code of conduct	C	Europe	√	√	√	√	√
SQF	S, L, CS	Global	√	-	-	-	√
BRC	S, L, SC	Global	√	-	-	-	√
QCS	CS, L	Global	√	-	-	-	√
Fairtrade	L	Global	-	-	-	√	-
ISO 22000	S	Global	√	-	√	-	√
ISO 9001/14001	S	Global	-	-	√	-	√
MSC	C, S, L	Global	-	-	√	-	-
Fair-Fish	S, L	Switzerland	-	√	√	√	-
ISEAL	S, C, L	Global	-	-	√	√	-
Scottish salmon producers organization (SSPO), (COGP)	C, L	Global	√	√	√	-	√
Pêche responsible Carrefour, France	C, L	Global	-	-	√	-	-
Tartan Quality mark (Scottish)	C, L	Global	√	√	√	-	√
SIGES Salmon Chile	CS, L	Europe/USA	√	√	√	-	√
Shrimp quality guarantee ABCC, Brazil	CS, C, L	UK, Europe	√	√	√	√	√
Thai quality shrimp, GAP, Thailand	S, L	Europe/USA	√	-	-	-	√
COC certified Thai shrimp, Thailand	S, L	Europe/USA	√	√	√	√	-
IFOAM	S, L	UK, Europe	√	√	√Organic	√	√
Soil Association	S, L	UK	√	√	√Organic	√	√
Agriculture Biologique	S, L	Europe	√	√	√ Organic	-	-
Bioland, Germany	CS, L	Europe	√	√	√ Organic	-	-
Bio Gro, New Zealand	S, L	Global	√	√	√ Organic	-	-
Debio, Norway	CS, L	UK, Europe	√	√	√ Organic	-	-
Krav, Sweden	C, L	Europe	√	√	√ Organic	-	-
BioSuisse	C, L	Switzerland	√	√	√ Organic	-	-
NASAA, Australia	C, L	Europe	√	√	√ Organic	-	-
Irish Quality salmon and trout	C, L	Europe	√	√	√ Organic	-	√
Label rouge, France	C, L	France, EU	√	-	-	-	√
La truite charte qualité	C, L	France, EU	√	-	-	-	√
Norway Royal Salmon	S, L	Europe	√	√	-	-	√
Norge Seafood, Norway	S, L	Europe	-	-	√	-	-
Qualité aquaculture de France	S, L	France / EU	-	-	√	-	√
Shrimp Seal of Quality, Bangladesh	S, L	Global	√	-	√	√	√
China GAP	C, CS	Global	√	√	-	-	√
Fishmeal and fish oil Code of Responsible Practice (CORP)	C, CS	Global	√	-	√ Sustainability	-	√
The responsible fishing scheme	C, CS	U.K	-	-	√ Responsible fishing	√ Safety of fishers	-

[97] FAO (2009), pages 16-17.

[98] Note that animal welfare problematic is not addressed by any of these requirements, situation brought into attention of stakeholders during the Round Table on co-labelling and certification in fisheries sector, held in The Hague in April 2009.

APPENDIX 6.[99] Guide to unique identification of traceable units

In order to assure the efficiency of the traceability system, the traceable units have to be uniquely identified. Furthermore, a minimum of additional information has to be linked to the traceable units throughout their lifetime. Later on, these data may be accessed via the unique identification number. Common practice for creation of the smallest traceable unit varies in different industries. In the fish farming business a bucket of roe, a full containment of a well boat or a fish crate are typical TUs. In the capture fish sector, a crate of fish is a typical TU.

The GS1[100] numbering system

GS1 administers a global number system for identification and description of items. Traceability standards recommend the use of the GS1 numbers for unique identification for TUs and LUs. The concept of the GS1 128 symbology is to code a set of data elements frequently used in trade and logistic (*i.e.* Net weight, Production date, etc) and explain the meaning of the data elements by using a prefix called an Application Identifier (AI). Hence, the AI identifies the meaning and the format of the data that follows it (data field). In the example data (3101) 05545, 3101 is the Application Identifier telling that this data element means Net weight with an accuracy of one decimal, and 05545 specifies the Net weight to be 554,5 Kg.

The GS1 128 Symbology provides adequate predefined data elements to enable unique identification of both Trade Unit and Logistic Unit.

Uniquely identifying the Logistic Unit

GS1 provides a globally unique data element for the identification of a Logistic Unit, called SSCC (Serial Shipping Container Code). A pallet of fish crates or 20 meters containers of fish are typical logistic units. Traceability standards require that the IDs of

[99] http://www.tracefood.org/index.php/GTP:Unique_Identification (accessed: 01.05.2009).
[100] GS1 is a global organization which main activity is the development of the GS1 System, a series of standards designed to improve supply chain management. The GS1 Identification System provides two types of identifiers. The first or primary identifiers are called GS1 Keys like the Global Trade Item Number (GTIN) or Global Location Number (GLN). (www.gs1.com, accessed: 02.05.2009).

the separate TU's within the LU shall be linked to the LU identifier, in practice to the SSCC.

The SSCC number structure is (00) 235467985462312345, were 00 is the Application Identifier and the following figure is an 18 digit unique number.

Uniquely identifying the Trade Unit

The GS1 128 Symbology does not have one single data element for the unique identification of a Trade Unit (*i.e.* a particular fish crate). However the symbology provides a trade item number, named GTIN, which identifies a variant of Trade Units (*i.e.* crate of 20 Kg fresh Superior Atlantic salmon of 4-5 kg each fish). GTIN is an abbreviation for Global Trade Item Number.

To uniquely identify the particular crate, one has to add one or more predefined data elements. In the traceability standards this identifier is called GTIN+, where the + indicates that additional information is needed for this purpose.

To make up the GTIN+, the GTIN (AI 01) must be combined either with a Batch number (AI 10) and a Serial number (AI 21), or only with the Date and time of production (AI 8008).

GS1 defines the Batch number as an internal number of a production batch. It is common practice to allocate this number to all produced units with similar properties (*i.e.* origin / farm area, time of arrival, supplier, etc) and/or produced within a certain time period (*i.e.* one hour, a shift, one day, one week, etc). Since most commonly many Trade Units are given the same Batch number, unique identification of each separate Trade Unit demands further specification. An appropriate solution is to allocate a Serial Number to each produced Trade Unit (*i.e.* a meat crate).

Using example data, the GTIN+ applying the Batch- and Serial number looks as follows:

(01)07038010000065(10)123456(21)1234567890

The second alternative is to make up a unique identification of a Trade Unit by combining the GTIN and Date and Time of production (AI 8008).

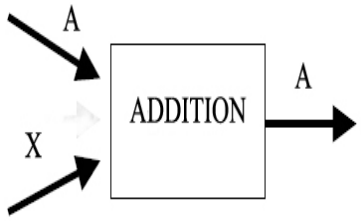
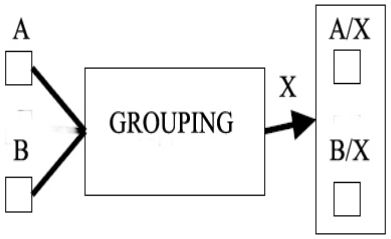
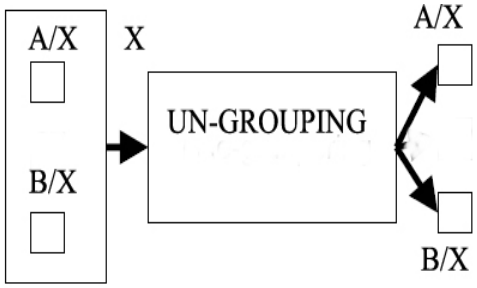
Exemplified with real data GTIN+ may be presented as follows:

(01)07038010000065(8008)040915125603

The figures behind AI (8008) have a structured format, meaning year/ month/ time/ minute/ second.

In some cases a Logistic Unit and a Trade Unit will be of equal size (*i.e.* a full containment of a cargo boat carrying grain).

APPENDIX 7[101]. Additional types of operations/transformations of traceable units and their linked data.

1. Addition. During processing, additional ingredient(s) are added to the product. Since the ID-code is still unique to the product, it is continued to be used although the processing records should identify the ID-code(s) of the ingredient(s) used. Example: Brining operation. The same ID-code would be kept by the fish after this process step, although the processing records would show the ID-code of the salt used to produce the brine (as well as brine strength, time pf processing etc.)	
3. Grouping. Trade units are grouped in a logistic unit. The ID-codes of the separate TU's within the LU shall be linked to the LU identifier. Example: A slaughterhouse has defined the day's production of slaughtered salmon as a batch. The batch is splitted to be packed in crates (TUs), and the crates are arranged on pallets (LUs).	
4. Un-grouping. Logistic trades are un-grouped in trade units. The ID-codes of the separate TUs from within the LU have to be linked to the LU identifier. Example: A slaughterhouse produces pallets (LUs) with crates (TUs) of 3-4 kg and 5-6 kg fresh salmon. The LUs are transported to a distribution terminal. One client wants 5⅓ pallets with crates of 3-4 kg, and 3⅓ pallets with crates of 5-6 kg. The pallets are un-packed, the crates counted and packed again.	

[101] Based on Karlsen, K.M.; Olsen, P. and J. Storøy (2006), pages 11-12, and Derrick, S.; Dillon, M. (2004), pages13-14.