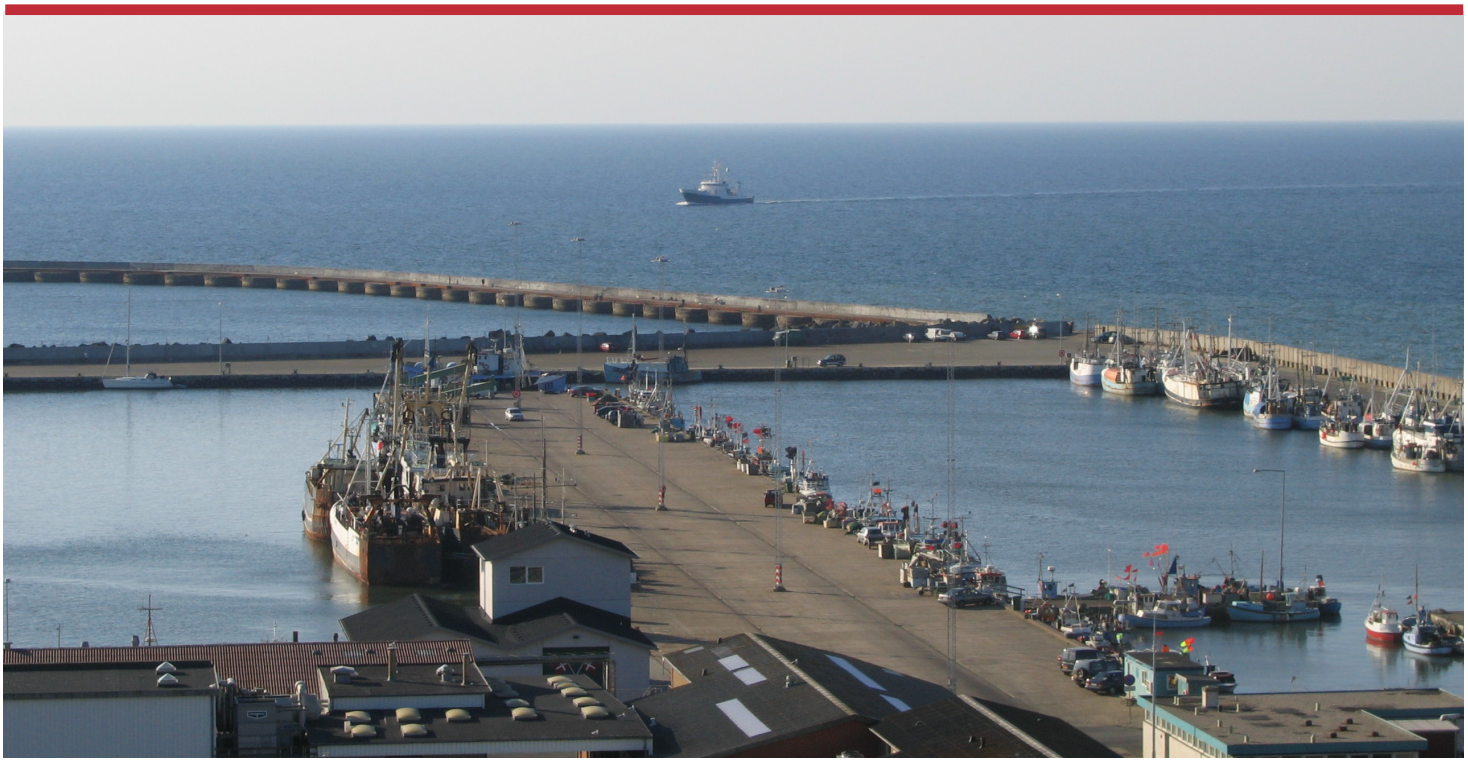
A study of traceability and quality assurance in fish supply chains



Maria-Louise Randrup Rasmussen
PhD Thesis
2012

DTU Food
National Food Institute

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Abstract

Due to declining sales of fresh fish to the European market over the last decade, there is a need for Danish fish supply chains to enhance the appeal of their products and services. The main objective of this thesis is to give suggestions as to how the operations in a fish supply chain can be improved in order to increase the chain's competitiveness.

The development in the legal requirements for traceability of fish in the European Union has been studied and reported. The traceability of fish products in actual supply chains was investigated by tracing the path of a fish product from a retailer and as far back to the origin as possible and tracking the batches containing the fish product forward in the distribution networks. The investigations revealed inadequate traceability and information loss along some of the chains.

Case studies were conducted to gain insight into the current practices of two fish supply chains that had three companies in common. These studies were conducted as semi-structured, personal in-depth interviews with representatives from each company in the chains.

It appears that there are some aspects of the fish handling and storage that the steps can improve. Procedures for handling and storage of fish onboard the fishing vessels, at the collector and at the auction in the case studies were compiled. It is recommended that the raw material steps adjust their procedures accordingly.

The study showed that the communication in the chains is not optimal, since some of the steps do not receive the information types that they would like, even if the information exists and is easily available. Some steps were not satisfied with the quality of the fish and had some wishes in this regard. On the basis of these and similar results, a list of suggestions on how the operations can be improved within quality of fish, information flow, and traceability was prepared. Some suggestions are recommendable to institute without much delay, such as ensuring that the fish boxes have excess ice at all times and that the graders at the collector are more careful when assessing the freshness of the fish. It is recommended that the information types that are readily available and wanted, such as the catch date, vessel ID, and landing place, are forwarded. Sharing such information also contributes to raising the trust in the chain.

One of these suggestions is to grade cod weighing 2-3.99 kg/fish into two size categories instead of one prior to sale at the auction. The effects of this suggestion were simulated in a mathematical model. It was found that the average prices of each of the new categories would have to be rather high for the auction to be able to obtain a change in revenue for cod weighing 2-3.99 kg/fish of just 2% (under certain assumptions).

The suggestions for improving the operations of the chains can benefit the competitiveness of the chains because the products are fresher upon arrival at the retailer and have a longer shelf life. In addition, there is less variation in the quality of the fish, more information about the fish products is available for the steps and for the consumers, and customers know they can trust the information and the quality of the fish from the steps in the chains. These initiatives are expected to result in a higher product value and an increase in the value of the chains leading to improved competitiveness.

Resumé

På grund af faldende salg af fersk fisk til det europæiske marked over det sidste årti er der behov for, at de danske fiskeforsyningskæder forbedrer deres produkter og services. Hovedformålet med denne afhandling er at give forslag til, hvordan driften i en fiskeforsyningskæde kan forbedres, således at kædens konkurrenceevne forøges.

Udviklingen i de lovpligtige krav til sporbarhed af fisk i den Europæiske Union er blevet undersøgt. Sporbarheden af fiskeprodukter i faktiske forsyningskæder blev undersøgt ved at spore et fiskeprodukt fra en detailhandler og så langt tilbage til oprindelsen som muligt og ved at spore partier indeholdende fiskeproduktet frem i distributionsnetværkene. Undersøgelsen viste utilstrækkelig sporbarhed og tab af information i nogle af kæderne.

Case studier blev udført for at få indsigt i nuværende praksis i to fiskeforsyningskæder, der havde tre virksomheder til fælles. Studierne blev udført som semi-strukturerede personlige dybdeinterviews med repræsentanter fra hver virksomhed i kæderne.

Det ser ud som om, at der er nogle aspekter af behandling og opbevaring af fisk som trinene kan forbedre. Procedurer for behandling og opbevaring af fisk ombord på fiskefartøjerne, på samlecentralen og på auktionen i case studierne blev udarbejdet. Det anbefales, at råvaretrinene reviderer deres procedurer efter de anbefalede tiltag.

Studiet viste, at kommunikationen i kæderne ikke er optimal, idet nogle af trinene ikke modtager de informationstyper, som de gerne vil have, selvom informationen eksisterer og er nemt tilgængelig. Nogle trin var ikke tilfredse med fiskekvaliteten og havde nogle ønsker i forhold til dette. På baggrund af disse og lignende resultater blev der udarbejdet en liste med forslag til, hvordan driften kan forbedres indenfor kvalitet af fisk, informationsflow og sporbarhed. Nogle forslag kan gennemføres uden det er nødvendigt med større tiltag, som for eksempel at sørge for, at der hele tiden er overskud af is i fiskekasserne, og at dem der sorterer på samlecentralen er mere omhyggelig, når de skal vurdere friskheden af fisk. Det anbefales, at de informationstyper, der er nemt tilgængelige og ønsket, fx fangstdato, fiskefartøjets navn/nummer og landingssted, bliver videresendt. Videregivelsen af disse informationstyper bidrager også til at øge tilliden i kæden.

Et af forslagene er at sortere torsk, der vejer 2-3,99 kg/fisk, i to størrelseskategorier frem for én, inden fisken sælges på auktionen. Effekterne af dette forslag blev simuleret i en

matematisk model. Det blev fundet, at gennemsnitspriserne på hver af de nye kategorier skal være ret høje for at auktionen kan opnå en ændring i indtægterne for torsk på 2-3,99 kg/fisk på bare 2% (under visse forudsætninger).

Forslagene til at forbedre driften i kæderne vil gavne konkurrenceevnen i kæderne fordi produkterne bliver friskere ved ankomst til detailhandleren og har længere holdbarhed. Samtidig bliver der mindre variation i kvaliteten af fiskene, mere information om fiskeprodukterne er tilgængelig for trinene og for forbrugerne, og kunderne ved at de kan stole på informationen og kvaliteten af fiskene fra trinene i kæderne. Disse tiltag forventes at resultere i en højere værdi for produktet og en højere værdi af kæderne med bedre konkurrenceevne til følge.

Preface

This thesis is submitted as a requirement for obtaining the Ph.D. degree at the Technical University of Denmark (DTU). The study was carried out at the Division of Industrial Food Research at DTU National Food Institute in Kgs. Lyngby during the period from August 2007 to March 2012 and was funded by DTU.

Initially, the main supervisor of this Ph.D. project was senior research scientist Jette Nielsen, DTU Food, with researcher Marco T. Frederiksen, Ph.D., DTU Food, and professor Jens Clausen, DTU Management, as co-supervisors. As of January 2010, due to Jette Nielsens retirement, the main supervisor has been associate professor Bo M. Jørgensen, DTU Food. Early in the Ph.D. project period, co-supervisor Marco T. Frederiksen joined Eurofish International as senior project manager. Mid-2010, co-supervisor Jens Clausen passed away. All my supervisors are thanked for their involvement and support of the project. I especially wish to thank Marco T. Frederiksen for introducing me to traceability and for inspiring discussions and Bo M. Jørgensen for encouragement and constructive advice at the later stages.

The people in the fish industry that I have visited and interviewed, and whose wish for anonymity I respect, are gratefully acknowledged for their participation and time.

Anne C. Bech from Consumer Insight is sincerely thanked for valuable advice during the preparation of Paper IV. Additionally, I would like to thank my former colleagues Toke Koldborg Jensen and Erling P. Larsen for traceability discussions. M.Sc. students Haiping Wu and Sanna í Túni Nielsen, both of whom I have been co-supervisor for, are thanked for their project results and interest in the subject.

My sister and brother deserve thanks for all their help. I am also grateful to Philippa and Brigid for broadening my horizons and for always being overly joyful when I come home. Finally, I owe my gratitude to my husband, Sten, for his utmost patience and time for discussions.

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List of papers

This thesis is based on the following papers:

Paper I
Randrup, M. (2007). *American and EU legislation and food management standards: A comparative study of food traceability requirements with a focus on seafood products*. Technical report. Kgs. Lyngby, Denmark: Technical University of Denmark, National Food Institute.

Paper II
Randrup, M., Storøy, J., Lievonen, S., Margeirsson, S., Árnason, S. V., í Ólavsstovu, D., Frosch Møller, S., & Frederiksen, M. T. (2008). Simulated recalls of fish products in five Nordic countries. *Food Control, 19*(11), 1064-1069.

Paper III
Randrup, M., Wu, H., & Jørgensen, B. M. (2012). On the track of fish batches in three distribution networks. *Food Control, 26,* 439-445.

Paper IV
Randrup, M. & Bech, A.C. Systematic use of stimuli in in-depth interviews to uncover the information flow in supply chains. (Manuscript submitted to *Food Quality and Preference*)

Paper V
Randrup, M. (2012). *Case studies of quality, quality assurance, and traceable information in auction-based fish supply chains*. Technical report. Kgs. Lyngby, Denmark: Technical University of Denmark, National Food Institute.

Additional publications that I have co-authored, but which are not included in the thesis:

Frosch, S., Randrup, M., & Frederiksen, M. T. (2008). Opportunities for the herring industry to optimize operations through information recording, effective traceability systems, and use of advanced data analysis. *Journal of Aquatic Food Product Technology*, *17*(4), 387-403.

Randrup, M. & Frederiksen, M. (2007). *Traceability - a literature review*. SEAFOODplus Publication Series, Report 6.1.2. ISBN 978-87-7075-004-2.

Frederiksen, M. T., Randrup, M., Frosch, S., Storøy, J., Forås, E., Senneset, G., Zachrau, R., Olavsstovu, D., Margeirsson, S., Arnason, S. V., Östergren, K., Janson, C. G., Olsen, P., & Karlsen, K. M. (2007). *Integrating Food Safety and Traceability (IFSAT)*. Oslo: Nordic Innovation Centre.

List of abbreviations

BRC – British Retail Consortium
BSE – Bovine Spongiform Encephalopathy
DKK – Danish kroner
EU – European Union
FAO – Food and Agriculture Organization
IFS – International Food Standard
ISO – International Organisation for Standardisation
MSC – Marine Stewardship Council
nvCJD – new variant Creutzfeldt-Jakob Disease
QIM – Quality Index Method
RFID – Radio Frequency Identification
SIF – Sporbarhed i fiskeriet (Traceability in fisheries)
Vessel ID – Vessel identification

1 Introduction

1.1 Background and objectives

The Danish fresh fish sector has experienced declining sales to the European market over the last decade (Danish AgriFish Agency and Statistics Denmark, 2012). Due to increasing competition from for example Norway and Iceland, there is a need for Danish fish supply chains to enhance the appeal of their products and services. Some reasons for this are that it is not possible to deliver large amounts of fish due to limited resources and that the suppliers in the other countries have become better at handling the logistics in the supply chain. Thus, where being close to the European market was an advantage for the Danish fish suppliers earlier, this cannot be relied on longer and other parameters must be brought into play.

It is indeed relevant to consider the companies, or steps, in the fish industry as supply chains since fresh fish landed in Denmark may pass through the hands of several companies before ending at a retailer. The handling of the fish in one company affects the fish on its way downstream in the supply chain. Information about the fish that is known in one company may be useful and desired by one or more of the other companies that the fish passes through.

The competitive edge of the fish supply chains can be strengthened by increasing the value of the whole chain. It is proposed that this can be done by, among other things, improving the traceability at each step and in the chain, ensuring proper handling and storage of the fish, establishing quality assurance procedures at the steps, optimizing the use of information about the fish, and improving the confidence among the steps in the chain. A traceability system is not only useful to identify fish in the event of a recall, but can also be used as a means of forwarding information about the fish, which can be used by the companies internally or by the retailer for marketing towards the consumers. Proper handling and storage of the fish ensures longer shelf life of the fish and may bring in higher revenues at the auction and further downstream in the chain.

With these issues in mind, the objectives of this study were to find out:

- What are the legal requirements for traceability of fish products?
- What is the status of traceability in the fish industry?
- What are the current views and practices in fish supply chains concerning quality, information about the fish, traceability, feedback, and relationships of trust?
- How can the operations of a chain be improved using traceability, information about the product, and a quality assurance approach?

1.2 The approach

As background material, the legislative requirements of fish traceability were studied and compared to the requirements for traceability in three food management standards. Further background material was provided by investigations into the traceability of fish products in actual supply chains. This included both the tracing of fish products back to the fishing vessels or fish farms and the tracking of the batches containing the fish product forwards in the chain.

Then, the current practices of two fish supply chains having three companies in common were studied in detail concerning their views on quality, the process steps, the flow of information, traceability, and the state of feedback and trust in the chain. This study was conducted as qualitative interviews. For this purpose, an interview guide was designed which included a technique involving cards for categorization.

On the basis of the current practices and the companies' own ideas for improvement, a list of suggestions on how the operations can be improved was compiled. The effects of one suggestion were simulated using a mathematical model in order to provide an evaluation of whether the suggestion could be worthwhile to implement.

1.3 Outline of the thesis

This thesis is divided into seven chapters. Chapter 2 provides a background on traceability in the fish industry. The chains used for the case studies and the methodology employed for collection of data are described in Chapter 3. The next two chapters embrace the results of the case studies: Chapter 4 deals with maintaining the freshness of fish and associated procedures for quality assurance while Chapter 5 examines the information flow and traceability as well as trust in the chains. Both Chapters 4 and 5 propose suggestions to improve the operations of the chains. One of these suggestions is explored further in Chapter 6, in which the effects of the suggestion are simulated in a model. Finally, the conclusion and future perspectives are presented in Chapter 7. Papers I-V are enclosed as appendices.

2 Traceability

The occurrence of various food scandals in the 1980's and 1990's set off an amplified interest in traceability in the food chain in order to assure food safety, public health, and consumer confidence in the food supply. The food scandals include the BSE/nvCJD (Bovine Spongiform Encephalopathy/new variant Creutzfeldt-Jakob Disease) crisis in the UK beef industry, the dioxin contamination of fat used in animal feed in Belgium, and outbreaks of *Salmonella* and *E. coli* contamination as well as listeriosis (Shears, Zollers, & Hurd, 2001; Knowles, Moody, & McEachern, 2007). Such events have demonstrated to food business operators that deficiencies in the traceability of products in the food supply chains can have detrimental effects, as the companies may not be able to account for which batches have been contaminated and which batches are not contaminated. This will lead to the necessity of recalling all their products from the market.

The increased focus on traceability and the need to be able to perform targeted and accurate withdrawals in order to avoid "the potential for unnecessary wider disruption in the event of food safety problems" (EU, 2002) led to the enactment of new legislation in the European Union requiring one up, one down traceability in the feed and food supply chains. This requirement, found in Article 18 in EU Regulation 178/2002 (EU, 2002), means that food business operators shall be able to identify any person who has supplied them with a food and the businesses to which their products have been supplied. Details about the requirements of this article as well as a comparison to the American food traceability requirements are found in Paper I.

The traceability requirements for fisheries products became more stringent upon the passing of the new Control Regulation in 2009: EU Regulation 1224/2009 (EU, 2009). This legislation stipulates that the fisheries products must be "put into lots prior to the first sale" (Articles 56 and 58, EU Reg. 1224/2009), and thus, the requirements of Article 18 in EU Reg. 178/2002 are valid for lots, or batches, of fisheries products.

There are certain types of information specifically about fish and fish products which must be available at each company, or step, in a supply chain (Table 2.1). These requirements have also become tougher, as seen in Table 2.1: there are more types of product information to be recorded and they must be recorded for each lot of fisheries products. In addition, the designation of the catch area has been narrowed down to a smaller body of water than a FAO catch area, as previously required by EU Regulation 104/2000 (EU, 2000) and EU Regulation 2065/2001 (EU, 2001).

Table 2.1. Information types that each step in the chain are required to be made available according to the indicated legislation. (Source: Paper V, Chapter 2)

Legislation	**Information types**
EU Reg. 104/2000, Article 4 and EU Reg. 2065/2001, Article 8	Fish species (commercial name[1] and scientific name[2]) Catch area Production method (caught or farmed)
EU Reg. 1224/2009, Article 58 and EU Reg. 404/2011, Article 67 (the information requirements are for each lot)	Identification number of each lot[3] Identification number and name of the fishing vessel[3] FAO alpha-3 code of each species[3] Date of catch or the date of production[3] Quantities of each species in kg[3] Name and address of the suppliers[3] Whether the fisheries products have been previously frozen or not[1] Information to consumers as stated by Article 8 of EU Reg. 2065/2001[1]

[1]Must also be available to the consumers.
[2]The scientific name was not required to be indicated upon sale to the final consumer according to EU Reg. 2065/2001, but became mandatory to provide to the final consumer according to EU Reg. 1224/2009.
[3]Not applicable for fish products imported into the EU with catch certificates submitted in accordance with EU Reg. 1005/2008.

There are also traceability requirements to comply with if a step considers certification against quality and food safety management standards like ISO 9001, ISO 22000, BRC, and IFS (Paper I). In addition, specific traceability standards have been developed (Paper V, Chapter 2). The Marine Stewardship Council (MSC) Chain of Custody (MSC, 2011) is a certifiable standard that is a requirement for steps that handle fish and fish products from fisheries certified to the MSC environmental standard for sustainable fishing. ISO 12875:2011 (ISO, 2011) lists precise information to be recorded about the fish in a standardized manner, while ISO 22005:2007 (ISO, 2007) specifies the principles and basic requirements for the design and implementation of a food traceability system. ISO 12875:2011 and ISO 22005:2007 are both non-certifiable.

All steps have some level of product traceability. However, their batch size may be rather large, such as one day's or even one month's production of cod fillets. Assurance of food safety and compliance to the legislation outlined above are, however, not the only incentives to implement a higher level of traceability in the food supply chain (Figure 2.1).

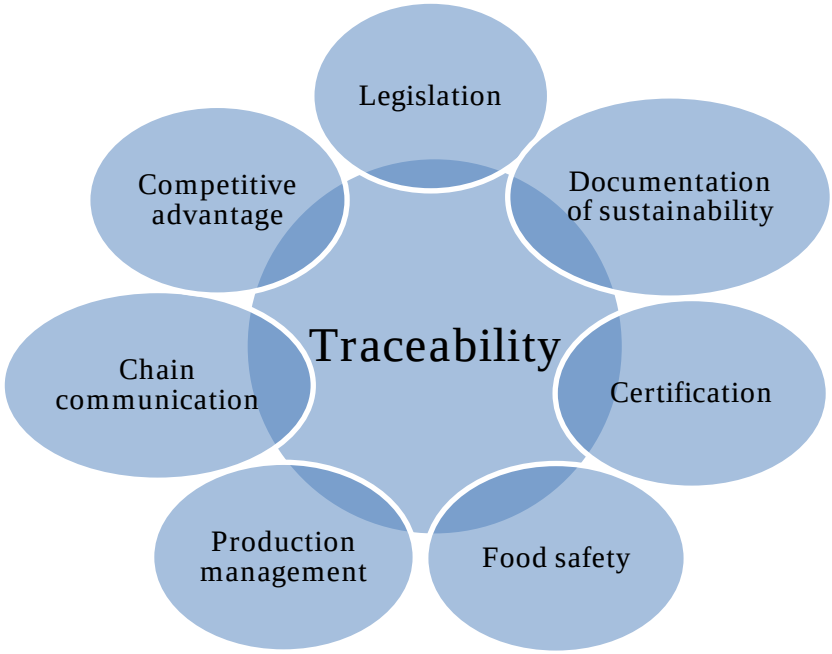

Figure 2.1. Drivers for implementing higher levels of traceability in the food industry. (Modified after Olsen, 2009.)

Traceability can also be used as a tool to create a higher product value and thereby, increase the value of the supply chain. Product and process information provided through the traceability system can be used to differentiate one fish product from another, thus adding value to the fish product. Such information can be used for storytelling towards the consumers, e.g. which fishing vessel caught the fish, where did they catch it, and how did they catch it. Other information transferred through the traceability system can improve production management, for example by contributing to a more precise and reliable assessment of the quality of a fish, by saving time because information known previously in the chain is made available, or for use in industrial statistics and for optimizing the production. Furthermore, traceability can be a tool to enable better chain communication and chain management.

Without a certain level of traceability, these advantages cannot be achieved. The status of traceability in the fish industry has been explored in Papers II and III. Both papers investigated the ability to trace products bought at retailers back to their origins. In these studies, it was possible to trace just over half of the products (Paper II) and two of the three products (Paper III) back to a single fishing vessel or fish farm. These results are attributable to batch mixing and loss of information along the way. In Paper III, the batches from which the products originated at each step were additionally tracked forward in the distribution network. It was possible to identify the end destinations of the batches to the extent that the steps were willing to reveal the identities and the amount sold to

each. Some companies were reluctant to disclose the information to the researcher due to confidentiality.

Similar investigations conducted by Karlsen and Senneset (2006) and Karlsen, Donnelly, and Dreyer (2009) found that 31% and 50%, respectively, of the fish products purchased were traceable back to the origin. Other studies also found that information about the products and processes is lost both internally in a step and externally between steps in seafood supply chains (Pálsson *et al.*, 2000; Frederiksen & Bremner, 2001; Frederiksen, 2002; Frosch, Randrup, & Frederiksen, 2008; Donnelly & Karlsen, 2010; Karlsen, Donnelly, & Olsen, 2011a). Furthermore, there is a need for unique identification of the batches.

Thus, some fish supply chains have basic shortcomings regarding traceability that need to be solved. If information used to identify the fish batches is lost, then there will also be problems in transferring other traceable information to be used for storytelling, for better quality assessment, or other value-adding benefits of traceability.

Paper-based recording and transfer of information is still widely in use in the fish industry according to many studies, for example Mai *et al.* (2010b), Senneset, Forås, and Fremme (2007), Karlsen and Senneset (2006), and Karlsen *et al.* (2011b). In Denmark, an electronic national traceability system for the fish industry, called SIF, has just been launched. The system collects data from several systems, including the fish boxes with affixed RFID tags, the fishing vessels' computers, and the fish auctions' systems (Lyngsoe Systems, 2012). All data is stored in a central database, from which all the steps, including consumers, can access relevant data, e.g. the catch area and catch method of a box of cod. The system makes it easier to comply with the new EU legislation on availability of product information, but also provides promising opportunities for exploiting other uses of the traceable information.

3 Methodology – The case studies

3.1 Design of the study

Case studies of two fish supply chains were performed. The steps were interviewed about their current practices and their views on certain matters (Table 3.1). Based on these, a list of quality assurance procedures for fish handling and storage was prepared and a list of suggestions that may improve the operations in the chain was proposed. One of the suggestions was examined further to find out if it would be economically beneficial to implement.

Table 3.1. Topics covered during the interviews with the steps.

All steps	Raw material steps[1]
Background about the step	Process steps within fish handling and storage
Fish quality, quality assurance, quality variation	
Information flow	
Traceability	
Feedback and trust	

[1]The fishing vessels, collector, and auction.

3.2 Description of chains

The cases dealt with in this thesis comprise two fish supply chains (Figure 3.1). The chains have the auction, processor, and retailer in common and therefore, they will be denoted Chain 1-1 and 1-2.

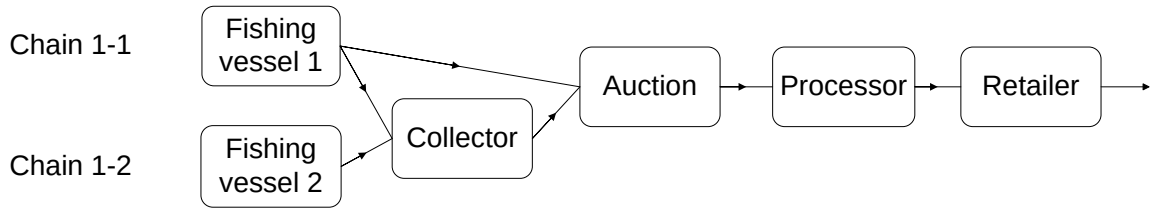

Figure 3.1. The steps in the selected fish supply chain. Arrows show the direction of the product flow.

Fishing vessel 1 is a trawler under 30 m in length. They seapack the fish, meaning that they grade the gutted fish according to species and size onboard before packing the fish in ice in labeled fish boxes. At the auction, the fish is classified into freshness categories. Then, the fish is sold to the highest bid among the registered buyers at the auction. The processor buys fish at this auction, among other places, and may head, skin, and fillet the fish, but also has wholesaler activities, in which the fish is resold whole. One of the processor's customers is the retailer, which is a fresh fish counter at a supermarket.

In Chain 1-2, Fishing vessel 2 is a small vessel under 10 m whose fishing gear is bottom gillnet. Fishing vessel 2 delivers all its fish to the collector ashore, who grades the fish according to species, size, and freshness category before the fish is ready to be auctioned off. Some of the fish supplied by Fishing vessel 2 is marketed as kystfisk (literally "coastal fish" in Danish) which is a so-called brand to which several criteria are associated, among others that the fish has been caught maximum 24 hours before being put up for sale at the auction.

More information about the steps is found in Paper V, Chapter 3.

3.3 Collection of data: Interviews

Six qualitative personal in-depth interviews of representatives of each step in the fish supply chains shown in Figure 3.1 were conducted. The interviews were explorative in nature since the purpose was to collect knowledge about the subject area in order to shed light on possible causal relationships and to obtain a deeper understanding of the behavior and motives of the steps in the chain (Bech, 2009; Andersen, 2006). Interview guides were used to direct the course of the interview and ensure that all the topics were covered. The sections in the interview guide reflect the topics shown in Table 3.1. Details of the interview guide and data processing are found in Paper IV and in Paper V, Chapter 3.

During the interviews, visual aids such as diagrams and maps were employed as stimuli. Small credit-card sized cards were used to obtain information about the process steps onboard the fishing vessels. The process steps were printed on individual cards and the respondents were asked to place the cards according to the decks on which they take place and in the order in which they are carried out. Another particular use of such cards was in gathering and structuring data about the flow of information in the chain along with the importance and use of the information (Paper IV; Paper V, Chapter 3). For this purpose, up to 21 different types of information about fish and fish catch were printed on cards which the respondents were asked to categorize according to importance and whether they received or forwarded the information. The technique is presented in detail and reflected upon in Paper IV.

4 Quality of fresh fish

Shortly after a fish is caught, the degradation processes begin. These consist of autolytic changes caused by digestive enzymes. Thereafter, bacterial activity causes the quality changes in the fish and the gradual spoilage. The rate of spoilage is dependent on the temperature. Fish is best kept fresh when the temperature of the fish is just below 0°C, which can be achieved by letting ice melt around the fish. Due to the salt water accompanying the fish, the ice will melt at around -0.5°C. To ensure that the ice melts at a reasonable speed, the surrounding temperature, e.g. in a fishing vessel's hold or in an auction hall, should be about 2-4°C (Huss, 1995).

Certain fish sold in the EU must be classified into freshness categories and size categories (EU, 1996). The freshness categories are E, A, or B, where category E represents the freshest fish. The fish can also be categorized as "not admitted" if the fish is unfit for human consumption. The classifications are based on assessment of the fish according to the criteria listed in EU Regulation 2406/96 (EU, 1996). For the group "whitefish," the parameters to be appraised are skin, skin mucus, eye, gills, peritoneum, smell of gills and abdominal cavity, and flesh.

There is some variation in which criteria the investigated steps use to assess the quality of fish (Paper V, Section 4.1). The collector thinks the color of the gills is most important and the auction places emphasis on the clearness of the eyes and the shininess of the skin. The processor and retailer regard the firmness as most significant, whereas this criterion is not even mentioned by the collector and auction. This is inconsistent with the table in EU Regulation 2406/96 (EU, 1996) listing all the parameters to be assessed and which freshness category the assessment corresponds to. That is, it is all the parameters that must be assessed and not just a few of them. In addition, there appears to be some divergence in the understanding of the concept of freshness, or at least how to assess freshness. Looking at the steps from a chain perspective, it is important that they have a common "language" in this regard.

The processor has a number of requirements regarding the quality and handling of the fish that he buys at the auction, but it appears that these requirements are seldom fulfilled (Paper V, Section 4.1). Among other things, the processor is dissatisfied with the variation in the quality of fish within freshness category A. The collector and auction are aware that freshness category A covers a broad range of degrees of freshness, but point out that the buyers are responsible for assessing the freshness of the fish and for

determining the use of the fish. However, the processor has also experienced that fish of different freshness categories has been mixed in the same batch.

In order to provide a common language to communicate freshness, the catch date may be used. The catch date may also be used to alleviate the broadness of freshness category A by giving a more precise indication of the freshness of the fish. Though, this requires that the catch date is forwarded in the chain and that the fish is always iced. Further, the steps must build up a relationship of trust such that they may be confident that the previous steps in the chain always ensure that the fish is stored in sufficient ice.

It is also a possibility to log the temperature of the fish at small intervals since catch and use this as input in the Seafood Spoilage and Safety Predictor (SSSP) software (Technical University of Denmark, 2009) in order to obtain an indication of the freshness of the fish (expressed as the equivalent number of days in ice) and the remaining shelf life of the fish. However, it is not that easy to obtain temperatures of the fish itself, and not the surroundings. Thus, if one could trust that the fish has always been stored in ice, then the catch date would be a reliable measure of the freshness and subsequent remaining shelf life of the fish on ice. In such situations, the catch date can also be used instead of permanent product assessment upon reception of the fish at each step further downstream in the chain.

The use of the catch date in this way may play a role in enhancing quality awareness throughout the chain, although over the years, the interviewed steps seem to have become more aware of maintaining the quality of the fish (Paper V, Section 4.1). For example, the fishing trips have become shorter, the fish is gutted more thoroughly, and the fish is chilled faster. The quality awareness of the fishing vessels is reflected in the process steps onboard, although there is room for improvement, such as the use of ice during primary grading by Fishing vessel 2. The current practices onboard Fishing vessels 1 and 2 and at the collector and auction are found in Paper V, Section 4.2 along with a collection of procedures for optimal quality assurance at these steps. Based on the number of measures that these raw material steps are recommended to take, it appears that there are some aspects of the fish handling and storage that they can do better. It is possible, though, that the steps did not mention some of their process steps because they thought that it was taken for granted that they did so. It is recommended that the raw material steps take a look at the recommended measures (found in Paper V, Section 4.2) and adjust their procedures.

Other aspects of quality assurance should be introduced, such as a goal of continual improvement and corrective and preventive actions. Continual improvement involves

receiving requirements to the fish (e.g. maximum number of days since catch date, details of catch handling, storage conditions) from the buyers and feedback on their satisfaction with the fish along with the implementation of new procedures based on both the requirements and the feedback. All this necessitates communication within the step and along the supply chain. Preventive actions entail eliminating the causes of potential deviations to prevent them from occurring while corrective actions eliminate the causes of errors that have already occurred. By considering such aspects of quality assurance, the steps cannot only improve their operations internally, but also in relation to the other steps along the chain. Willingness to improve on their operations and to react on feedback are just some factors that contribute to assuring buyers that a step supplies consistently high-quality fish.

Aside from the use of catch date to provide a better assessment of freshness, there are other initiatives that can be taken. Table 4.1 lists the wishes from the steps and suggestions from the author regarding quality issues. It is foreseen that the effects of these suggestions are for example contributions to maintaining freshness, to matching the buyers' needs better, and to assessing the freshness of the fish. Thus, these suggestions are a part of improving the operations in the steps and in the chains. These suggestions could apply to other companies of the same type as well.

As mentioned earlier, the steps are generally aware of how to ensure good quality fish. Based on issues that the steps have raised leading to the suggestions in Table 4.1, it appears that they can improve and that more awareness and action is necessary. Some suggestions are recommendable to institute without much delay, such as ensuring that the fish boxes have excess ice at all times, that the graders at the collector are more careful when assessing the freshness of the fish, and that the criteria for the labeling program "kystfisk" are agreed upon and put in writing. Other suggestions are also recommendable, but they may require larger investments and/or it would be advantageous to perform a simulation of the effects of the suggestion to find out if the effect is as desired and if the suggestion is economically feasible. Examples of such suggestions are the installation of a slush ice machine onboard the vessel, implementing QIM at the auction, or the division of freshness category A into subcategories.

Table 4.1. Suggestions for improvement of operations in the chains which relate to quality and quality assurance and their supposed effects. (Adapted from Paper V, Section 4.5.)

Suggestions	**Supposed effects**					
	Maintain freshness	Match buyers' needs better	Contributes to the assessment of freshness/ quality	Fewer com-plaints	Saves time	Story-telling/ marketing
Excess ice in all boxes at auction	*					
Use of slush ice for chilling onboard; more chilling	*					
Low temperature in auction hall[1]	*					
Low temperature at processor's packing room	*					
Shorter fishing trips	*					
Improvement of catch handling (at sea)	*					
Seapacking by more vessels	*					
No mixing of fish of different freshness categories at collector/ auction		*	*		* for buyers	
More careful quality assessment by the collectors		*	*	*	* for buyers	
More careful labeling of fish at the collector		*	*			
Better reviews of criteria for quality assessment among the packers at the processor			*	*		
Access to catch date by all steps			*			*
Written rules for kystfisk			*			*
QIM at auction			*			
Sufficient labeling[2] by suppliers					* for buyers	
Smaller size intervals at the auction		*				
Division of freshness category A into subcategories		*	*		* for buyers	

[1] fish 0°C, room 2°C

[2] including compliance to legislative requirements regarding labeling of supplied fish

5 Information flow, traceability, feedback, and trust in fresh fish supply chains

5.1 Information flow and importance of the information types

The flow of information in each step and through Chains 1-1 and 1-2 and the importance of the information for each step were investigated (Paper V, Section 4.3). The three types of product information required by EU Reg. 104/2000 and EU Reg. 2065/2001, namely the fish species, the catch area, and the production method, are generally passed through to each step in the chains. The processor and retailer sometimes do not receive the production method and the processor sometimes does not receive the catch area. It was not investigated whether the steps received all the product information types required by EU Reg. 1224/2009 and EU Reg. 404/2011 (see Table 2.1) since these legislations were not passed at the time of the investigation.

Aside from the three information types mentioned above, Fishing vessels 1 and 2 generate ten and eight types of information, respectively, that are relevant to the individual fish. In both Chains 1-1 and 1-2, the retailer receives maximum five of these ten and eight types of information, respectively (see Chain 1-1 in Figure 5.1). These are the information types that are available to the retailer for marketing the fish towards the consumers. Of these, only three are sometimes communicated to the consumer: landing date, catch method of plaice, and size grade of the whole fish.

There are two information types that are classified as most important by five of the six steps studied: the size grade of whole fish and the sales weight. The sixth step is Fishing vessel 2, for which these information types are irrelevant. These information types are essential to know to be able to trade the fish according to the five steps. This explains why these information types are forwarded through the whole chain. There are other information types that the auction and processor denote as essential; they are either generated by the steps themselves or always received by these two steps. For details on the information flow and importance of the information types for the steps in Chains 1-1 and 1-2, please refer to Paper V, Section 4.3.

There are six information types that the steps do not or only sometimes receive even if they consider them most important or important (Table 5.1). The auction checks the weight of random samples from each batch in the auction hall because only ± 5% weight

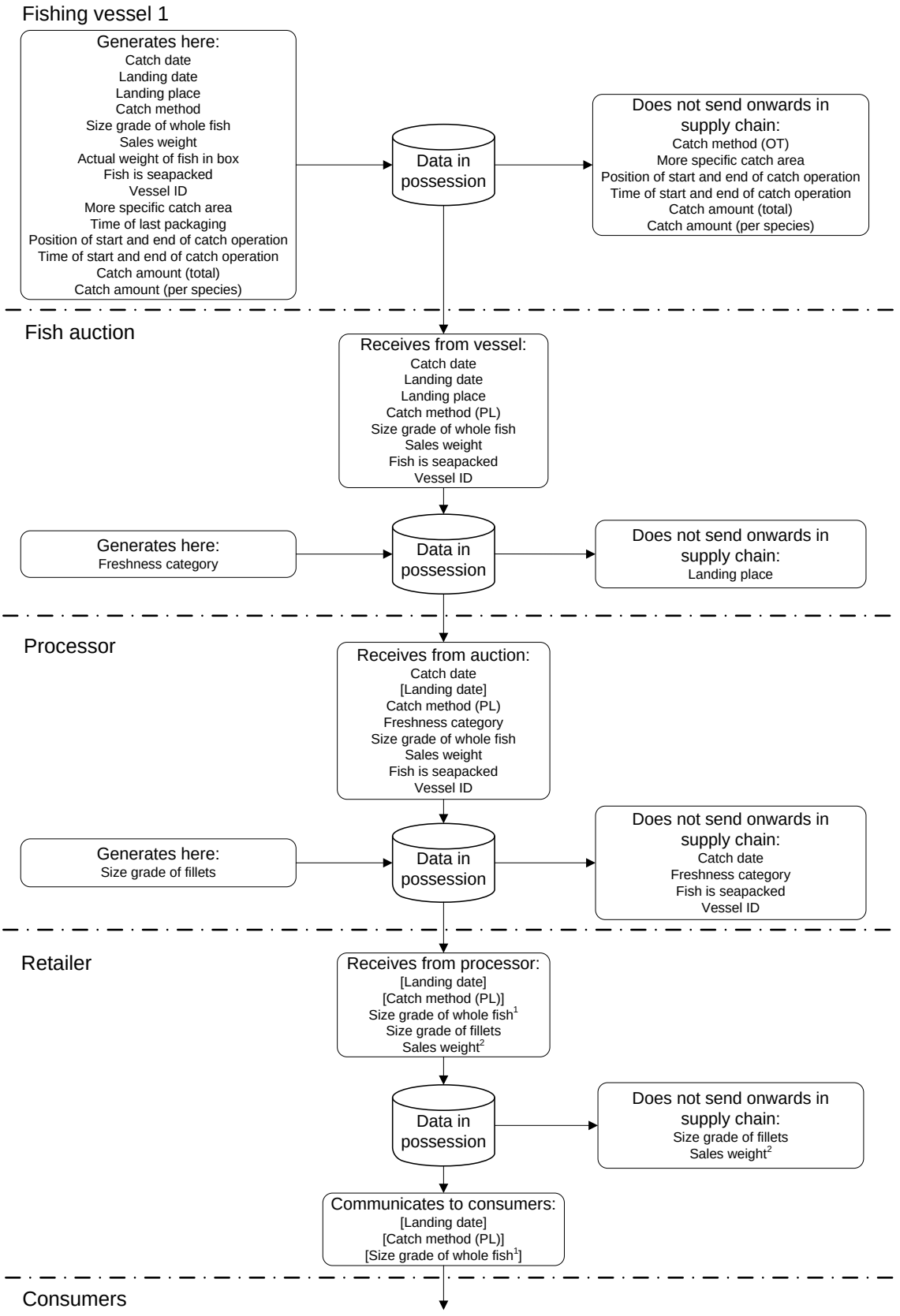

Figure 5.1. The information flow in Chain 1-1, which starts with Fishing vessel 1. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species. [1]Fish that is traded whole. [2]Sales weight of the box of fish sold at the auction when that box is traded untouched.

deviation is permitted. If this is exceeded, the auction may be fined by the authorities. Therefore, the actual weight of fish in the boxes is important to the auction, and it would be beneficial for the auction to know this information. With regards to the more specific catch area, the auction believes that more detailed information on the catch area is gaining ground and is beginning to be important. The processor would like numbers on the fish boxes or batches of fish boxes at the auction for traceability purposes, such that he easily can link the fish with the intended customer. The retailer considers the catch date as a measure of freshness while he regards the landing date and the catch method as bonus information which he uses for storytelling towards the consumers.

Table 5.1. Overview of the information types which the steps consider important and most important but do not receive or do not always receive (the latter in square brackets). (Source: Paper V, Section 4.3.)

Importance of information	Steps		
	Auction	Processor	Retailer
Most important	Actual weight of fish in box		Catch date
Important	More specific catch area	Fish box no.	[Landing date] [Catch method]

As described, these information types would be useful for the steps to have for their operations for varying reasons. They are examples of information that exists, and that can be transferred further through the supply chain via the traceability system, since they must be linked to fish/batch identifications, but which is not being done. However, a more specific catch area, the catch date, and an identification number for each batch became compulsory to have available at the steps as of January 1, 2012 (EU, 2009; EU, 2011). Though, the catch date might not prove to be so useful because it is permitted to state the catch date as the period of time that the fishing trip lasted (i.e. departure date until landing date).

In addition to the information types in Table 5.1, sustainability information is important, but not received by the auction and the retailer, but since sustainability information in these chains in effect means whether the fish is MSC-certified or not, and neither Fishing vessels 1 nor 2 catch MSC-certified fish, this information type is not listed in Table 5.1.

A summary of the suggestions relating to the reception of information types that could improve the operations in the chains is shown in Table 5.2. Some of the suggestions stem from the investigated steps and some of them are suggestions which the author believes may be beneficial for the mentioned step. For example, the retailer may use the vessel ID as bonus information, as mentioned above. It is now compulsory to have records of the vessel ID at the steps (EU, 2009). Though, the retailer may end up receiving not one but

several vessel IDs since after the first point of sale (i.e. at the auction), it is permitted to mix fish from different vessels as long as all the contributing vessels are listed.

Table 5.1 indicates that the communication in the chains is not optimal, since there are information types that some steps consider important, but do not receive, even if the information exists (e.g. more specific catch area, landing date, catch method). The collection of information types (Table 5.2) that would be useful to receive also indicates that the steps' familiarity with each other is not the best. Otherwise, they would ensure that the other steps received the information they wanted and could use. The steps ought to tell their suppliers which information about the fish they would like and ask their customers which information they would like to receive. It is recommended that the information types that are readily available and wanted, such as the catch date, vessel ID, and landing place, are forwarded along with the fish or transferred to an electronic database such that the steps can retrieve the information that they want. The availability of such information also contributes to raising the trust in the chain.

Table 5.2. Suggestions for improvement of operations in the chains which relate to the reception of various information types and their supposed effects. (Adapted from Paper V, Section 4.5.)

Suggestions (Reception of information type by the step mentioned)	**Supposed effects**			
	Contributes to the assessment of freshness/quality	Saves time	Storytelling/ marketing	Improved traceability
Actual weight of fish in the box by auction		* for auction		
Towing time by processor	*			
Temperature records by processor	*	*		
Catch date by processor and retailer	*		*	
Catch method by auction, processor, retailer	*		*	
Fish is seapacked by retailer and processor	*		*	
Landing date by retailer			*	
Landing place by retailer			*	
Sustainability/ MSC information by processor and retailer			*	
More specific catch area by auction and processor			*	
Vessel ID by retailer			*	*
Batch number by processor				*

5.2 Traceability

The outgoing products at the steps can be traced back to batches of varying sizes: one trawl haul, one day's catch, one day's production of the same species or one day's delivery (Paper V, Section 4.3). Once the processor has purchased some fish at the auction and used it in their production, it appears that the fish cannot always be traced back to either the vessel or the group of vessels that caught the fish. Throughout both chains, a paper trail is used as the means of identifying the fish, with slips of paper either in or on the box of fish or accompanying the box. Combinations of different types of information are used to identify the fish depending on which step the fish is located at.

Due to the new legislation, the steps will have to make changes that improve their traceability systems in order to manage the new information types that they will have to record and forward to the next step. As part of this, the steps also have to give identification numbers for each batch. Several studies report that it is time-consuming to record and send data manually compared to electronically (Chryssochoidis *et al.*, 2009; Mai *et al.*, 2010a; Karlsen *et al.*, 2011b). Based on that, it must be assumed that as more information is linked to the fish product, it becomes more difficult to use a paper-based traceability system.

Enhanced traceability systems can improve the operations of the steps and the chains in various ways. The batches will be linked to an identification number, making it easier to trace the fish in the batch in case of food safety problems and recalls, and thereby minimizing the damage to the company and if relevant, the brand. It would be possible to forward information that the other steps can use e.g. for assessing the quality or for marketing.

5.3 Feedback and trust

In general, the steps say that their relationships of trust with their suppliers and their customers are fairly good (Paper V, Section 4.4). Fish chains 1-1 and 1-2 are of such a nature that the next step in the chain to a certain extent can check if the information given about the fish is correct. The possibility to inspect if the fish received matches the quality that one has been promised by the supplier may serve to increase the relationship of trust provided that there have been no mistakes, whether intentional or not. If the steps have been disappointed by their suppliers repeatedly, the relationship of trust suffers and the steps would probably as far as possible avoid buying fish from their suppliers. In general, there seems to be a good dialog between the different parties, with both positive and negative feedback being exchanged as well as new ideas and wishes.

Positive feedback is important so that the step knows that the product they deliver lives up to or exceeds the expectations of the customer. If a step has introduced a new procedure to improve the quality of the fish, then positive feedback indicates to them that the initiative was worthwhile and gives them an idea of what their customers emphasize. Negative feedback gives the step the opportunity to improve inappropriate procedures in handling, processing, packing, etc.

Developing a trusting relationship between a supplier and a customer means that they trust the information they exchange with each other, which gives the customer the opportunity to optimize their operations, e.g. by planning ahead and using less time on product inspection. An example of the latter is described in Chapter 4 regarding the use of catch date and trust in the other steps to ensure that the fish is properly iced at all times. If more information is exchanged in the chain and the information proves to be correct in the long run, then trust is built up. However, even if the steps have the information, it is not sure that they want to forward them. The processor indicated that he prefers not to inform about the catch date (Paper V, Section 4.3). This is not conducive to a trusting relationship and signifies that a change of attitude is needed at some steps for improved chain cooperation.

6 A simulation of the effects of new size categories at two fish auctions

6.1 Background and objective of the simulation

EU Regulation 2406/1996 (EU, 1996) stipulates which size categories the different species of fish must be divided into before the fish is sold for the first time on Community territory. However, those who sell the fish, e.g. an auction, are permitted to classify the fish into additional size categories as long as the new categories are within the EU-specified categories (Auction, personal communication). The size categories vary according to the fish species.

At the auction studied in Paper V, cod is presently graded into the freshness categories E, A, and B, where E is the freshest, and thereafter into size categories (Table 6.1). Cod of freshness category E and size category 3 is denoted E3. Compared to the EU-specified categories for cod, size category 0 has been added.

Table 6.1. Weight ranges of the size categories for cod.

Category	Weight range (kg/cod)
5	0.30 – 0.99
4	1.00 – 1.99
3	2.00 – 3.99
2	4.00 – 6.99
1	7.00 – 9.99
0	≥ 10.00

According to Fishing vessel 2, the buyers at the auction in general have had a wish that size category 3 for cod (2-3.99 kg) be divided into two categories, i.e. 2-2.99 kg and 3-3.99 kg (Paper V, Chapter 4). The reason for this wish is that among the buyers' customers, there is a large demand for 3-3.99 kg cod, while the demand for 2-2.99 kg cod is not as high. Therefore, the buyers would like to target their purchases at the auction to better match their needs. Upon inquiry, a processor supported Fishing vessel 2's observation, saying that it was easier to sell the 3-3.99 kg cod than the 2-2.99 kg cod.

With respect to the abovementioned EU regulation, it is possible for the auction to make this change. However, if the auction is to change the current size categories, the auction will have to be "convinced" that dividing size category 3 into two categories is a good idea. Thereafter, the auction will communicate the new size categories to the collectors and the seapacking fishing vessels. In order for the new size categories to be accepted by

these steps, it would be best if the auction could give a good indication to these steps that it is worth the extra time and expense to grade cod into one more size category.

A condition for implementing the suggestion is that the suggestion must, at the least, be cost-neutral. It would be preferable if the suggestion could generate so much income that profits can be made. This means that the costs of implementing the suggestion must be compensated for by a higher revenue on average for 2-3.99 kg cod and other changes in a positive direction, for example an increased number of buyers at the auction because they are able to buy cod of a size interval that fits their needs better. The new buyers may normally buy at other auctions where they do not divide size 3 cod further. Thus, the objective is to develop a model that can show whether it is profitable to grade cod weighing 2-3.99 kg into two size categories (2-2.99 kg and 3-3.99 kg) instead of one size category as done currently.

6.2 Description of applied data and definitions

6.2.1 Applied data

Data from two auctions are used as examples. The auctions will remain anonymous and will therefore be denoted Auction 1 and Auction 2. The data has been provided by the respective auctions.

Data from Auction 1 consists of amounts of cod sold at the auction on a weekly basis and the average price per week. The data used is for each size category in freshness category E. Furthermore, the data is labeled if the cod is kystfisk or caught by Danish seine. Almost 82% of the cod is sold as kystfisk while nearly 8% of the cod is caught by Danish seine.

Data from Auction 2 consists of amounts of cod sold at the auction per day and the average price per day. Like for Auction 1, the data used is for each size category in freshness category E, although no data is reported for cod of category E5.

The data from both auctions is from every week or day, respectively, in 2011.

6.2.2 Definitions

E3 = a category describing cod weighing 2.00-3.99 kg/fish
E3a = a new category describing cod weighing 2.00-2.99 kg/fish
E3b = a new category describing cod weighing 3.00-3.99 kg/fish

Input variables:
P_{E2} = price of cod of category E2 (4.00-6.99/cod) (DKK/kg)
P_{E3} = price of cod of category E3 (2.00-3.99 kg/cod) (DKK/kg)
P_{E3a} = price of cod of category E3a (2.00-2.99 kg/cod) (DKK/kg)
P_{E3b} = price of cod of category E3b (3.00-3.99 kg/cod) (DKK/kg)
P_{E4} = price of cod of category E4 (1.00-1.99 kg/cod) (DKK/kg)
W_{E3} = weight of cod of category E3 sold at the auction (kg)
W_{E3a} = weight of cod of category E3a sold at the auction (kg)
W_{E3b} = weight of cod of category E3b sold at the auction (kg)

Parameters:
r = fraction of cod of category E3a within category E3 (weight-based)
s = 1 – r = fraction of cod of category E3b within category E3 (weight-based)

Output variables:
R_{E3} = revenue generated by cod of category E3 (2.00-3.99 kg/cod) (DKK)
R_{E3a} = revenue generated by cod of category E3a (2.00-2.99 kg/cod) (DKK)
R_{E3b} = revenue generated by cod of category E3b (3.00-3.99 kg/cod) (DKK)
ΔR = change in revenue that could be generated by cod of 2.00-3.99 kg/cod if they were graded into categories E3a and E3b instead of E3 (in % of R_{E3})

6.2.3 Known relations

Given the definitions in Section 6.2.2, the equations below may be established. Equation 1 shows that the sum of the weight of cod in categories E3a and E3b is equal to the weight of cod in category E3. In Equation 2, the weight of cod in category E3a is equal to the total weight of cod in category E3 multiplied with the parameter r, which indicates the fraction of cod of category E3a within the fish of category E3. Equation 3 shows a similar relation for cod of category E3b.

$$W_{E3} = W_{E3a} + W_{E3b} \quad \text{(Equation 1)}$$
$$W_{E3a} = r \cdot W_{E3} \quad \text{(Equation 2)}$$
$$W_{E3b} = s \cdot W_{E3} \quad \text{(Equation 3)}$$

In Equations 4-6, the revenue of a category is equal to the price of the same category multiplied with the weight of cod in the same category.

$$R_{E3} = P_{E3} \cdot W_{E3} \quad \text{(Equation 4)}$$
$$R_{E3a} = P_{E3a} \cdot W_{E3a} \quad \text{(Equation 5)}$$
$$R_{E3b} = P_{E3b} \cdot W_{E3b} \quad \text{(Equation 6)}$$

6.3 Assumptions for the model

6.3.1 Assumption #1

Assumption #1 considers the price of the categories and subcategories. Figure 6.1 shows that the average prices of the categories of cod rise in the interval from category E5 (0.30-0.99 kg/cod) to category E1 (7-9.99 kg/cod). The prices are always expressed per kg.

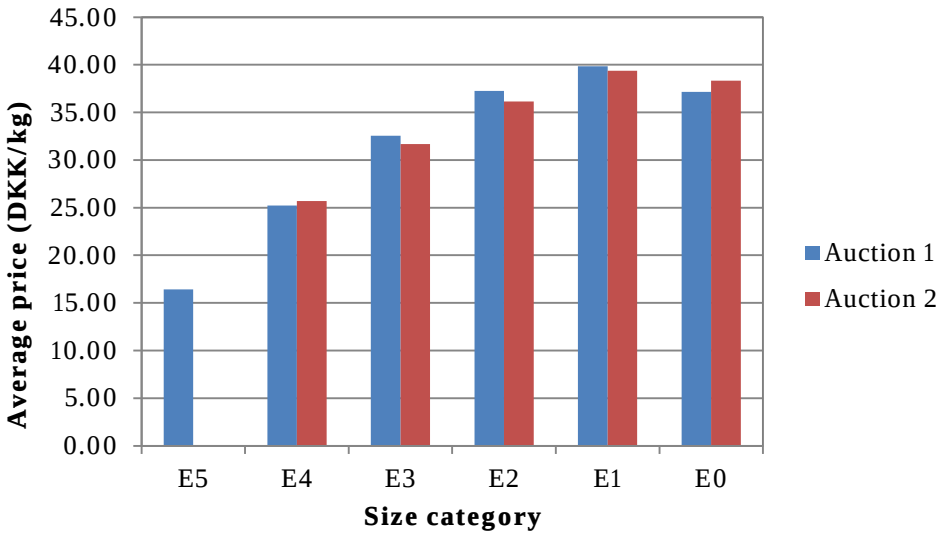

Figure 6.1. Average price of each size category of cod from E5 (0.30-0.99 kg/cod) to E0 (≥ 10 kg/cod). The price is the average over a year.

Since category E3, and hence the two derived categories E3a and E3b, lie in the interval from E5 to E1, it is reasonable to assume that:

$$P_{E4} < P_{E3a} \leq P_{E3}$$

and

$$P_{E3} \leq P_{E3b} < P_{E2}$$

That is, E3a cod (2-2.99 kg/cod) will on average be assumed to achieve a price that is higher than the current average price of the category of cod which are lower in weight (E4; 1-1.99 kg/cod), but not higher than the present average price of E3 cod (2-3.99 kg/cod). E3b cod is assumed to achieve a price within a price range in which the lower boundary is the current average price of E3 cod and the upper boundary is the current average price of the category of cod that weigh 4-6.99 kg/cod (E2). When the boundary is P_{E3}, the ≤ sign is used because E3a and E3b are a part of the E3 category.

When considering the two auctions studied here, the actual intervals which the price of each subcategory is assumed to lie within are as shown in Table 6.2.

Table 6.2. Intervals that the average prices of E3a cod (P_{E3a}) and E3b cod (P_{E3b}) are assumed to lie within at the two auctions.

	P_{E3a} (DKK/kg)	P_{E3b} (DKK/kg)
Auction 1	$25.22 < P_{E3a} \leq 32.54$	$32.54 < P_{E3b} \leq 37.27$
Auction 2	$25.70 \leq P_{E3a} < 31.69$	$31.69 \leq P_{E3b} < 36.16$

The assumptions above about the price ranges of E3a and E3b cod are in line with the apparent larger demand for E3b cod than E3a cod. Thus, it follows that due to larger demand, the average price of E3b cod is assumed not to be lower than the average price of E3a cod. However, it is unknown whether dividing the E3 category into two subsequently will lead to a fall in the demand and thus, the price, of cod of category E3a, but it is assumed that the price of E3a cod will not decrease to below the price of E4 cod.

As mentioned in Section 6.2.1, the data from Auction 1 was described as being cod that was sold as kystfisk, cod that was caught with Danish seine, or cod with no special description. In the determination of the price intervals in Assumption #1, the average price across all these descriptions is used. This decision was made because there is not much difference in the average prices within each description, although certain of them stand out from the rest (Figure 6.2). For example, the average price of Danish seine cod of category E5 is approximately 4 DKK/kg higher than the average prices of kystfisk and cod with no description and the average price of kystfisk of category E1 is around 2.50 DKK/kg higher than the average price of cod with no description.

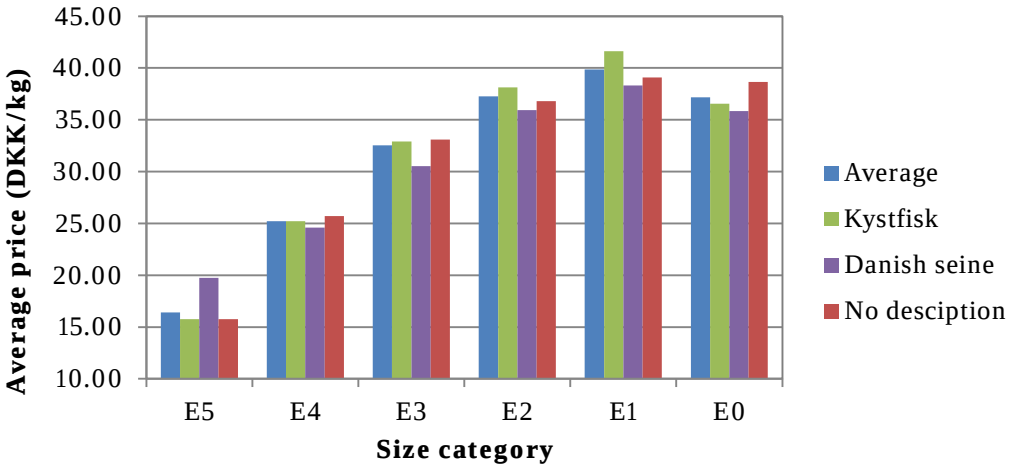

Figure 6.2. Average prices of cod classified as kystfisk, caught with Danish seine, or with no description for each size category at Auction 1 throughout 2011. The average price of all the cod within each size category is also shown.

6.3.2 Assumption #2

A second assumption is that the extra costs of grading the E3 cod into two categories instead of one may be disregarded in the calculations.

Plausible costs of dividing the E3 cod into two subcategories are shown in Table 6.3. In Table 6.3 and in the following discussion on costs, Fishing vessel 1, the collector, and the auction, which refer to the steps in Chapter 3 in this thesis, are used as examples. The auction in Chapter 3 is denoted Auction 1 here.

Table 6.3. Possible costs associated with an introduction of new classification rules at the auction concerning cod weighing 2-3.99 kg/fish that are to be graded into two categories (2-2.99 kg/fish and 3-3.99 kg/fish) instead of one. The steps mentioned are described further in Paper V, Chapter 3.

	Direct costs		Indirect costs
	Item	Involved steps	
Fixed costs	Training of staff	Fishing vessel 1 and collector	More space in the auction hall
	Update of IT-system	Fishing vessel 1 and auction	
Variable costs	An extra fish box per batch	Fishing vessel 1 and collector	
	Extra ice for the extra fish box	Fishing vessel 1 and collector	
	Extra time to grade the cod into an extra size category	Fishing vessel 1 and collector	
	Extra time to conduct the auction and during the settling of accounts due to a larger number of batches	Auction	

Dividing the E3 category into two will require some new instructions and training of the grading staff onboard Fishing vessel 1 and other seapacking vessels as well as at the collector. It should be pointed out that the fish is not to be classified as E3 first and then subdivided into E3a and E3b, but that the fish is to be classified directly into E3a or E3b. On Fishing vessel 1 and the collector, manual grading is used. If grading was done by machine, there may be costs for readjustment of the machine to include the two new categories. This cost, though, is assumed minor compared to the overall cost of maintenance of the machine. The IT-systems used onboard Fishing vessel 1 (e.g. for the seapacking labels) and at the auction will also need some modifications to handle the extra categories. Since these changes are directly related to the new classification, but not dependent on the amounts of fish that are to be graded, they are direct fixed costs. It is

assumed that these costs are minimal, since the graders are experienced and the IT-updates are expected to be rather simple.

For each batch of 2-3.99 kg cod that is graded into the two new categories, the need may arise for one more fish box than otherwise necessary had there only been one category. This extra fish box is the "last" box to be graded, which will contain ≤ 25 kg. (The sales weight of cod in category E3 is 25 kg per fish box.) In the event that there is an extra box per batch, the extra box per batch will require extra ice than previously necessary. In addition, if there are many batches with an "extra" fish box, they may take up more space in the auction hall. The latter is classified as an indirect fixed cost because, if carried through, it entails a new building construction, which may be used for other fish and which is an expense that does not vary with the number of "extra" fish boxes per day.

When grading of fish is done manually, it may take extra time to grade the cod into one extra size category, although the extra time must be considered as minimal. Also, it might appear that when the range of fish weights is narrowed down, it becomes more difficult to attain the right sales weight without giving away too much overweight and also staying within the ± 5% limit as stipulated by EU Regulation 3703/1985 (EEC, 1985). However, the grading becomes more difficult when the fish weights become larger as in category E2, where the sales weight also is 25 kg per box.

When an extra category is created, there will be a larger number of batches to be auctioned off. It may take extra time to conduct the auctioning process. In addition, there will be a larger number of batches to be handled during the settling of accounts. The costs involving extra fish boxes, extra ice, and extra time are direct, variable costs because they change according to the amount of fish to be graded in the E3a and E3b categories.

The auction in Table 6.3 is able to manage differing amounts of fish each day. That is, over a period of a year, there is a large variation in the amount of fish that is handled by the auction each week (Auction 1 in Figure 6.3) and each day (Auction, personal communication). The auction is able to manage the large amounts of fish both in terms of the extra space necessary in the auction hall and in terms of the extra time for auctioning off the fish. In addition, the collector is also able to manage the large amounts of fish with regards to the extra number of boxes needed, the extra ice needed, and the extra time needed to grade the extra fish. The extra box, ice, and time needed on Fishing vessel 1 is without significance since they, too, catch varying amounts of fish. Thus, it is reasonable to assume that the extra costs that may be incurred by grading the 2-3.99 kg cod into two categories may be disregarded in the simulation.

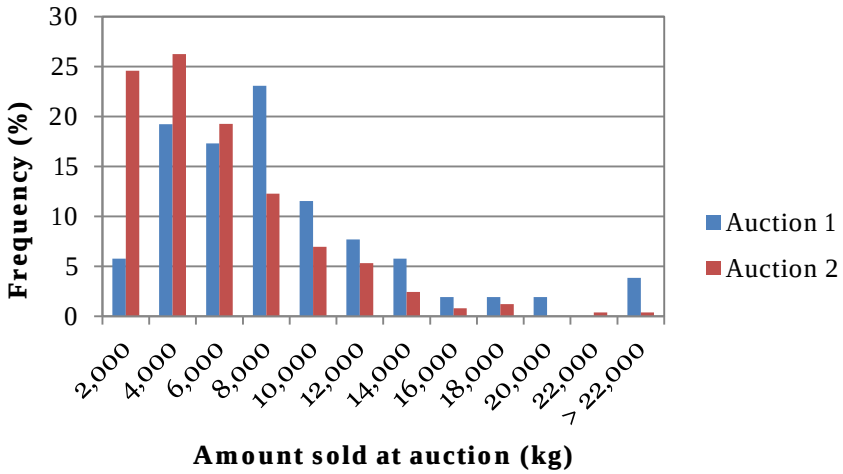

Figure 6.3. Histogram showing the frequency of the amounts of cod of category E3 sold at Auction 1 (per week) and Auction 2 (per day) throughout 2011 in intervals of 2000 kg (i.e. 0-2000 kg, 2001-4000 kg, 4001- 6000 kg, etc.). The frequency is shown as the percentage of weeks (days) that the amounts of sold E3 cod were in the depicted intervals.

Figure 6.3 also shows the distribution of sold amounts of 2-3.99 kg cod according to intervals of total weight in another auction. This auction, Auction 2, sells far larger amounts of fish than Auction 1, and thus, the amounts of E3 cod sold by them is shown per day in Figure 6.3. Nonetheless, the figure shows that this auction is also able to handle extreme amounts of fish on one day.

6.4 The simulation model

Given the definitions, known relations, and assumptions, a formula can be set up in order to calculate the change in revenue as a result of dividing the E3 cod category into two subcategories as a percentage of the "original" average revenue of the E3 cod. This can give an indication of whether it is worth implementing the two new size categories.

The percent change in revenue may be calculated by (1) adding the revenues generated by cod of category E3a and E3b, (2) then finding the difference between that and the "original" revenue of category E3, and (3) dividing the difference with the "original" revenue of category E3 and multiplying by 100 to get the result in percent.

$$\Delta R = \frac{(R_{E3a}+R_{E3b})-R_{E3}}{R_{E3}} \cdot 100 \qquad \text{(Equation 7)}$$

Substituting Equations 4-6 into Equation 7 gives:

$$\Delta R = \frac{P_{E3a}\cdot W_{E3a}+P_{E3b}\cdot W_{E3b}-P_{E3}\cdot W_{E3}}{P_{E3}\cdot W_{E3}} \cdot 100 \qquad \text{(Equation 8)}$$

Then substituting Equations 2 and 3 into Equation 8 gives:

$$\Delta R = \frac{P_{E3a} \cdot r \cdot W_{E3} + P_{E3b} \cdot s \cdot W_{E3} - P_{E3} \cdot W_{E3}}{P_{E3} \cdot W_{E3}} \cdot 100 \qquad \text{(Equation 9)}$$

and hence:

$$\Delta R = \frac{W_{E3}(r \cdot P_{E3a} + s \cdot P_{E3b} - P_{E3})}{P_{E3} \cdot W_{E3}} \cdot 100 \qquad \text{(Equation 10)}$$

Thus, the change in revenue (ΔR) in percent of the "original" average revenue can be calculated as:

$$\Delta R = \frac{r \cdot P_{E3a} + s \cdot P_{E3b} - P_{E3}}{P_{E3}} \cdot 100 \qquad \text{(Equation 11)}$$

If the costs of implementing and running the operations with the two new categories can be disregarded according to Assumption #2, then the change in revenue will be equal to the change in profit.

6.5 Simulation results

6.5.1 Estimation of parameters r and s

The fraction of the E3 category that is made up of 2-2.99 kg cod (r) and 3-3.99 kg cod (s), respectively, need to be known or estimated to find out whether dividing the E3 category into two provides a higher revenue. Five companies (an auction, two collectors, and two processors) were inquired about the average ratio of r:s based on weight, but none were able to provide this nor their impression of the ratio. As an alternative, a few calculations can give a rough estimate of the distribution ratio.

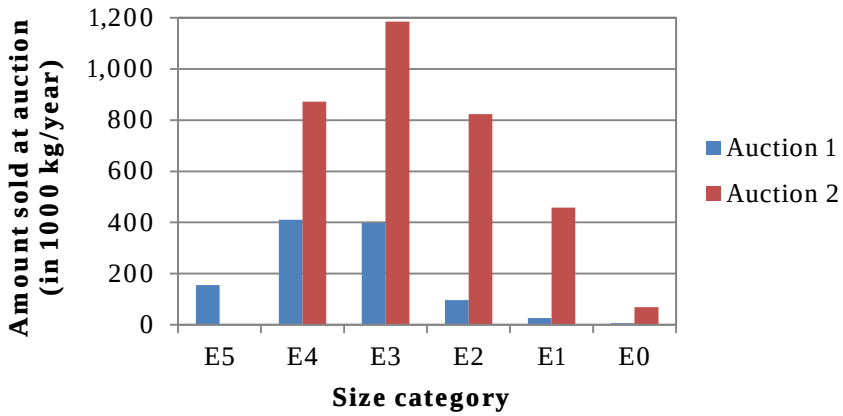

Figure 6.4. Amount of cod sold in each size category within freshness category E at two auctions in 2011. Weight intervals of the size categories are shown in Table 6.1.

Using the amounts of cod sold in each size category (Figure 6.4), it is possible to plot these against the midpoints of each size category interval (Figure 6.5). Since category E0 is open-ended (≥ 10 kg/cod), an arbitrary midpoint of 12.5 kg/cod has been chosen for this category. Since the size categories have different ranges and since the midpoints are a relatively large distance from each other, the smooth curves are subject to great uncertainty. The curves may follow a different "path" between the midpoints, but this is unknown since the amount sold is not known for shorter ranges.

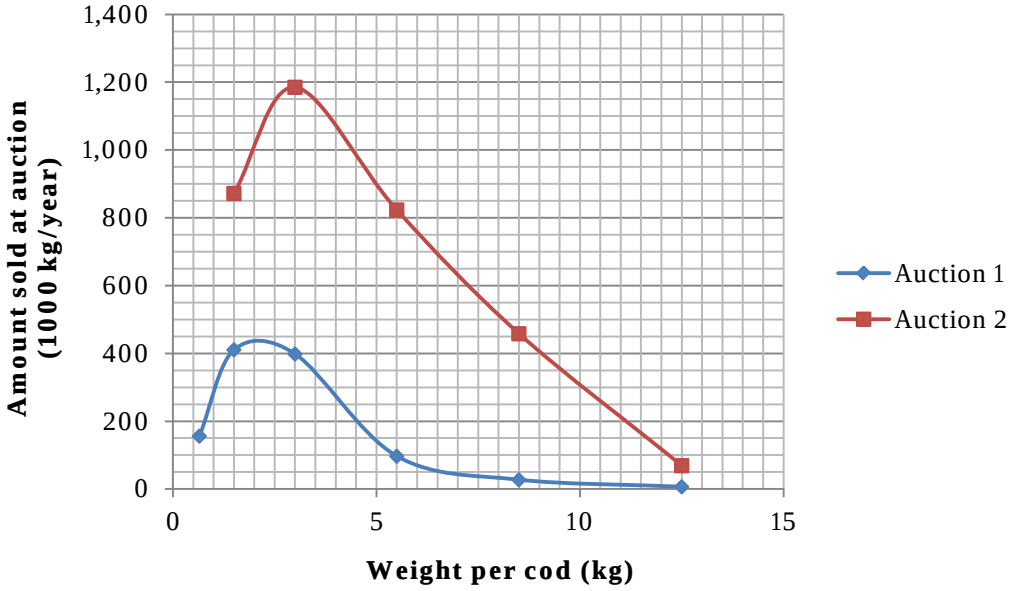

Figure 6.5 Amount of cod sold in each size category within freshness category E at two auctions in 2011 as a function of the midpoints of the size category interval.

Taking the midpoints of E3a and E3b, the corresponding y-values can be read off Figure 6.5. Subsequently, the ratio between these may be found (Table 6.4). Thus, very rough estimates of the r:s ratios in 2011 are 0.55:0.45 for Auction 1 and 0.5:0.5 for Auction 2. In the following, simulations using the model will be performed at varying values of r and s.

Table 6.4. Calculation of rough estimates of the r:s distribution ratio in the E3 cod sold at both auctions in 2011. The amount of cod sold is read off Figure 6.5.

	Size category	Midpoint (kg) (x)	Amount of cod sold (kg/year) (y)	r[1]	s = 1 – r
Auction 1	E3a	2.5	430,000	0.55	0.45
	E3b	3.5	345,000		
Auction 2	E3a	2.5	1,140,000	0.50	0.50
	E3b	3.5	1,150,000		

[1] $r = \frac{\text{y–value at x=2.5}}{\text{y–value at x=2.5} + \text{y–value at x=3.5}}$

6.5.2 Determination of the price combinations at which ΔR is 0%, 2%, and 4%

The minimum average prices that the E3a and E3b categories of cod in combination must achieve in order for the revenue to remain the same as before the subdivision or to increase the revenue by 2% or 4% are shown graphically in Figure 6.6 for five ratios of r to s. The figure illustrates that the lower the price of E3a is, the higher the corresponding price of E3b has to be to break even or achieve the targeted increase in revenue. The larger the share of E3a cod compared to the share of E3b cod, the higher the price of E3b has to be to break even.

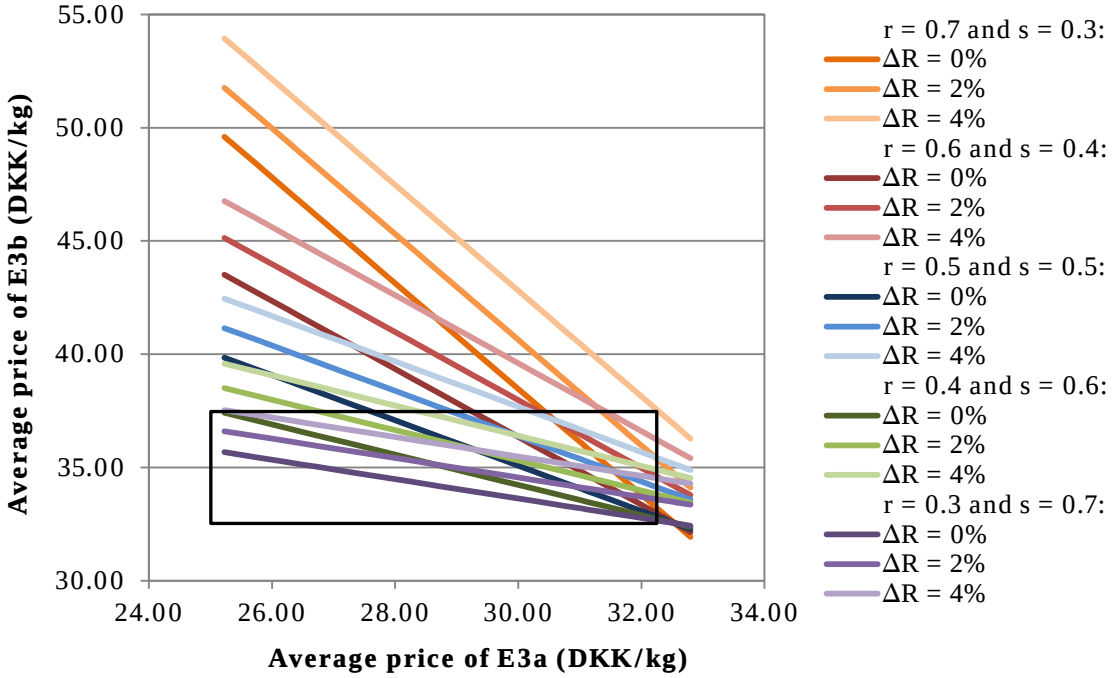

Figure 6.6. Examples of combinations of average price of categories E3a and E3b at Auction 1 which give a change in revenue (ΔR) of 0%, 2%, and 4% at five different ratios of r and s, where r = the fraction of the E3 category that is made up of 2-2.99 kg cod (E3a) and s = the fraction of the E3 category that is made up of 3-3.99 kg cod (E3b). The black rectangle encases the situations in which the prices of E3a and E3b are within the intervals mentioned in Assumption #1 (Section 6.3.1).

6.5.3 Determination of ΔR (%) for the best and worst case scenarios

The best case and worst case scenarios are the situations in which the changes in revenue (ΔR) are the highest and lowest, respectively, under the given assumptions. Given the price ranges in Assumption #1, the best and worst case scenarios can be calculated for different fractions of E3a (r) and E3b (s) (Figure 6.7). Assuming that r = 0.55 and s = 0.45 for Auction 1 (see Section 6.5.1), then in the best case the revenue will increase by 6.5% (i.e. when $P_{E3a} = P_{E3} = 32.54$ DKK and $P_{E3b} = 37.26$ DKK), while in the worst case, the revenue will drop by approximately 12% (i.e. when $P_{E3a} = 25.23$ DKK and $P_{E3b} = P_{E3} =$

32.54 DKK). For Auction 2, if r = 0.5 and s = 0.5, then the change in revenue in the best case will be 7%, while in the worst case it will be -9.4%. It must be remembered that these calculations indicate predictions based on the average prices of the categories over a year and that there are a number of assumptions connected to the calculations (e.g. the highest and lowest "possible" prices).

The points where ΔR has the highest positive value are of course when r = 0 and s = 1, that is, when all the fish in the E3 category are 3-3.99 kg and therefore achieve a higher price than if some of them were in the 2-2.99 kg group. In addition, the price used for E3b is higher than the average price for E3. Conversely, when r = 1 and s = 0, then ΔR will decrease the most.

The intermediate case shows that if the average prices of E3a and E3b are in the middle of their assumed range, then the ratio of E3a cod (r) to E3b cod (s) must not be greater than around 0.39:0.61 for Auction 1 and around 0.42:0.58 for Auction 2 in order for the change in revenue to be minimum 0. This means that there has to be a relatively large percentage of cod that weigh 3-3.99 kg/cod or that the prices on average must be higher than the middle of the assumed ranges if there are equal amounts of E3a cod and E3b cod.

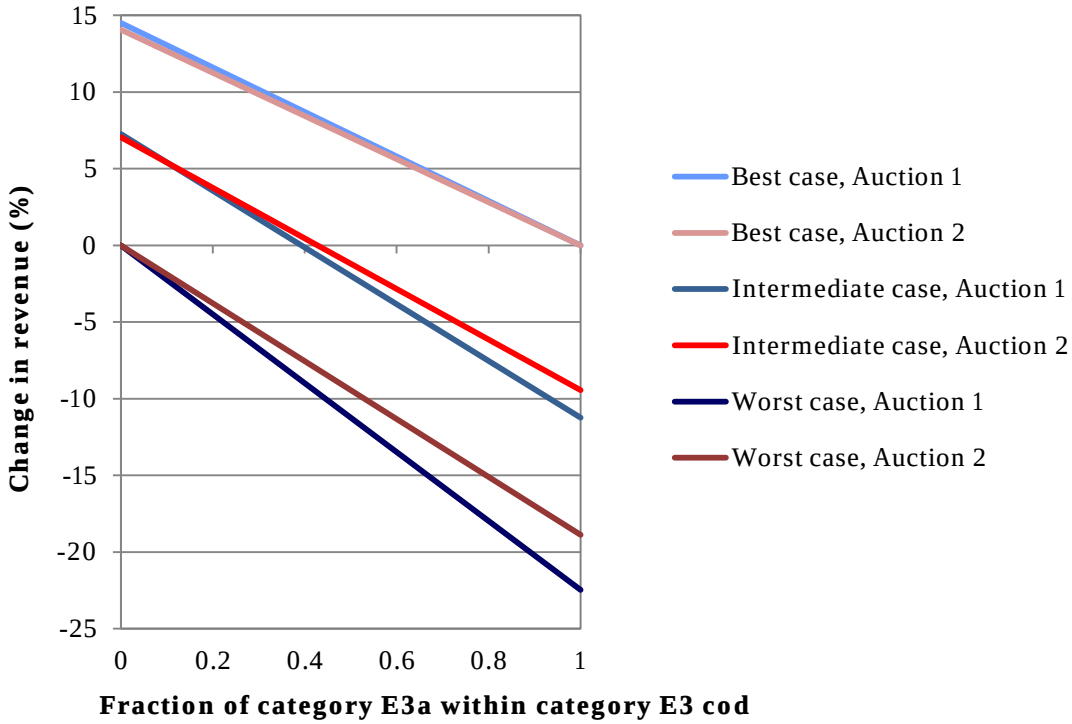

Figure 6.7. Best case, intermediate case, and worst case scenarios at Auctions 1 and 2 with respect to the change in revenue (ΔR in percent) at different distributions of r (and consequently, s) if the cod E3 category is subdivided into categories E3a and E3b.

6.5.4 Determination of ΔR for 2011 in the best case scenario

Taking the prices that give the best case scenario under the assumed price range, it would be interesting to see how much the revenue generated by the E3 cod at the two auctions in 2011 could have increased if the E3 cod had been sold as E3a and E3b cod (Table 6.5). If the ratio of amount of E3a cod to amount of E3b cod was 0.5:0.5 on average, then Auction 1 could have increased the revenue of 12.2 million DKK for E3 cod in 2011 by 7%. Auction 2 could also have increased their 2011 revenue of 34.6 million DKK for E3 cod by around 7%. With the distribution ratio estimated in Section 6.5.1, 0.55:0.45, the increase for Auction 1 would be 6.5%.

Table 6.5 The change in revenue (ΔR) for Auctions 1 and 2 if they had graded the 2-3.99 kg cod into categories of 2-2.99 kg cod and 3-3.99 kg cod in 2011. The calculations use the prices of E3a and E3b as in the best case scenario and the total amount of E3 cod sold at the auctions in 2011. The change in revenue for five distribution ratios of amount of E3a cod (r) to amount of E3b cod (s) are shown.

Distribution ratio (r:s)	Auction 1			Auction 2		
	Amount E3 sold in 2011 (kg)	ΔR (%)	ΔR (DKK/yr.)	Amount E3 sold in 2011 (kg)	ΔR (%)	ΔR (DKK/yr.)
0.3:0.7	398,402	10.2	1,316,319	1,185,126	9.9	3,699,963
0.4:0.6	398,402	8.7	1,128,273	1,185,126	8.4	3,171,397
0.5:0.5	398,402	7.3	940,228	1,185,126	7.0	2,642,831
0.6:0.4	398,402	5.8	752,182	1,185,126	5.6	2,114,265
0.7:0.3	398,402	4.4	564,137	1,185,126	4.2	1,585,699

However, the best case scenario does not appear so probable, since that requires that the price of E3a (which is assumed to have a lower demand than E3b) is equal to the average price of the original E3 category and that the price of E3b is just under the average price of the E2 category. If the prices from the intermediate case scenario were used instead of the best case scenario, then for Auction 1 the ratio r:s must be lower than 0.39:0.61 in order for ΔR to be greater than 0, as mentioned earlier. At 0.3:0.7, ΔR would be 1.7%, equivalent to 222,109 DKK/year. Though, it does not seem likely that the distribution ratio is 0.3:0.7, so the best prospects lie in a high level of the prices for E3a and E3b.

6.6 Discussion of the simulation model and results

6.6.1 Validation and sensitivity of the model

Validation of the model is not possible since the simulations are based on actual data. That is, the price ranges in Assumption #1 are based on data from the two auctions in 2011. Similarly, the amount of E3 cod sold by the auctions in 2011 is used in the

examples of how much more money the cod could have brought in if the two new categories were used and assuming the prices of the best case scenario.

Since the model is linear, it is not sensitive to small changes in the input, i.e. small changes in the input will not give large changes in the output.

6.6.2 Discussion

Achieving a change in revenue of 0% presumably does not provide enough incentive for an auction to implement the suggestion of grading the fish into two new size categories. There would not be much motivation for the seapacking fishing vessels, the collectors, and the auctions to make this change if it does not in some way increase their earnings. Thus, the goal should be a change in revenue that is somewhat more than 0%. At any distribution ratio between the two categories there will be a limited number of price combinations within the assumed price intervals that will give a change in revenue of more than 0% (as seen in the rectangle in Figure 6.6). Of course, the average prices are welcome to exceed the assumed price intervals, but they should preferably not be lower than the assumed price intervals.

Although Auction 2 sells around three times as much cod as Auction 1, the average prices for the various size categories as well as the estimated distribution ratios between E3a cod and E3b cod are alike. As a result, the percent change in revenue during the best case scenarios at the two auctions are also very similar.

As explained in Assumption #2, the costs of implementing the new classifications are not daunting. Hence, if the auctions believe that the average price of the E3a and E3b categories will be sufficiently high, then it is worth trying out the new size categories. Though, the costs of implementing the suggestion should be investigated further to obtain an estimation of the actual costs and to verify whether they can be disregarded in the model.

Implementation of the suggestion can be carried out during a pre-defined trial period to get an idea of the price levels that the E3a and E3b categories can achieve. It may also be decided to implement the new categories for just the kystfisk segment as a means of raising the profile of kystfisk. The new categories may be considered as a method to keep one’s customers and perhaps attract new customers.

The prices achieved at the auction are influenced by the supply and demand of the fish of a particular species, size, and freshness category. The supply and demand are in turn affected by many factors, such as the weather, the season, the quotas, etc. These are not

included in the model and thus, constitute a limitation of the model. Instead the average price of E3 cod over a year has been used.

The model can be used in a modified form if there is a wish to divide a size category into three subcategories instead of two. The two subcategories in the present model do not necessarily have to cover intervals of 0.99 kg each. Though, adjusting the size of the intervals is in effect equivalent to the different ratios of r to s.

The model can also be used to simulate a subdivision of a freshness category instead of a size category. The subdivision of freshness category A was specifically mentioned in Paper V, Chapter 4. The EU regulation instituting the three freshness categories states that "a small but adequate number of freshness categories should be established" (EU, 1996). However, the number of freshness categories appears not to be adequate since there is much variation in the freshness within the A category (Paper V, Chapters 2 and 4). The experiences from other auctions in the subdivision of freshness categories may be incorporated if the model is to be used for division of freshness categories.

6.7 Conclusion

A model to find out if it could be economically sound for an auction to implement two new size categories for cod of freshness quality E was developed under certain assumptions. Whether dividing the E3 category into two will provide higher revenue depends not only on the prices of each new category, but also on the distribution ratio of the E3 cod into the two categories. Simulations using the model were performed under varying distribution ratios of the new size categories E3a and E3b using data from two auctions.

It was found that in the best case scenario, a change in revenue of around 7% could be attained by implementing the new size categories if the distribution ratio between them is 0.5:0.5. However, this requires that the average prices of the new categories are at the maximum of the assumed price intervals. The prices will also have to be rather high for the auction to be able to obtain a change in revenue for cod weighing 2-3.99 kg/fish of 2%. Thus, if the auction believes that the prices can be maintained at a high level compared to the average price of E3 cod, then, in combination with the assumption that the costs of implementation are minimal, the suggestion could be implemented for a trial period to see if the change could give a profit.

7 Conclusion and perspectives

The one step forward, one step back legislative requirement regarding traceability of food in the EU was introduced in 2002. Since then, the traceability requirements for fish products in particular have become tougher. Requirements such as the introduction of an identification number for each batch and the fact that companies must record which fishing vessels caught the fish in each batch place demands on the traceability systems of each company. These requirements will hopefully contribute to improving the traceability of fish products, which as seen in the simulated recall studies included in this thesis, is insufficient and includes points of information loss.

The information types required by the new legislation cannot only be used for food safety reasons, but also for adding value to the fish products. For example, a catch area more specific than the FAO catch areas, the name of the fishing vessel, and the catch date may be of interest to the consumers. The usefulness of the vessel ID and the catch date depends, among others, on whether batch mixing has taken place and on whether the catch date has been expressed as a single date or as a time period at the first point of sale.

Case studies of two fish supply chains were carried out, resulting in suggestions as to how the operations in the chain can be improved and the presumed effects of these suggestions. Some suggestions are recommendable to institute without much delay, such as ensuring that the fish boxes have excess ice at all times and that the graders at the collector are more careful when assessing the freshness of the fish. It is also recommended that the information types that are readily available and wanted, such as the catch date, vessel ID, and landing place, are forwarded along with the fish or transferred to an electronic database such that the steps can retrieve the information that they want. The availability of such information also contributes to raising the trust in the chain.

The effects of one suggestion, namely to grade cod weighing 2-3.99 kg/fish into two size categories instead of one prior to sale at the auction, were simulated in a mathematical model. It was found that the average prices of each of the new categories would have to be rather high for the auction to be able to obtain a change in revenue for cod weighing 2-3.99 kg/fish of just 2% (under certain assumptions). Since the prices depend on many factors, they can vary from one day to the next. Therefore, if the auction believes that the prices of the two new categories can be maintained at a high level compared to the average price of cod of the 2-3.99 kg/fish category, then, in combination with the

assumption that the costs of implementation are minimal, the auction could try to implement the suggestion for a trial period to see if the change could give a profit.

The suggestions for improving the operations of the chains can benefit the competitiveness of the chain because the products may be fresher upon arrival at the retailer and have a longer shelf life, there is less variation in the quality of the fish, more information about the fish products is available for the steps and for the consumers, and customers know they can trust the information and the quality of the fish from the steps in the chain. The optimization of the chain operations, including improved chain cooperation, is expected to result in a higher product value and an increase in the value of the chain.

The suggestions in Chapters 4 and 5 can be used by other steps and chains in the fish industry as inspiration for ways they can improve their operations within the quality of fish, the exchange of information, traceability, feedback, and trust. The manual in Paper V, Section 4.2 specifies procedures for handling and storage of the fish onboard the fishing vessels, at the collector, and at the auction in order to achieve fish products of a long shelf life and with traceable information which is consequently expected to improve the buyers' confidence in the quality of the fish.

For some of the suggestions mentioned, it could be worthwhile to construct a model and perform simulations of the effects of implementing the suggestion before deciding to put the suggestion into practice. This could give an idea of how effective the suggestion is and if the suggestion could lead to improved operations while also being cost-neutral as a minimum.

Since traceability and the information that is exchanged via traceability systems are an important part of improving the operations in the chains, it would be valuable to examine how a traceability system and the traceable information can be made trustworthy. This could for example involve the use of RFID tags and unique identifications of the fish batches.

Finally, it would be interesting to study other fish supply chains, e.g. a chain that is not auction-based, to find out how they handle the fish, how the information flow and traceability systems function, and the state of feedback and trust in those chains. The chains in this thesis might be able to learn from the other chains' experiences and operating procedures.

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Papers

Paper I

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Technical report

American and EU legislation and food management standards: A comparative study of food traceability requirements with a focus on seafood products

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1. Introduction

Requirements for traceability within the food supply chain can be set forth by legislation, standards, the food business itself and the food business' customers (B2B). Food businesses must abide by the relevant legislation in the resident country and the countries to which they export. Once they live up to these requirements, they can seek to conform to the requirements set forth by e.g. quality management standards. It is voluntary to be certified against these standards. However, some businesses, such as some supermarket chains, require that their suppliers are certified against a specific quality management standard.

In this technical report, selected legislative food traceability requirements of the United States (U.S.) and the European Union (EU) will be compared to the requirements of three food management standards. Are the food traceability requirements in the legislations of the U.S. and the EU similar? Will an American company, which follows the American traceability requirements, also comply with the EU legislation and vice versa? How do the traceability requirements in the quality management standards differ from each other and from the legislative requirements? Does a company that follows the procedures in the standards also comply with the legislative food traceability requirements in either the U.S. or the EU? These and related issues will be discussed in this technical report.

The legislations that will be dealt with are:

United States:

- The Public Health Security and Bioterrorism Preparedness and Response Act of 2002
- The final rule 21 CFR Part 1, Subpart J: Establishment, Maintenance, and Availability of Records
- The Farm Security and Rural Investment Act of 2002
- The interim final rule 7 CFR Part 60: Mandatory Country of Origin Labeling for Fish and Shellfish

European Union:

- Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety
- Council Regulation (EC) No 104/2000 of 17 December 1999 on the common organisation of the markets in fishery and aquaculture products
- Commission Regulation (EC) No 2065/2001 of 22 October 2001 laying down detailed rules for the application of Council Regulation (EC) No 104/2000 as regards informing consumers about fishery and aquaculture products

The selected food management standards are:

- International Food Standard (IFS)
- BRC Global Standard – Food (BRC)
- International Standards Organisation 22000 (ISO 22000)

Only the traceability requirements in the above-mentioned legislations will be discussed in this report. There may be traceability requirements in other legislations in the U.S. and in the EU, for example traceability with regards to beef, but these are out of the scope of this report. Likewise, there are also other food quality management standards, such as the SQF 2000 Code (Food Marketing Institute, 2005) and the EFSIS Standard (Anon., 2007), but these will not be dealt with in this report.

2. Traceability requirements in American and EU legislation

2.1. United States: Bioterrorism Act of 2002, Section 306 and Final Rule 21 CFR Part 1, Subpart J

The American *Public Health Security and Bioterrorism Preparedness and Response Act of 2002* (known as the Bioterrorism Act of 2002) (Anon., 2002b) contains traceability requirements, which are specified in the final rule 21 CFR Part 1, Subpart J: *Establishment, Maintenance, and Availability of Records* (Department of Health and Human Services, Food and Drug Administration, 2004).

Section 306 of the Bioterrorism Act allows the Secretary of Health and Human Services, by regulation, to set up requirements regarding the establishment and maintenance of records by persons (excluding farms and restaurants) who manufacture, process, pack, transport, distribute, receive, hold, or import food. These records shall allow the Secretary to identify the immediate previous sources and the immediate subsequent recipients of the food, including its packaging, in order to address health or death threats to humans or animals. This principle is known as “one step forward, one step back” or “one up, one down.” However, persons who distribute food directly to consumers are excluded from the requirement to identify the recipient if the recipient is the final consumer (§1.327(d) in final rule 21 CFR Part 1, Subpart J). The records must be maintained for up to two years, depending on the perishability of the article of food and on whether the person is a transporter or a nontransporter (§1.360 in 21 CFR Part 1, Subpart J). Details about the type of information that must be recorded are found in §1.337, §1.345, and §1.352 in 21 CFR Part 1, Subpart J. These requirements are denoted the recordkeeping requirements.

Exceptions as to which persons are subject to the recordkeeping rule are found in §1.327 in 21 CFR Part 1, Subpart J. It is worth noting that fishing vessels that only harvest, head, eviscerate, freeze and transport fish are exempt from all the requirements in 21 CFR Part 1, Subpart J except §1.361, concerning the availability to the Food and Drug Administration (FDA) of records and other information, and §1.363. Fishing vessels engaged in other types of processing of fish are subject to the whole of Subpart J of 21 CFR Part 1.

The term food as it is used in Sec. 306 of the Bioterrorism Act and in 21 CFR Part 1, Subpart J is as defined in Sec. 201(f) of the *Federal Food, Drug, & Cosmetic Act* (Anon., 2004a), i.e. (1) articles used for food or drink for man and other animals, (2) chewing gum, and (3) articles used for components of any such article. This includes dietary ingredients, live food animals and animal feeds (U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, 2005). Notwithstanding, food that is within the exclusive jurisdiction of the U.S. Department of Agriculture

(USDA) is not subject to 21 CFR Part 1, Subpart J, as mentioned in §1.327(g). These include meat, poultry and processed egg products.

The Bioterrorism Act was signed into law on June 12, 2002. The compliance dates for the final rule 21 CFR Part 1, Subpart J were December 9, 2005, June 9, 2006 or December 9, 2006, depending on the number of full-time employees in the food business concerned.

2.2. European Union: Regulation (EC) No 178/2002, Article 18

Article 18 of *Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety* (Anon., 2002d) requires the traceability of food to be established at all stages of production, processing, and distribution. In other words, food business operators shall be able to identify any person who has supplied them with a food and the businesses to which their products have been supplied. Food businesses must have systems and procedures in place that allow for this information to be made available to the authorities on demand. Furthermore, food placed on the market shall be adequately labeled or identified to facilitate its traceability.

The above-mentioned article regulates food as well as feed, food-producing animals or any substance intended to be, or expected to be, incorporated into a food or feed. The article applies to all stages of production, processing, and distribution of food, but not to primary production for private domestic use or to the domestic preparation, handling or storage of food for private domestic consumption. In addition, food businesses are not required to be able to identify the final consumer of their products.

Article 18 of Regulation (EC) No 178/2002 became effective on January 1, 2005.

2.3. Comparison of the Bioterrorism Act of 2002, Section 306 and Final Rule 21 CFR Part 1, Subpart J to Regulation (EC) No 178/2002, Article 18

The Bioterrorism Act of the U.S. states specifically that the purpose of the implementation by law of one up, one down traceability is to be able to address health or death threats to humans or animals. The EU regulation is not quite as dramatic. According to Preamble 28 of Regulation (EC) No 178/2002, traceability is necessary so that “targeted and accurate withdrawals can be undertaken or information given to consumers or control officials, thereby avoiding the potential for unnecessary wider disruption in the event of food safety problems.” These differences in viewing the matter stem from the background for passing legislation on this topic. In the U.S., the events of Sept. 11, 2001 sparked the preparation of the Bioterrorism Act, part of which is aimed at protecting the food supply (U.S. Food and Drug Administration, 2007), while in the EU, recent food scares like BSE in the U.K. in 1996 and the dioxin crisis in Belgium in 1999 have shown the need for traceability within the food supply chain (The Standing Committee on the Food Chain and Animal Health, 2004).

The American legislations on one up, one down traceability are more detailed than the EU legislation. The final rule 21 CFR Part 1, Subpart J is very concrete in its requirements and the process of

fulfilling those requirements. In contrast, Article 18 in the EU regulation 178/2002 is expressed in terms of its objective and intended result, rather than dictating how that result is to be achieved. This gives the industry greater flexibility when implementing the requirement, which is expected to lower the compliance costs (The Standing Committee on the Food Chain and Animal Health, 2004). Thus, it is a question of whether the food businesses meet the goal of Article 18 and not how.

2.3.1. Persons and products covered

The American and the EU legislations generally apply to the same types of persons. However, as described in section 2.1., farms are exempt from all requirements in Sec. 306 of the Bioterrorism Act and fishing vessels that only harvest, head, eviscerate, freeze and transport fish are exempt from all requirements in 21 CFR Part 1, Subpart J except §§1.361 and 1.363. This means that neither farms nor these types of fishing vessels must record the immediate subsequent recipients of their articles of food. This is in contrast to the EU legislation, to which farms and all fishing vessels are subject since they are part of the production step.

Aside from the articles of food regulated by the USDA, as mentioned in section 2.1., the American and the EU legislation generally cover the same products.

2.3.2. Identification of suppliers and recipients

The American and the EU legislations are similar in that they both require that food businesses must be able to identify their suppliers and their recipients (except the final consumer). 21 CFR Part 1, Subpart J specifies which information must be recorded about the immediate previous source and the immediate subsequent recipient, while the EU regulation does not specify the type of information. The *Guidance on the Implementation of Articles 11, 12, 16, 17, 18, 19 and 20 of Regulation (EC) No 178/2002 on General Food Law* (hereafter referred to as "the EU guidance") (The Standing Committee on the Food Chain and Animal Health, 2004) gives suggestions as to which information is necessary to fulfill the objective of the EU regulation, but the EU guidance is not a formal legal document. Neither the American nor the EU legislation requires internal traceability within a company, but in order to reap the full benefit of the existing one step forward, one step back requirement, it is essential to set up in-company traceability.

2.3.3. Record availability

Both the American and the EU legislations require that the records of food businesses that can be used for traceability shall be made available to the authorities. 21 CFR Part 1, Subpart J requires that the traceability information be given to the authorities within 24 hours of a request, while the EU legislation does not specify a time deadline. The EU guidance states that minimal information such as the name and address of the supplier/recipient, the nature of the supplied/delivered products and the date of transaction must be available immediately, while supplementary and more detailed information about the products shall be available "as soon as reasonably practicable."

2.3.4. Recordkeeping

The American legislation (21 CFR Part 1, Subpart J) requires that traceability records shall be maintained for up to two years after the date of receiving or releasing the food. The EU legislation has no such requirements, but the EU guidance suggests that a record retention time of 5 years will meet

the objective of the legislation, though with either shorter or longer retention times depending on the shelf life of the product in question. For example, for products with a shelf life above 5 years, the record retention time should be the shelf life plus 6 months. For highly perishable products like fruits, vegetables, and fresh fish, the record retention time should be 6 months. For all other products, also those without a specified shelf life, like wine, the record retention time should be 5 years from the date of manufacturing or delivery.

2.3.5. Packaging materials

The American legislation requires that the food businesses also record traceability information about the packaging materials used for the food. In the EU, this requirement is not covered by Regulation (EC) No 178/2002, but by Article 17 in *Regulation No 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food and repealing Directives 80/590/EEC and 89/109/EEC* (Anon., 2004b) (effective October 27, 2006), which requires one up, one down traceability of materials and articles that come into contact with food and the access to this information by the authorities.

2.4. United States: The 2002 Farm Bill and Interim Final Rule 7 CFR Part 60 (COOL)

Section 10816 of the *Farm Security and Rural Investment Act of 2002* (known as the 2002 Farm Bill) (Anon., 2002a) requires that a retailer of one of the covered commodities shall inform consumers, at the final point of sale, of the country of origin of the commodity, and in the case of fish and shellfish, of the method of production. This requirement is specified for seafood in the interim final rule 7 CFR Part 60: *Mandatory Country of Origin Labeling for Fish and Shellfish* (Department of Agriculture, Agricultural Marketing Service, 2004). The traceability requirements of the interim final rule (hereafter referred to as COOL, Country of Origin Labeling) are listed in Tables 1, 2, and 3.

The 2002 Farm Bill became effective on September 30, 2004, but was delayed for all covered commodities but fish and shellfish until September 30, 2008. The interim final rule 7 CFR Part 60 became effective on April 4, 2005.

2.5. European Union: Regulation (EC) No 104/2000 and Regulation (EC) No 2065/2001

Article 4 of the *Council Regulation (EC) No 104/2000 of 17 December 1999 on the common organisation of the markets in fishery and aquaculture products* (Anon., 2000) does not permit products covered by Article 1(a), (b), or (c) in the same regulation to be offered for retail sale unless the label or other marking indicates the commercial name of the product, the production method and the catch area. This rule is specified in *Commission Regulation (EC) No 2065/2001 of 22 October 2001 laying down detailed rules for the application of Council Regulation (EC) No 104/2000 as regards informing consumers about fishery and aquaculture products* (Anon., 2001). Details of the traceability requirements in the two regulations are found in Tables 1, 2, and 3.

Article 4 of Regulation (EC) No 104/2000 and Regulation (EC) No 2065/2001 have both been applicable since January 1, 2002.

2.6. Comparison of 7 CFR Part 60 (COOL) to Regulation (EC) No 104/2000 and Regulation (EC) No 2065/2001

The intent of both COOL and the two EU regulations (Article 4 in Regulation No 104/2000 and Regulation No 2065/2001) is to provide consumers with additional information on which to base their purchasing decisions (Department of Agriculture, Agricultural Marketing Service, 2004; Anon., 2000). According to Preamble 8 of Regulation (EC) No 104/2000, the broad variety of fishery products available, particularly fresh and chilled, makes it essential to provide consumers with a minimum amount of information on the main characteristics of products. The requirements of COOL and the two EU regulations are primarily labeling programs, but traceability throughout the supply chain is a necessary tool in order to fulfill the requirements. The requirements of COOL and the two regulations of the European Union are compared in Tables 1, 2 and 3 below.

Table 1. Persons and products covered and exemptions thereof in the American interim final rule 7 CFR Part 60 (COOL) and Regulation (EC) No 104/2000 (Articles 1 and 4) and No 2065/2001 of the European Union.

	7 CFR Part 60 (COOL)	**Regulation (EC) No 104/2000 & No 2065/2001**
Persons and products covered	The following commodities when offered for sale by any person licensed as a retailer under the Perishable Agricultural Commodities Act (PACA) of 1930 (§§60.124, 60.200), but not if they are part of a processed food item (definition and examples in §60.119) (§§60.105, 60.200): • farm-raised fish and shellfish • wild fish and shellfish (§60.105)	The following products when offered for retail sale to the final consumer irrespective of the marketing method (Article 4, 104/2000), but not products with added ingredients or which have been further processed (Food Standards Agency, 2003): Fish, crustaceans, and molluscs caught at sea or in inland waters or as products of aquaculture. See Article 1 in 104/2000, Danish Veterinary and Food Administration (2004), and Food Standards Agency (2003) for details.
Exemptions to the persons and products covered	• Fish markets and similar specialty shops do not generally sell fruits and vegetables, and therefore are not licensed as retailers under PACA. Hence, they are not subject to 7 CFR Part 60 (I. Background). • Food service establishments (restaurants, etc.) (§60.200)	• Small quantities disposed of directly to consumers by fishermen or aquaculture producers (Article 4, 104/2000) from the seller's own business and not exceeding the value of EUR 20 (Article 6, 2065/2001). • Restaurants, etc. (Danish Veterinary and Food Administration, 2004)

2.6.1. Persons subject to the rule

In both the American and the EU legislations, the persons that are subject to the rule are retailers that sell to the final consumer (Table 1). However, food service establishments (such as restaurants) are not covered by any of the rules. In addition, the definition used by COOL of a retailer results in an exclusion of fish markets and fish mongers. According to COOL, the use of the PACA definition of a retailer ensures that the vast majority of covered commodities will be subject to this rule without unduly burdening small businesses (Department of Agriculture, Agricultural Marketing Service,

2004). This may be considerate towards the small businesses, but this exemption means that consumers who buy fish and shellfish at such specialty shops are not provided with the required information, which after all was the intent of COOL.

The EU legislation exempts fishermen and aquaculture producers from the rule when they sell small quantities directly to consumers. There is no specification of such an exemption in COOL, but if fishermen and aquaculture producers are not licensed as retailers under PACA, they would be exempted from COOL, too.

Although retailers (with the above-mentioned exemptions) are the persons subject to these legislations, the other steps in the supply chain also have an obligation to pass on through the supply chain the information that retailers must make available to the consumers.

2.6.2. Products subject to the rule

The two legislations cover similar products (Table 1), but differ in some details about what unit operations causes the fish to be considered as processed. For example, cooked (but not peeled) crustaceans are subject to the EU legislation (Food Standards Agency, 2003), while all cooked fish and shellfish are not subject to the American legislation. In addition, smoked fish is subject to the EU legislation, but not subject to the American legislation.

Table 2. The main requirements of the American interim final rule 7 CFR Part 60 (COOL) and Regulation (EC) No 104/2000 (Articles 1 and 4) and No 2065/2001 of the European Union.

	7 CFR Part 60 (COOL)	**Regulation (EC) No 104/2000 & No 2065/2001**
Main requirement	Labeling of covered commodities offered for sale must contain country of origin and method of production information. (§60.200)	The covered products may not be offered for retail sale to the final consumer unless appropriate marking or labeling indicates the commercial designation of the species, the production method, and the catch area. (Article 4, 104/2000)
Geographical origin	• Must be stated as country of origin (§60.200) • Of U.S. Country of Origin (may be labeled "Product of the U.S.") if: ▪ For farmed products: hatched, raised, harvested *and* processed in the U.S. ▪ For wild products: - harvested in the waters of the U.S. *or* by a U.S. flagged vessel, *and* - processed in the U.S. *or* aboard a U.S. flagged vessel (§§60.128, §60.200) • Imported products, no substantial transformation in the U.S.: E.g. "Product of country X", "Made in country X" (U.S. Customs and Border Protection, 2004)	• Must be stated as catch area (Article 5, 2065/2001) ▪ For products caught at sea: areas defined by FAO (area name upon sale of the product to the final consumer; area number is sufficient at the previous steps in the chain) (Danish Veterinary and Food Administration, 2004; FAO Fisheries Department, 2007) ▪ For products caught in freshwater: name of the country of origin ▪ For farmed products: name of the country in which the product undergoes the final development stage • A more precise catch area may be indicated for all three types in addition to

	7 CFR Part 60 (COOL)	Regulation (EC) No 104/2000 & No 2065/2001
	• Imported products, substantial transformation in the U.S.: "From country X, processed in the United States" (§60.200)	the FAO area. (Article 5, 2065/2001)
Method of production	• Examples of permitted designations: ▪ "wild caught", "wild" ▪ "farm-raised", "farmed" • Examples of designations not permitted: ▪ "Ocean caught", "caught at sea", "line caught" ▪ "Cultivated", "cultured" (§60.300)	• Exclusive permitted designations in English: ▪ "caught", "caught in freshwater" ▪ "farmed", "cultivated" • May be omitted for products caught at sea if it is obvious from the commercial designation and the catch area that the species is caught at sea. (Article 4, 2065/2001)
Commercial designation of the species	–	Shall be indicated by marking or labeling (Article 4, 104/2000)
Scientific name of the species	–	• May be indicated upon sale of the product (Article 3, 2065/2001) • Must be registered at all the previous steps in the chain (Article 8, 2065/2001)

2.6.3. Main requirements of the rule

The legislations of the U.S. and the EU require the indication of certain information to the final consumer, as shown in Table 2 and discussed below. There are no requirements as to how the information is indicated; examples include on the label, on the package, or on a sign.

Geographical origin

Both legislations require that the geographical origin of the product must be conveyed to the consumer, but there are different requirements. The biggest difference is that COOL requires the geographical origin for products caught at sea conveyed as a country, while the EU legislation requires it conveyed as a catch area, i.e. the body of seawater. COOL lists the different requirements for labeling a product as being of American origin. Thus, a U.S. flagged vessel catching fish off the western coast of South America and landing it in the U.S. would give the product the label "Product of the U.S." according to COOL, while according to the EU regulations 104/2000 and 2065/2001, the product would be labeled "Caught in the Southeast Pacific."

Method of production

Both legislations require the conveyance of the method of production, i.e. wild or farmed, to the consumer. COOL gives examples of some accepted expressions, while the EU regulation 2065/2001 states all accepted expressions in all the EU languages. It is noteworthy that the expression "cultivated" for farmed shellfish is not permitted in the U.S., while it is accepted in the EU.

Commercial designation

Only the EU requires an indication of the commercial designation of the species. However, there may be other American legislation requiring this labeling, such as legislation about labeling of consumer food products. In the EU, it is voluntary to indicate the scientific name of the species upon sale to the end consumer. However, it is mandatory to indicate the scientific name at all the previous steps in the chain.

Table 3. Recordkeeping and record access requirements of the American interim final rule 7 CFR Part 60 (COOL) and Regulation (EC) No 104/2000 (Articles 1 and 4) and No 2065/2001 of the European Union.

	7 CFR Part 60 (COOL)	**Regulation (EC) No 104/2000 & No 2065/2001**
Record-keeping and record access	Direct and indirect suppliers to retailers: • shall make available to USDA representatives records and other documentary evidence that will permit substantiation of an origin claim and method of production. (§60.400(a)(2)) • must also make the same information available to the buyer, either on the label or in an accompanying document. The supplier who is responsible for initiating the claim of country of origin and method of production must possess records that can substantiate that claim. (§60.400(b)(1)) • must maintain records to establish and identify the immediate previous source (if applicable) and immediate subsequent recipient of a covered commodity for 1 year from the date of transaction. (§60.400(b)(3)) Retailers: • shall make available to USDA representatives records and other documentary evidence that will permit substantiation of an origin claim and method of production (§60.400(a)(2)) for as long as the product is on hand. (§60.400(c)(1)) • must maintain records that identify the retail supplier, the products unique to that transaction, and for products that are not pre-labeled the country of origin and the method of production for 1 year from the date the declaration is made at retail. (§60.400(c)(2))	The information required concerning the commercial designation, the production method and the catch area shall be available at each stage of marketing of the species concerned. This information together with the scientific name of the species concerned shall be provided on the label/package or on a commercial document accompanying the goods. (Article 8, 2065/2001)

2.6.4. Establishment of and access to records

As shown in Table 3, the EU requires that at each stage of marketing (i.e. all steps in the supply chain from the primary producer/harvester to auction, processor, wholesaler, etc. up to but not including the point of retail sale) (Food Standards Agency, 2003) the commercial designation, the scientific name, the production method and the geographical origin (catch area) shall be available to the authorities either on the label/package or in an accompanying commercial document. The EU legislation does not mention for how long time the preceding information shall be available. COOL requires that direct and indirect suppliers and retailers must maintain records of the geographical origin (country of origin) and the method of production and that these shall be available to the authorities. The time period in which these records must be available to the authorities varies for suppliers and retailers and according to whether the product is pre-labeled or not. Thus, the two legislations both require that the geographical origin and the method of production information must be available at all direct and indirect suppliers (i.e. at each stage of marketing) and at retail.

Moreover, COOL requires that the suppliers and retailers maintain records to establish one step back, one step forward traceability (excluding the final consumers) of the covered commodities for one year. This is not a requirement of regulations 104/2000 or 2065/2001. This COOL requirement is also a requirement of Sec. 306 of the Bioterrorism Act of 2002. However, the record retention time according to the Bioterrorism Act and 21 CFR Part 1, Subpart J is 6 months, 1 year or 2 years depending on the shelf life of the product. So, there seems to be an inconsistency between the one up, one down requirement in COOL and in Sec. 306 of the Bioterrorism Act and 21 CFR Part 1, Subpart J. In addition, it must be mentioned that the Bioterrorism Act and 21 CFR Part 1, Subpart J, in contrast to COOL, have specific requirements concerning the information that must be registered.

Another discrepancy between the two American legislations is that farms and fishing vessels that only harvest, head, eviscerate, freeze and transport fish are exempt from the registration of immediate subsequent recipients according to 21 CFR Part 1, Subpart J, while they are not exempt from this registration according to COOL, since they are indirect suppliers to retailers.

Although these inconsistencies exist, the regulations enforce different laws from different governmental agencies. Therefore, companies in a fish supply chain must comply with each of the regulations (Altizer, 2007). In practice, this means that the one up, one down traceability records must be maintained for minimum one year and that farms and the above-mentioned fishing vessels must register the immediate subsequent recipients of their products.

2.7. Overall comparison of the traceability requirements in American and EU legislation

The four American legislations and the three EU legislations described above have similar traceability requirements and similar structures, but differ in the details. Sec. 306 of the Bioterrorism Act, 21 CFR Part 1, Subpart J and Article 18 in Regulation (EC) No 178/2002 deal with the establishment of one up, one down traceability of food. The Bioterrorism Act also covers packaging materials, while the requirements for traceability of packaging materials for the EU are found in other legislation, namely Regulation (EC) No 1935/2004.

Sec. 10816 of the 2002 Farm Bill, COOL, Article 4 in Regulation (EC) No 104/2000 and Regulation (EC) No 2065/2001 are all about the provision of certain information about articles of food to consumers. For this information to be available at every step in the chain and to be supported by a recordkeeping trail, some level of traceability is necessary. COOL also includes the requirement of being able to identify the immediate previous source and immediate subsequent recipient of an article of food (like the Bioterrorism Act and Regulation (EC) No 178/2002), which the "corresponding" EU regulations do not include.

Since the legislations discussed above have differing details, an American company will not completely comply with the EU traceability requirements. A company in the EU will not completely comply with the American requirements, either. Some adjustments will have to be made when companies from the EU wish to export to the U.S. and vice versa, but the principles of the legislations are the same.

3. Traceability requirements in three food management standards

3.1. ISO 22000

Food safety management systems – Requirements for any organization in the food chain, ISO 22000:2005 (Danish Standards Association, 2005) (hereafter referred to as ISO 22000 or the ISO 22000 standard), is a management standard issued by the International Standard Organization specifically for food safety. All parts of the food chain can implement this standard, which specifies the requirements for a food safety management system in order to ensure food safety along the food chain. The traceability requirements in ISO 22000:2005 are found in Section 7.9, and these are outlined in Tables 4, 5, and 6 below.

A new standard, *Traceability in the feed and food chain – General principles and basic requirements for system design and implementation,* is being developed solely dealing with traceability in the food and feed industry, but it is still in the draft phase.

3.2. BRC Global Standard – Food

The British Retail Consortium introduced their first standard for the food industry in 1998 in order to ease retailers' supplier assessments. Instead of each retailer having to audit each supplier/food manufacturer, the supplier could verify their own performance against just one standard and only be audited once by an accredited certification body. In addition, compliance to the standard of the British Retail Consortium promotes best practice in food manufacturing.

The current standard is the BRC Global Standard – Food 2005, Issue 4 (British Retail Consortium, 2005b) (hereafter referred to as BRC or the BRC standard). The traceability requirements are found in Section 2.13 in the BRC standard and are shown in Tables 4, 5, and 6 below.

The BRC standard from 2005 has only one status level, i.e. there are no higher levels or recommendations. Some of the requirements, such as traceability, are designated as fundamental requirements.

This means that if a critical or major non-conformity is noted with regards to the traceability statement of intent, the certification can be withheld, suspended, or withdrawn.

3.3. IFS

The International Food Standard (HDE (German Retail Federation) & FCD (French Retail and Wholesale Federation), 2004) (hereafter referred to as IFS or the IFS standard) is a standard jointly developed by the German and French retail organizations. The purpose is to avoid producers being overwhelmed by different requirements, to reduce costs associated with the audits performed by each retailer and to bring transparency in the whole supply chain.

The first version of IFS is from 2002. The current standard is Version 4 from 2004, in which the traceability requirements are found in Section 4.18. The requirements are listed in Tables 4, 5, and 6 below.

IFS is divided into two levels plus recommendations (foundation level = minimum, higher level = high standard, recommendations = best practice). There are four "KO-criteria" defined in the standard. A company must have full or almost full compliance (an A or B rating) to these criteria in order to be awarded the certificate. The traceability section has a foundation level and a higher level. It is also a "KO-criterion," signifying that it is a very important part of the IFS certificate.

Table 4. The main traceability requirements in the quality management standards ISO 22000, BRC, and IFS. Numbers in parentheses refer to sections in the standards concerned.

	ISO 22000	BRC	IFS
Main requirement	The organization shall establish and apply a traceability system that enables the identification of product lots and their relation to batches of raw materials, processing and delivery records. The traceability system shall be able to identify incoming material from the immediate suppliers and the initial distribution route of the end product. (7.9)	The company shall have a system which has the ability to trace and follow all raw materials (including primary packaging materials) from source through all stages of processing and distribution of the finished product to the customer. (2.13)	The organization shall establish a traceability system, which enables the identification of product lots and their relation to batches of raw materials, primary and consumer unit packaging materials, processing and distribution records. (4.18.1)

3.4. Comparison of the traceability requirements in ISO 22000, BRC, and IFS

The three food management standards ISO 22000, BRC and IFS have the same two main requirements with regards to traceability, namely internal and external traceability (Table 4). That is, traceability through all steps of processing in the company and the principle of "one step forward, one step back" are both required. An interesting difference, however, is the choice of words. BRC and IFS require companies to "have" or "establish" a traceability system, while ISO 22000 requires companies to both "establish and apply." There is of course no doubt that BRC and IFS also require

the companies to *apply* their traceability systems. ISO 22000 and IFS, but not BRC, mention the use of identifiable product lots in the traceability system.

There are several aspects for which BRC and IFS set forth requirements while ISO 22000 does not (Table 5). First, BRC and IFS require that the traceability systems also encompass primary packaging materials. Moreover, IFS requires that consumer unit packaging must be traceable in case the consumer unit packaging is not the primary packaging material.

Second, BRC and IFS require that the traceability systems are tested regularly in order to verify the existence of one step forward, one step back traceability (from raw materials entering the company to the finished product leaving the company and vice versa). IFS requires that these tests are documented. BRC requires that in certain circumstances, procedures for testing must exist. In the BRC guidelines for frequency of traceability testing, though, it is suggested that traceability tests and associated corrective actions should be recorded (British Retail Consortium, 2005a).

Table 5. Traceability requirements in the quality management standards ISO 22000, BRC, and IFS: requirements for the traceability of packaging materials, system tests and product reworking. Numbers in parentheses refer to sections in the standards concerned.

	ISO 22000	**BRC**	**IFS**
Traceability of packaging materials	–	Primary packaging materials (2.13)	Primary and consumer unit packaging materials (4.18.1)
Test of traceability system	–	The system shall be regularly tested to ensure traceability can be determined from raw material to finished product and vice versa. (2.13.1) Where there is a requirement to ensure identity preservation within the supply chain, e.g. to use a logo or make claim to a product characteristic or attribute, appropriate control and testing procedures shall be in place. (2.13.2)	The system has to be tested on a regular basis in order to verify traceability from raw material sourcing to finished product shipment (downstream flow) and from finished product shipment to raw material reception (upstream flow). These tests are documented. (4.18.2)
Reworking of a product	–	Where rework or any reworking operation is performed, traceability shall be maintained. (2.13.3)	Where rework of a product is performed, traceability shall be maintained. (4.18.3)

Third, BRC and IFS require that traceability shall be maintained when any reworking of the product is done. Reworking is the processing of a product once more and can occur if something went wrong during the processing step. The product is treated as a raw material again or it is used for another purpose.

Table 6. Traceability requirements in the food management standards ISO 22000, BRC, and IFS: requirements for maintenance of records and samples. Numbers in parentheses refer to sections in the standards concerned.

	ISO 22000	BRC	IFS
Maintenance of traceability records	Traceability records shall be maintained for a defined period for system assessment to enable the handling of potentially unsafe products and in the event of product withdrawal. Records shall be in accordance with statutory and regulatory requirements and customer requirements and may, for example, be based on the end product lot identification. (7.9)	–	Traceability records shall be maintained for a defined period sufficient for recall purposes, in accordance with customer and regulatory requirements. These records shall be based at least on the product shelf life. (4.18.4)
Maintenance of samples of the production	–	–	Identified samples representative for the production (where appropriate, samples of all batches produced) shall be stored appropriately and kept until expiration of the "Use by" or "Best before date" of the finished product and if necessary for a determined period beyond this date ("sample bank"). (4.18.5) *Higher level:* From all relevant raw materials, when appropriated, identified samples shall be available and kept stored till the end of the expiry date of the end product. (4.18.6)

Establishment of traceability records is assumed to be implicit in the requirement of establishing a traceability system. With regards to the maintenance of traceability records, ISO 22000 and IFS have similar requirements while BRC has not specified any requirements in the traceability section (Table 6). ISO 22000 and IFS both require the traceability records to be maintained for a time period to be defined by the company. This time period must be sufficient for recall purposes according to IFS, while ISO 22000 does not make any demands to the length of the time period, but makes clear that the purpose of maintaining the records is to handle potentially unsafe products and to use

them in the event of a product withdrawal. IFS refers to “recall”, while ISO 22000 mentions “withdrawal”. However, none of these standards define these terms. According to the EU Directive 2001/95/EC on general product safety (Anon., 2002c), withdrawal is any measure aimed at preventing a dangerous product from being sold to a consumer while recall is any measure aimed at achieving the return of a dangerous product that has already been made available to the consumer. In other words, recall covers one step further than withdrawal.

Whereas BRC does not have specific requirements regarding the maintenance of traceability records, section 2.11 in the BRC standard on general documentation requirements states that the retention time of documents and records shall relate to the shelf life of the product and that if there is a possibility that the shelf life is extended by the customer, this shall be taken into consideration in setting the retention time of documents and records. IFS also requires that records shall be retained at least until the product’s shelf life has expired; this is stated both specifically with regards to traceability in section 4.18.4 and in general in section 1.6.3. ISO 22000 does not state specifically that traceability records must be maintained until the expiration of the product shelf life, but since this standard states that the records may be used during a product withdrawal, the records will naturally have to be kept until just around the expiration date.

ISO 22000 requires that traceability records be in accordance with statutory, regulatory, and customer requirements while IFS requires that the length of time that the records must be maintained must be in accordance with regulatory and customer requirements. However, these demands cannot be interpreted as anything else but matters of course, whether they cover only the time period or all aspects of the records, e.g. the kind of information, the way, and for which purpose it is to be recorded. Aside from that, regulatory requirements must by nature always observe the statutory requirements. Certainly, there may be some statutory requirements for which there are no corresponding regulatory requirements, in which case ISO 22000 is broader. But the companies must abide by all legislative and regulative requirements whether or not this demand is mentioned in the quality management standards. However, a company can use a certification against ISO 22000 or IFS to document that they fulfill the legal requirements with regards to traceability records, while a BRC certification cannot be used for this purpose.

IFS has a requirement which the other two standards do not have, namely the requirement to store samples that are representative for the production, preferably from each batch at least until the expiration of the stated shelf life of the product. Moreover, in order to be certified on the higher level of the IFS standard, the company must also store samples of the relevant raw materials (Table 6).

In conclusion, IFS has the most and the strictest requirements with regards to traceability compared to ISO 22000 and BRC. IFS distinguishes itself from the others by having requirements regarding consumer unit packaging materials, documented tests of the traceability system, maintenance of traceability records for recall purposes and establishment of a sample bank.

4. Comparison of legislative traceability requirements to traceability requirements of food management standards

The food management standards in general have more stringent traceability requirements than the American or EU legislation on food traceability (Sec. 306 of the Bioterrorism Act and Article 18 of Regulation (EC) No 178/2000). Whereas the standards require both internal and external traceability of food, the discussed legislations only require external traceability. All require external traceability of primary packaging materials, although this is in a separate regulation for the EU. The standards have requirements regarding e.g. test of the traceability system, maintenance of traceability during product reworking (may be considered as part of internal traceability) and the storage of representative samples from production. The legislations have no such requirements.

However, an aspect where the legislations are similar to or are stricter than the standards is the establishment and maintenance of records. First, the legislations require that the records must be available to the authorities on request (in the U.S. within 24 hours). Due to their nature, the standards cannot enforce such a requirement. Second, the American legislation specifies the record retention time and the EU guidance has some recommendations on the record retention time, while the standards require that the retention time must be defined by the company, taking into consideration the product's shelf life. However, with regards to traceability records, the standards state as a requirement that the records must be in accordance with the legislation, so a company must also meet the legislative requirements on traceability records in order to be certified to the standards.

Neither the legislations nor the standards have any requirements concerning the maximum batch size at any point in the supply chain. It is in a company's own interest to set a batch size that is a balance between the cost of implementing traceability for smaller batches and the cost of having to destruct large batches during a possible recall. The health consequences of a faulty batch can be far-reaching if the batch is so large that it is difficult for the involved companies to locate all the faulty products. Therefore, it should also be in the interest of the government to set maximum batch sizes in order to best protect its citizens from health threats.

The standards do not have any requirements regarding the topics covered by Sec. 10816 of the 2002 Farm Bill, the COOL regulations, Article 4 in Regulation (EC) No 104/2000 and Regulation (EC) No 2065/2001.

5. Conclusion

The principles in the American and EU legislations on food traceability are similar, but they differ in the details. While the legislations only require external traceability, the food management standards also require internal traceability in addition to other requirements. The American and EU legislation on labeling of seafood products are similar, but again there are differences. The standards do not have requirements concerning labeling of consumer products. The standards have more requirements than the legislations but do not include all the legislative requirements. Therefore, even if companies are certified against one of the mentioned standards, they must make sure that they also comply with the legislative requirements of the relevant country.

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Paper II

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Simulated recalls of fish products in five Nordic countries

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Abstract

Simulated recalls of fish products sampled in retailer shops were conducted in five Nordic countries to indicate the effectiveness and accuracy of chain traceability systems. The results suggested poor traceability practices at the vessels/auctions and revealed that batch sizes at the last traceable step of the raw material vary considerably. However, the existing traceable information seemed to be easily accessible. Altogether, the fish industry in the Nordic countries seems not to be fully prepared for a recall. Improved traceability awareness and practices in the whole chain can limit the batch sizes and minimize costs in case of a real recall.

Keywords: Simulated recalls; Traceability; Fish industry

1. Introduction

Food scares such as mad cow disease (BSE) in the UK beef industry in 1996 and the dioxin contamination in Belgium in 1999 have increased the demand for traceability (Derrick & Dillon, 2004; Frederiksen & Gram, 2003; The Standing Committee on the Food Chain & Animal Health, 2004). The inability to trace products through the food supply chain can ruin a company, as all the company's products will have to be removed from the market if the company cannot prove that certain batches of the product are not contaminated. Thus, traceability facilitates product withdrawal and recall by making it possible to trace a product back to its source, to identify other products affected and to locate the products in question.

The size of the batches at the individual steps in the supply chain is critical; large batch sizes may be cause for concern due to the value they represent. It would be beneficial for each step in a supply chain to determine an appropriate batch size based on e.g. the cost of having to destruct large batches during a possible recall, the cost of implementing traceability for smaller batches, and the expected frequency of critical faults. Apart from the costs associated with a recall, the damaging effect of a recall on the company's brand can be devastating. Limiting batch sizes creates the opportunity to be proactive and enable brand protection.

A truly functional traceability system includes both internal and external, or chain, traceability, as illustrated in Fig. 1. Not only is it necessary to be able to identify the immediate previous supplier and the immediate subsequent recipient of a company's product, but in order for traceability to be a useful tool for the optimization of processes and the utilization of traceable information, it is also crucial to be able to identify which raw materials came into

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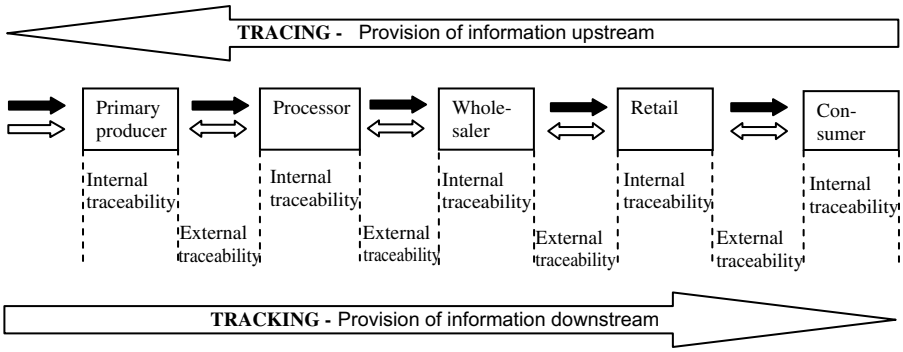

Fig. 1. Traceability along the food supply chain. Filled arrows show the product flow; open arrows show the information flow. Modified after Schwägele (2005) and GS1 (2006).

the company, which processes they went through, and of which of the company's final products they are a part (Moe, 1998; Storøy, Forås, & Olsen, 2007). Lastly, the usefulness relies on these identifications being a part of the standard operating procedures of each company in a supply chain. Otherwise, the batch size to be recalled will be larger than necessary. In such cases, the traceable information may primarily be useful only for recall purposes.

In addition to limiting the cost of a recall, specific pieces of information made available by traceability can be used actively towards the consumer for storytelling and internally for industrial statistics and chain management. Thereby, traceability also becomes a tool to create a higher product value.

External, but not internal, traceability is a requirement of Article 18 in the European Union's Regulation (EC) No. 178/2002, effective January 1, 2005, which states that all food products must be traceable one step forward and one step back at any point in the supply chain (excluding sales to the end consumer) (Anon, 2002b). This regulation applies to all food business operators residing in an EU member country. The United States has imposed similar requirements via the Bioterrorism Act of 2002 (Anon, 2002a).

There is a limited amount of literature on simulated recalls in the food industry. Recently, Karlsen and Senneset (2006) have developed a method for conducting a survey to test the fish industry's readiness to recall fish products. They found that 63% of the selected fish products could be traced back to the fishing vessel or breeder. In addition, they wished to establish the status of traceability systems in the Norwegian fish industry. Hence, their method also focused on the industry's use of GS1's Global Trade Item Number (GTIN) (EAN·UCC, 2002) and the TraceFish standard's GS1-based GTIN+ to identify trade units, the knowledge and application of the TraceFish standards (European Committee for Standardization, 2003a, 2003b), and the use of electronic information transfer.

The present study also focuses on testing the preparedness of the fish industry to successfully recall a product. However, the preparedness is evaluated not only in terms of the last traceable step of the raw material in the chain, but also in terms of the size of the batch at the last traceable step and the time needed to perform the recall operation. To achieve this aim, a simulated recall of a given number of fish products in five Nordic countries was carried out.

2. Methods

Simulated recalls were performed in five Nordic countries (Denmark, the Faroe Islands, Iceland, Finland, and Norway) in 2006–2007 based on a modified version of the method developed by Karlsen and Senneset (2006). Due to differing objectives compared to their study, the following points are not included in the present method: (a) mapping of the product information against the TraceFish standards, (b) investigation of how batches are identified throughout the supply chains and what kind of traceability systems the companies use, and (c) the number of times the researchers communicated with the companies. However, similar traceability logs to record information about the traced product are used in both methods.

Because of the changes made to the method, the present method is described step-wise below and schematically in Fig. 2. The step numbers refer to the steps shown in Fig. 2.

Step 1: Three to five fish products were chosen in each of the five countries. The products included at least one fresh, unprocessed fish product from an independent fish monger or a fish monger in a supermarket (shop-in-shop) and at least one frozen, unprocessed fish product from a supermarket. The rest of the product types and shop types were optional. Fish products caught in national waters or farmed nationally were chosen as this would best reflect the traceability levels in the particular countries. In this article, unprocessed fish is fresh or frozen either whole or filleted. Products that have undergone further treatment, including modified atmosphere packaging, are considered processed. For these products, only the fish/seafood was traced and not other ingredients such as spices, oil, batter, vegetables, etc.

Step 2 (A and B): Information that could be used to trace the product was noted from either the consumer package or, if the product was not in a consumer package, from interviews with the shop personnel. Examples of such information are (A) from the consumer package: name of

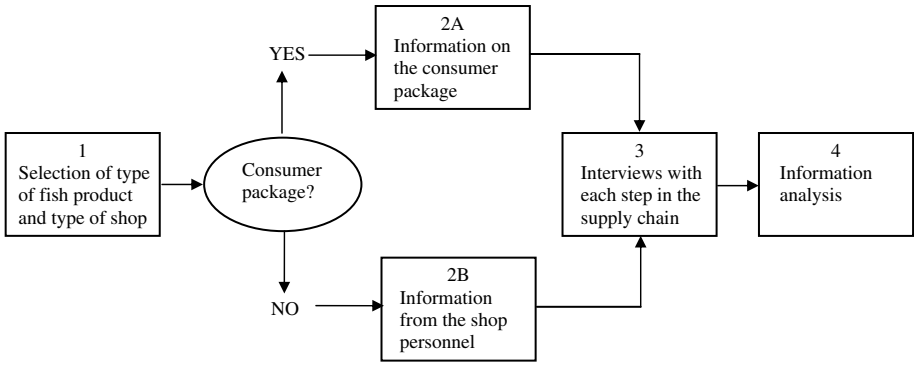

Fig. 2. Outline of the survey method. Modified after Karlsen and Senneset (2006).

brand owner, species of the main ingredient, country or area of origin of the main ingredient, internal batch number, and production date and (B) from the shop personnel: species of the main ingredient, name and telephone number of the shop/wholesaler from whom the fish was bought, invoice number, and batch size received from the previous shop/wholesaler.

Step 3: The brand owner/producer and each successive step backward were contacted by telephone to obtain the following information:

(a) the company name and telephone number of the previous step in the chain and a contact person at that step,

Table 1
Example of a traceability log

Date of selection of product	August 22, 06
Shop/fish monger	Supermarket A, Street B, City C
Information on the consumer package:	
Product (including species)	MAP fillets of plaice
Brand owner	Company D
Producer, address	Company D, City E, Denmark
Producer's telephone number, homepage	12 34 56 78, www.companyD.dk
Authorization no.	DK 1234
Country/area of origin	North-east Atlantic Ocean
Country of processing	Denmark
GS1 number	1234567890123
Internal batch number	No labelling
Production date	August 17, 2006
Best before date	August 24, 2006

Step	Company and contact person	Aid	Date	Time start	Time end	Estimated or measured time (min)	Information received
Retailer	Name of supermarket A	Purchase in shop	August 22, 06	18.25	18.28	3	On label (see above)
Producer	Name of company D, contact person F	Telephone	August 23, 06	11.00	11.04		Called company D. Required an email
Producer	Name of company D, contact person F	E-mail	August 23, 06	11.05	11.20	60 (estimated by company D)	Wrote mail to F with information about the project and information from the consumer package
Producer	Name of company D, contact person F	E-mail	September 5, 06	7.33	7.33		Received mail from F. Plaice bought at fish auction G, 2975 kg plaice, size 4, August 16, 06
Auction market	Name of fish auction G, contact person H	Telephone	September 5, 06	11.05	11.10	5	Company D bought 2975 kg plaice, size 4 from collector I on August 16, 06. Fish auction G sold in total 17,863 kg plaice, size 4 for collector I August 16, 06
Collector[a]	Name of collector I, contact person J	Telephone	September 5, 06	12.47	12.49	2	Received unknown quantity of plaice from 32 different vessels in one harbor August 16, 06. The fish was caught over several days

[a] A collector prepares the fish for auction by unloading the vessel, size-grading the fish and rating the fish according to freshness.

(b) the size of the batch including the given product, which was received from that company, and any other data to identify the batch (e.g. date, invoice number),
(c) in the event of a genuine recall situation, the time the company would estimate was necessary for them to find the information that they supplied to this study.

This procedure was repeated until the origin, being the fishing vessel or the fish farm, was reached. If this was not possible, the last traceable step was recorded as a number of fishing vessels or fish farms. The companies contacted were informed that this test was a part of a research project in the Nordic countries. The companies were also assured full anonymity and that there were no commercial interests in the project. As in the method of Karlsen and Senneset (2006), the companies were not required to verify their information by presenting orders, invoices, or other documentation.

Step 4: The information received about each traced product was recorded in a traceability log, as illustrated in Table 1. Thereafter, the results from the five countries were collected and assessed according to (a) the last traceable step in the chain, (b) the size of the batch at that step, and (c) the time needed to determine (a) and (b).

3. Results and discussion

The summary of the results of the simulated recalls is shown in Tables 2a, 2b, and 2c. It is seen that the levels of traceability differ from one product to the next. There are no similarities regardless of whether the products are grouped according to country or product type. This could be because there are too few products to see any difference among the groups.

The last traceable step varies from one vessel to 50 vessels. In 10 cases out of 18 (56%), it was possible to trace the fish products back to just one vessel or fish farm. Karlsen and Senneset (2006) were able to trace 63% of 16 fish products in Norway back to a single vessel or fish farm. If the investigated products were to be recalled, the economic losses for the involved companies could have been minimized if it was possible to trace each product back to one vessel or fish farm. The results indicate that improvement of chain traceability is needed at the steps at the beginning of the supply chains (e.g. the vessel and auction). In a study of three Danish fish supply chains, Frederiksen and Bremner (2001) also found that mixing of different catch days and vessels often occurs at the auctions, resulting in traceability back to the individual fishing vessel being lost at the auction. Improvement of traceability practices, also in other parts of the supply chain, could in the best case limit the recalled batch size to one single fish, but a more realistic objective in the fish industry is to obtain a batch size, which is reasonable, yet cost-effective both during production and in terms of a recall.

All the steps in the supply chains investigated in the present study comply with the one step forward, one step back traceability requirement in the EU Regulation (EC) No. 178/2002, since it requires, as a minimum, the ability to establish which type of products is supplied from which group of suppliers (The Standing Committee on the Food Chain & Animal Health, 2004), not which unique products are supplied from which unique supplier. Hence, a last traceable step of more than one vessel complies with the one step forward, one step back requirement of the EU Regulation.

The obtained information about the last traceable step can be used for marketing purposes, i.e. storytelling. Clearly, traceability back to a single vessel can be used by stating the name of the vessel that caught the fish. It is also possible to tell a story even if the last traceable step is 50 vessels. "This fish is caught in the North Sea by one of 50 fishing vessels from the harbor of xyz" offers more knowledge about the history of that fish than one which is simply labelled "Caught in the North-East Atlantic," as required by EU Regulation (EC) No. 104/2000 and No. 2065/2001 (Anon, 2000, 2001). However, the latter information must be stated on the package as well.

The batch sizes at the last traceable step vary from 5 kg to 600,000 kg. This large range may be due to differences in the type of fish business operators, i.e. different types and sizes of vessels used and differences in the size of the industry for different fish species. The large quantities indicate that the steps at the beginning of the supply chains should reconsider whether they have appropriate batch sizes and traceability procedures.

The batch size at the last traceable step is chosen in order to have comparable data. The cause of a recall may of course be located at all steps along the supply chain, and the batch sizes at these steps most probably

Table 2a
The results of the simulated recalls of fresh fish products in five Nordic countries

Country	Species (fillets)	Last traceable step	Batch size	Estimated time necessary (min)
Iceland	Haddock	One vessel	562 kg (one day's catch)	20
Finland	Lavaret	One vessel	5 kg (one day's catch)	10
Faroe Islands	Cod	50 small vessels in two harbors	6009 kg (three days' catch)	95
Denmark	Cod	20 small vessels in Øresund	One day's catch of 20 small vessels	60
Norway	Cod	One fish farm	4000 kg (one day's harvest)	36
Norway	Saithe	One small vessel	2700 kg (one day's catch)	23

Table 2b
The results of the simulated recalls of frozen fish products in five Nordic countries

Country	Species	Last traceable step	Batch size	Estimated time necessary (min)
Iceland	Haddock fillets	Six vessels through three auctions	1661 kg (one day's catch)	60
Finland	Perch fillets	Seven vessels in the Bothnian Bay and the Kvarken Archipelago	387 kg (four days' catch)	69
Finland	Herring fillets	One vessel	112,729 kg (one day's catch)	95
Faroe Islands	Haddock fillets	One vessel	600,000 kg (two months' catch)	100
Denmark	Saithe fillets	One vessel	45,235 kg	60
Norway	Sea trout	One fish farm	One day's harvest at one fish farm	11

Table 2c
The results of the simulated recalls of optional fish/seafood products in four Nordic countries

Country	Fish/seafood product	Last traceable step	Batch size	Estimated time necessary (min)
Iceland	Frozen breaded haddock portions	Five vessels in one harbor	39,039 kg (one day's catch)	60
Finland	Chilled rainbow trout in tomato sauce	One fish farm	9600 kg (one day's harvest)	45
Faroe Islands	Frozen C&P[a] shrimps	One vessel	335,140 kg (two months' catch)	50
Faroe Islands	Frozen fried fish cakes (haddock)	Three small vessels in two harbors	717 kg (one day's catch)	140
Faroe Islands	Canned cod roe	50 vessels	Three months' catch of 50 vessels	52
Denmark	MAP[b] plaice fillets	32 vessels in one harbor	Several days' catch of 32 vessels	70

[a] C&P = cooked and peeled.
[b] MAP = modified atmosphere packed.

differ. For example, if the unfortunate conditions causing the recall are in the refrigerated truck transporting the end product to the retailers, it would most probably be a smaller batch size that would be recalled than if the unfortunate conditions were on the factory trawler that caught the fish. Needless to say, this requires that the cause of the problem prompting the recall has been pinpointed.

The time needed to identify the last traceable steps and the corresponding batch sizes varies from 10 min to 140 min, which is acceptable. Not all the products in the survey have been traced back to a single vessel or farm. If this was possible for those products, then the time needed would be prolonged. Despite that, the reported time indicates that the traceability systems, whether paper-based or computerized, work at most of the steps. The products are marked in such a way that the companies are able to trace them back, and the existing information about the paths of the products is readily available.

Even though Karlsen and Senneset (2006) recorded the time used in acquiring the information from the companies, the time was unfortunately not reported, so no comparison can be done. Karlsen and Senneset (2006) state that the time recorded does not give a realistic picture because the companies would have prioritized differently in case of a real recall. Indeed, the involved personnel would put other work aside to focus on tracing and tracking the affected products. Therefore, in the present study, time used on unsuccessful telephone conversations (e.g. the person in charge was not present) and time spent waiting for a return call, for example, were omitted. Instead, the companies were asked to estimate the time they would need to find the information if a genuine recall were to happen. In this respect, it is important for companies to be aware that they have not only one, but several, employees that have access to the companies' traceable data.

All products originating from the same batch must be located and removed from the market during a recall. Therefore, the evident next step after this study is to track forward the batch at the last traceable step to find out where the other portions of that batch have been delivered. This will provide even more information on the preparedness of the fish industry for a recall.

The present method can be used to investigate the traceability status within other food industries and in other countries. It would be interesting to see how prepared the fish industries in other countries are for a recall.

4. Conclusion

Around half of the investigated supply chains were able to identify the origin of a product at the level of one single vessel or fish farm. The last traceable step for the remaining products was up to 50 vessels. Batch sizes at the last traceable step varied from 5 kg to 600,000 kg, the latter indicating that the fish industry, especially the fishing vessels and auctions, should reconsider their batch sizes in order to

make a potential recall as unproblematic and inexpensive as possible. The time necessary to trace back the products were all under 2 h and 20 min, suggesting that the existing traceable information is relatively easy to find. Overall, the fish industry in the Nordic countries complies with Article 18 in EU Regulation (EC) No. 178/2002, but they seem not to be fully prepared for a recall and the traceability of fish products can be improved. If the information provided by traceability systems are to be further utilized by the companies in the chain to achieve a higher product value, smaller batch sizes are a must.

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Paper III

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On the track of fish batches in three distribution networks

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ABSTRACT

Three fish products sampled in retail shops were traced back to their origin and fish from the same batch were tracked forward towards the retailer, thereby simulating a recall situation. The resulting distribution networks were very complex, but to the extent that companies were willing to provide the necessary information, it was possible to locate the end destinations of the fish batches. The batch sizes and the number of companies involved clearly rose when batch joining occurred. Thus, a fault in a small batch can potentially have widespread implications. The study also underlines the importance of discovering a fault as early as possible in order to minimise the costs of a recall. The localisation of distributed products during a recall operation can be facilitated by a well-constructed traceability system.

1. Introduction

The ability to perform food product recalls quickly and accurately is important to maintain food safety and public health (EU, 2002; Kramer, Coto, & Weidner, 2005; Levinson, 2009). This concern is shared by food authorities and the food industry. If a recall is unavoidable, the food industry is also interested in keeping the recall costs as low as possible and in protecting the reputations of both a company's brand(s) and the company itself (Dupuy, Botta-Genoulaz, & Guinet, 2005; Kumar & Budin, 2006; Velthuis, Reij, Baritakis, Dang, & van Wagenberg, 2010). At the core of these concerns rests the ability of the companies involved to locate and uniquely identify the affected food products as soon as possible. Factors contributing to this ability include discovering the problem prompting the recall as soon as possible, having appropriately sized batches, and preferably, refraining from mixing similar raw materials from different sources into one batch (Storøy et al., 2008; Teratanavat & Hooker, 2004; Velthuis et al., 2010). Crisis management readiness, including efficient communication, throughout a whole supply chain is also a central factor when a recall occurs in order to keep recall costs to a minimum and to maintain public trust (Charlebois, 2011; Kumar & Schmitz, 2011; Wynn, Ouyang, ter Hofstede, & Fidge, 2011). A discussion of direct and indirect costs of a product recall can be found in Kumar and Schmitz (2011).

In the EU, Article 19 of the General Food Law (EU, 2002) requires food business operators to commence procedures to recall food that is not in compliance with the food safety requirements or otherwise deemed unsafe immediately upon finding the non-compliance. Each step in the food supply chain is required to cooperate with each other, for example by forwarding relevant information necessary to trace a food. Article 18 of the General Food Law stipulates that food placed or intended to be placed on the market shall be adequately identifiable and that food business operators must be able to identify their immediate suppliers and their direct recipients (the so-called one step back, one step forward principle). However, Article 18 and Article 19 do not specify recommended batch sizes nor define what a reasonable time period is in which to locate and/or recover affected products during a recall.

A recall involves two or more companies, or steps, in a supply chain. In order for the recall to be successful, a functioning traceability system is necessary both within each step (internal traceability) and between the steps in the supply chain (chain traceability) (Moe, 1998). In fact, risk management and the ability to perform targeted recalls successfully is an important driver for the implementation of a traceability system (Coff, Korthals, & Barling, 2008; Dupuy et al., 2005; Golan et al., 2004). In other words, an effective traceability system with appropriate batch sizes can minimise the impact of a food safety crisis, which potentially may be runaway recalls, bad publicity and liability (Dupuy et al., 2005; Golan et al., 2004).

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The granularity of a traceability system describes the system's degree of detail, i.e. the smaller the batches are, the more batches there will be created (assuming a constant product amount), and the finer the granularity will be (Karlsen, Donnelly, & Olsen, 2011). This in turn will lead to a greater number of recordings, but this also provides the opportunity to attach more information to the batches (Bollen, Riden, & Cox, 2007). If reductions in the batch sizes are implemented, the amount to be recalled may be reduced, but at the same time, smaller batch sizes may also cause a reduction in the production efficiency (Dabbene & Gay, 2011; Fritz & Schiefer, 2009; Saltini & Akkerman, 2012). Determination of the optimal granularity (the optimal batch size) also depends on the desired use of the information generated, as discussed further in Karlsen et al. (2011). In addition, batches may undergo transformations, such as joining or splitting up, along the supply chain, which is a factor that also affects the granularity of the system and the traceability of the product (Derrick & Dillon, 2004; Donnelly, Karlsen, & Olsen, 2009).

Although it is fairly common practice to perform mock recalls in large food manufacturing companies, and it is further a requirement of certain food safety and quality assurance standards such as ISO 22000 (Danish Standards, 2005), IFS Food (International Food Standard, 2007) and BRC Global Standard for Food Safety (British Retail Consortium, 2008), the results of mock recalls conducted by food business operators are rarely publicly available. However, a few research studies have been performed (Table 1). It is worth noting that very few of the investigated products other than fish and shrimp products were traceable from the retailer back to the origin. The three studies which dealt with fish and shrimp products in Northern Europe found that it was possible to trace 31–55% of the selected products back through the supply chain to one single fishing vessel or breeder.

The simulated recalls in the aforementioned studies only covered the first part of a recall, namely tracing back the product in question to its origin (i.e. the fishing vessel, the breeder, or the farm) (Fig. 1a). During a recall situation, it is also important to be able to track the product batches forward in the supply chain from each step in the chain to the next, since the problem initiating the recall can occur anywhere along the chain. In the present study, we have expanded the scope to include both parts of a simulated recall: tracing back and tracking forward (Fig. 1b).

Our hypotheses are that both the tracing back of fish products and the tracking forward of fish batches are possible and that the distribution networks will be complex with many branches. This investigation reveals the distribution networks created by tracing three different fish products back to the origin of the fish and, at each step, tracking forward the corresponding batches to their end destination (excluding the final consumer). A schematic overview of the distribution networks provides an indication of the possibility of locating a product should a recall be required at any point along the supply chain. When the batch sizes at each step are known, the results show how large an effect a recall situation may have, for example with regards to the amount of fish to be recalled and the number of steps that may be involved.

2. Materials and methods

Simulated recalls of three fish products sampled in retailer shops in Denmark were performed based on the method of Randrup et al. (2008), including the use of traceability logs. The method entails (a) selecting a fish product at a retailer, (b) collecting data about the retailer product either from the package or from the shop personnel, (c) conducting telephone interviews with each step in the supply chain, and (d) analyzing the collected data. Compared to Randrup et al. (2008), the steps were interviewed about the product flow both upstream and downstream in the supply chain.

The following information was requested from the steps:

- The company name, address, and telephone number of the step that they received the fish from
- The amount of fish that they received
- The date that they received the fish
- Any kind of relevant information that they received along with the fish
- The type of production that they have (e.g. filleting, freezing) and the production date
- The batch size after production
- The company name, address, and telephone number of the other steps to whom they delivered fish from the same batch
- The amount of fish that they delivered to each of the other steps
- The date that they delivered the fish to the other steps
- Any kind of relevant information that they delivered along with the fish
- The amount of time that they estimated was necessary for them to find the information that we requested

When tracing back, the procedure was repeated at each step in the chain until we reached the origin. When tracking forward, the procedure was repeated until we reached the steps just before the final consumer or as far downstream as possible due to unavailability of information from some of the steps.

The three fish products were selected in such a way that there was correspondence with the three Danish fish products traced in Randrup et al. (2008). The products were (a) fresh iced cod fillets from a fish monger, (b) chilled modified atmosphere packed (MAP) plaice fillets from a supermarket, and (c) frozen saithe loins from a supermarket.

The companies contacted were informed that this investigation was part of a research project, that there were no commercial interests in this project, and that they were assured full anonymity. For this reason, in Fig. 2–4, the companies are coded and labelled according to the type of company.

Table 1
Percentage of investigated products traceable back to the origin (a single fishing vessel, breeder, or farm) in published studies.

Type of food	Total no. of products	Products traceable to the origin	Country of product purchase	Reference
Fish and shrimp products	16	31%	Norway	Karlsen & Senneset, 2006; Karlsen, KM, personal communication, 2011
Fish and shrimp products	18	55%	Denmark, Norway, Iceland, Finland, Faroe Islands	Randrup et al., 2008
Fish products	6	50%	Norway	Karlsen et al., 2009
Dairy products, grain products, meat products, produce	24	8%	Norway	Karlsen et al., 2009; Donnelly, KAM, personal communication, 2011
Dairy products, grain products, produce, beverages	40	10%	U.S.A.	Levinson, 2009

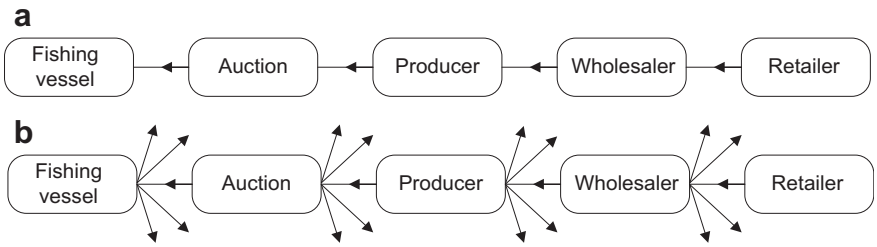

Fig. 1. Simplified illustration of a fish supply chain with five steps. Product flow is from left to right. (a) The trace back procedure starts at the retailer where the product is purchased and follows the arrows upstream towards the origin. (b) After tracing back, the track forward procedure proceeds downstream with the product flow and may branch out from one or more steps.

3. Results

3.1. Case 1: cod fillets

Iced cod fillets (Fig. 2) were bought at a fish monger in a supermarket (Retailer O). The cod fillets were traced back to a batch of 2475 kg of gutted cod of a specific size category and freshness rating caught over four days by a single Danish fishing vessel, which had seapacked[1] the cod and landed it in southern Sweden. The cod was transported by truck to an auction in Denmark. At the auction, the cod was sold to seven producers, five of whom we knew either headed or filleted the fish. Three of the producers sold the cod directly to individual retailers in Denmark, while the remaining four producers sold the cod to wholesalers in at least four countries. In all, the batch from the fishing vessel was distributed to at least 55 retailers. The batch size at each retailer varied from approximately 3–25 kg fillets per retailer. In some cases, for example at Producer I, the cod received from the auction was mixed with 20 boxes of cod from one or more other batches, such that it was not possible to track the cod from the batch in question only. The fish was received by the retailers 2–8 days after landing. For those chains without wholesalers, the fish was available at the retailers 2 days after landing. However, for one of the chains with a wholesaler in Germany, the fish was also available at the retailers 2 days after landing. Otherwise, for the rest of the chains with wholesalers, 5 days passed before the fish was at the retailers in Denmark and 7–8 days passed when the retailers were in Spain.

3.2. Case 2: plaice fillets

Chilled MAP plaice fillets (Fig. 3) were bought at a supermarket (Retailer GG) and traced back to one or more of 11 Danish fishing vessels, giving a total batch size at the last traceable step of 5028 kg of gutted plaice of one freshness rating and two size categories. One vessel sold their catch directly to a wholesaler while ten of the vessels had their catch size-graded and rated for freshness by five collectors. Thereafter, the fish was put up for sale at five auctions. Producer AA bought plaice from four of the auctions and from two wholesalers and the plaice from all these sources were mixed into one batch of 3633 kg. Three of the auctions sold plaice from the same batch to four other producers, of whom it is known that three filleted the plaice before selling them to retailers and wholesalers. One producer mixed the plaice with another batch and sold them to wholesalers in Hungary. The batch created at Producer AA is distributed to 112 retailers, who received the fish 5 days after the fish was landed. There are at least 39 other retailers in the network; as far as we know, they received the fish only 1–2 days after landing. The batch size received by the retailers varies from approximately 10–55 kg.

3.3. Case 3: saithe loins

Frozen saithe loins (Fig. 4) were bought at a supermarket (Retailer F) and traced back to a single Norwegian fishing vessel that sold the fish directly to a producer in Norway. The producer prepared the fish into frozen loins, which via a wholesaler were sold to a producer in Denmark, who packed the loins in retailer packages. It was not possible to track the saithe forward from Fishing vessel A and Producer B, since these steps were not interested in supplying information to the study.

3.4. Time consumption

In Case 1, the time needed to trace the cod back to the origin was short because the batch of which the cod was a part could be traced back to a single fishing vessel (Table 2). There were only 4 steps to contact in order to trace the fish all the way back to the vessel. In Case 2, there were 15 steps to be contacted and the time for tracing was almost 7 times as long as for Case 1. Nonetheless, it is possible within a reasonable time frame and compares well with the results of Randrup et al. (2008) and Karlsen, Donnelly, and Dreyer (2009). The time needed for both tracing and tracking the fish in Cases 1–3 varied from 1½ to 8 h, which must be considered reasonable considering how widespread the fish has been distributed.

4. Discussion

It was possible to trace the fish products back to the fishing vessel(s) that caught the fish. The cod and saithe could be traced back to a single vessel, while the plaice stemmed from a pooled batch of 11 vessels. To a certain extent, it was also possible to track the fish products forward to the retailers. It was not possible to disclose the entire distribution network for any of the three fish products. Some of the destinations remain unidentified due to reasons of confidentiality or time constraints on the part of the contacted companies. Therefore, this study is based on the information which has been made available to us.

It is said that modern food supply chains are complex and globalised (Jensen, Nielsen, Larsen, & Clausen, 2010; Olsson & Skjöldebrand, 2008; Schröder, 2008). All three cases in this work show involvement in the global market while Cases 1 and 2 clearly visualise the complexity of the modern fish industry. Case 1 shows how widely 2475 kg of cod from a single vessel can be distributed. Case 2 shows that parts of the catches of many vessels may be mixed together at one producer, while the other parts of the same catches may be split up further and be widely distributed. The batch sizes are very varied; they increase upon batch mixing and decrease

[1] Seapacked fish are gutted fish that are size-graded onboard the vessel, packed in fish boxes with ice, and labelled in order of catch date.

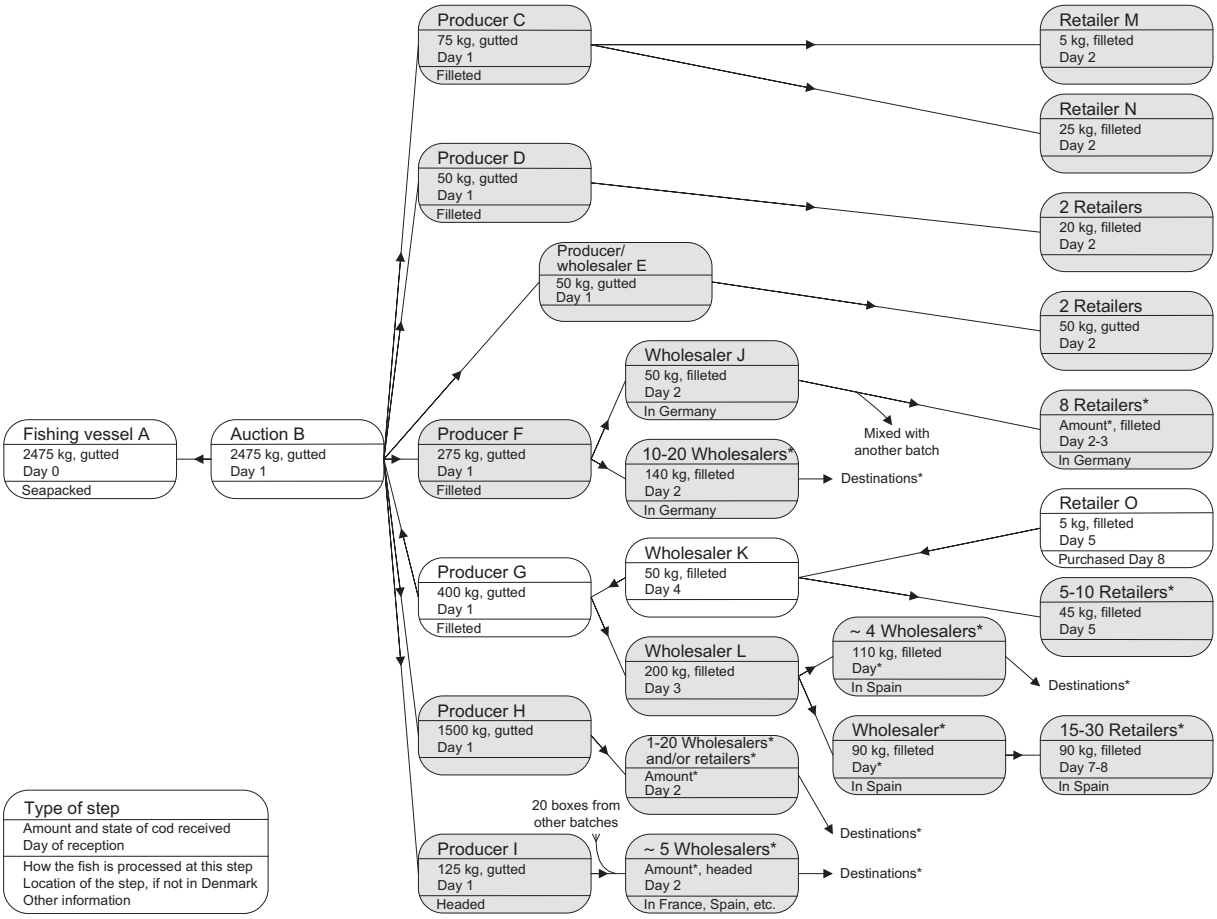

Fig. 2. Distribution network of Case 1: cod. Arrows pointing left indicate tracing back (white boxes). Arrows pointing right indicate tracking forward (shaded boxes). Product flow is from left to right. * = Unidentified for the researchers.

upon batch splitting. The batch sizes at the last traceable steps in this work resemble the batch sizes found in an earlier study (Randrup et al., 2008).

The study showed that from the landing date, it took 1–8 days for the cod and plaice to arrive at the retailers. Overall, there is no correlation between this length of time and either how many steps there are in the chain or the types of companies. In this regard, it is important to note that the landing date is not necessarily the same as the catch date. Therefore the fish may be several days older than the landing date indicates. It is known that the fishing vessel in Case 1 was on a 4-day fishing trip, so the cod caught by that vessel may be up to 4 days older than the landing date. It is known that two of the vessels in Case 2 are day boats, meaning that their fishing trip only lasts one day. It is also known that the plaice in Case 2 is of such a freshness rating that the fish can only be up to 3 days old upon landing. These facts must be considered when evaluating the freshness of the fish upon arrival at the retailers.

The landing date is used as the reference point (Day 0) in Figs. 2–4 in order to have a measure of the time that elapses between each step the fish passes through. The catch date would be more appropriate than the landing date to use as the reference point and clearly more meaningful to evaluate the freshness of the fish. The catch date should be more readily accessible as of January 1, 2012, since EU Regulations 1224/2009 (EU, 2009) and 404/2011 (EU, 2011) require that from this date, the catch date or group of catch dates for a batch of fish must be available at all the steps in a supply chain (excluding the final consumer). However, these legislations do not regulate the availability of the catch date to the consumers. If so, this would represent significant progress in enhancing product information to the consumers.

The cod in Case 1 is seapacked, but the information given by the seapack-label (i.e. catch date, name of fishing vessel), is not passed on by the processors to the rest of the distribution network. Only the information required by EU Regulation 2065/2001 (EU, 2001) is sent onwards to the next steps in the chain (i.e. catch area, species, and production method (wild-caught or farmed)). If the fish is stored on ice since catch, the catch date gives reliable information about the freshness of the fish. The name of the fishing vessel can be used for storytelling to the consumers, but also as a 'guarantee' of freshness/high quality if the producers' customers repeatedly receive outstanding fish from the same vessel. Other information which is forwarded in the distribution networks is the freshness rating, fish size, and production date, although not all of these are forwarded by every company.

Cases 1 and 2 clearly show the importance of discovering any fault prompting a recall as soon as possible. For example, in Case 1, if one of the 15–30 retailers in Spain on Day 8 were to discover a deviation in the cod which could be traced back to defective conditions onboard the fishing vessel, then the rest of the cod from the same batch on the fishing vessel would already have been distributed to the other retailers, i.e. a total of 2475 kg. Wholesaler J mixed the cod from this batch with cod from another batch before distribution, and if cod from the two batches in fact were inseparable, the total amount to be recalled would also have to include

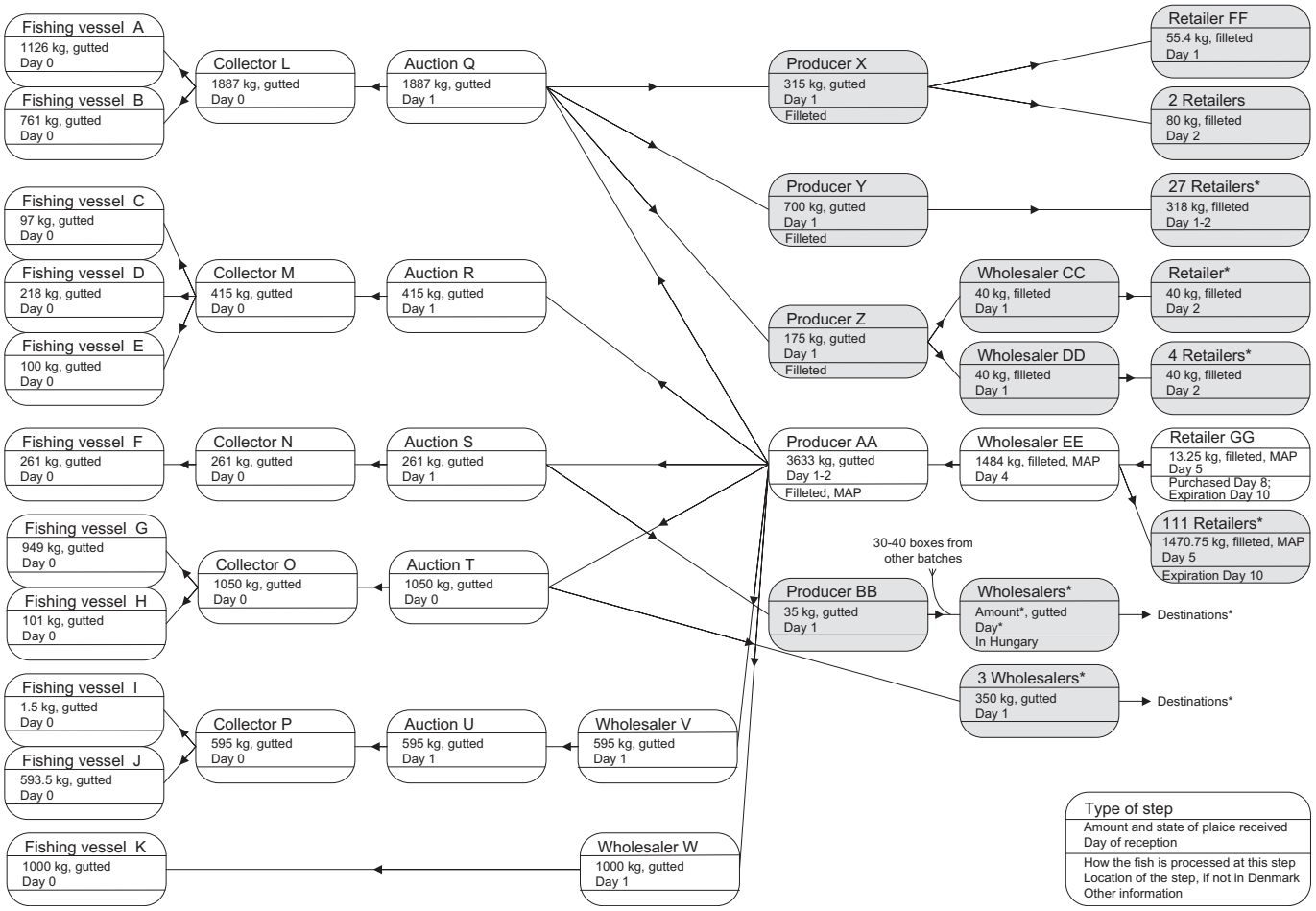

Fig. 3. Distribution network of Case 2: plaice. Arrows pointing left indicate tracing back (white boxes). Arrows pointing right indicate tracking forward (shaded boxes). Product flow is from left to right. * = Unidentified for the researchers.

cod from this other batch. The same situation is seen at Producer I. On top of this, other batches and species of fish onboard the vessel might be affected, too. However, if the fault were to be discovered on Day 1, then the fish would only have reached the producers, and a recall would have been easier to perform.

In Case 2, we see the potential consequences of pooling fish from 6 different sources (Producer AA). If Producer AA discovers a deviation in this pooled batch of fish, then the problem may stem from any one of the six sources. If the source of the problem is unidentified, then these six sources may have to recall fish from the same

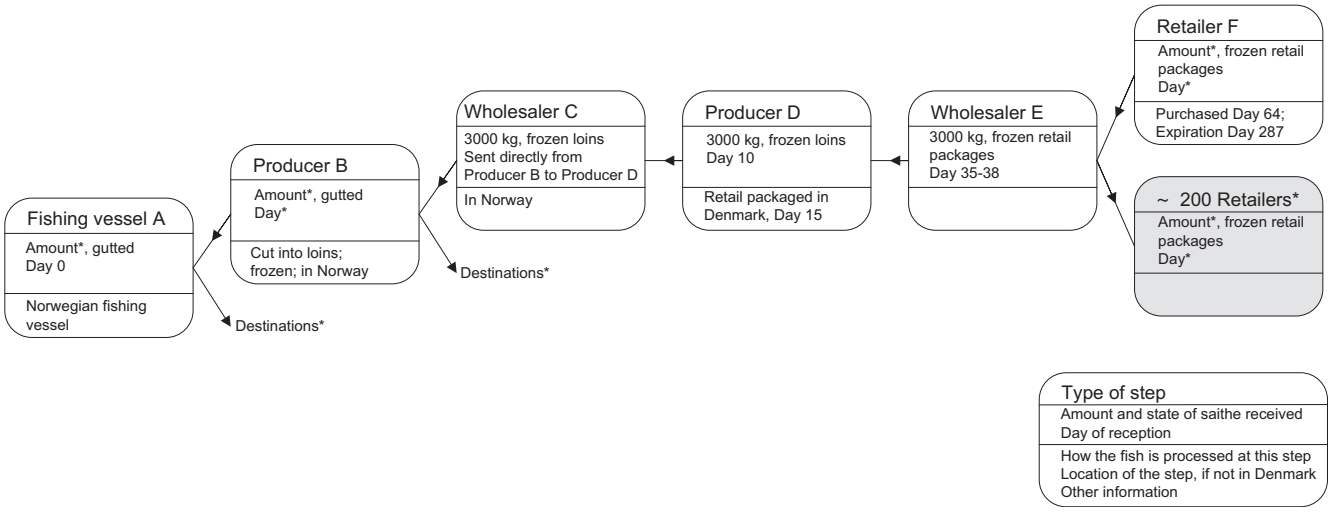

Fig. 4. Distribution network of Case 3: saithe. Arrows pointing left indicate tracing back (white boxes). Arrows pointing right indicate tracking forward (shaded boxes). Product flow is from left to right. * = Unidentified for the researchers.

Table 2
The batch sizes at the last traceable steps and the estimated time used to trace the products back to the origin and to track the product forward to the extent possible in this study.

Case	Species (fillets)	Product description	Last traceable step	Batch size at last traceable step	Estimated time necessary for tracing (min)	Estimated time necessary for tracing and tracking[d] (min)
1	Cod	Fresh, iced	One vessel	2475 kg cod	31	90
2	Plaice	MAP-packed[a]	11 vessels	5028 kg plaice[b]	215	476
3	Saithe	Frozen	One vessel	Several days' catch of one vessel	–[c]	485

[a] MAP = modified atmosphere packed.
[b] The batch sizes from the 11 vessels are summed up.
[c] Not distinguishable from tracking.
[d] Time for tracking will be longer (for all three cases), since some of the companies did not give specific information about the names of their customers. Therefore, these companies could not be contacted and the fish could not be tracked further.

batch which they have delivered to other producers. This increases the amount of affected fish and thereby, the financial losses. This illustrates the recommendation of restricting the mixing of raw materials from different origins (Storøy et al., 2008). Although EU Regulations 1224/2009 and 404/2011 require the recording of the range of catch dates that may be present in a mixed batch of fish, only the oldest catch date in the batch may be considered as an indication of the freshness for the whole batch. Moreover, it is generally recommended to decrease the size of production batches (Storøy et al., 2008). Together with these recommendations, one must also take into consideration the potential increase in the costs of production with reduced batch sizes (Dabbene & Gay, 2011; Fritz & Schiefer, 2009; Saltini & Akkerman, 2012). However, it is clear that the smaller the amount of affected fish to trace, track and locate, the easier it is to control the problem.

A study like this relies on the willingness of the contacted companies to supply researchers with the desired information and to spend the time necessary to find this information. Some companies are reluctant to participate in such a study, possibly because they may regard the information as confidential, because the researchers are not from the authorities, or because the enquiry is not a genuine recall. As shown in Figs. 2–4, there are a number of destinations that remain unidentified for us. Some steps are labelled with the type of step but are still unidentified, since the previous step did not give us the companies' names. Other types of information that we sometimes did not receive were the amounts of fish traded and the date that the fish was received. It is assumed that most of the steps had the requested information, but that they, for example for one of the reasons mentioned above, did not wish to forward the information to us. In the event of a genuine recall, we would expect the companies to participate in the recall action immediately, and not, as we for example experienced in this study, that some companies accepted to help us find the desired information, but that they in some instances did not prioritise the enquiry. However, a factor such as accessibility to the information by a too limited number of people in the staff must also be taken into consideration as a potential delay if a genuine recall were to take place, as also discussed in Karlsen and Senneset (2006) and Randrup et al. (2008).

Case 3 is especially characterised by missing information, since Fishing vessel A and Producer B were not interested in supplying information to the study. Therefore, it is unknown to us (a) which companies Producer B sold the rest of the saithe to after preparation into loins and (b) whether Fishing vessel A sold part of the batch of saithe to other companies or if the whole batch was sold to Producer B. In addition, because Producer D did not have a lot code, Producer B could not tell us the batch size or the date they received the fish. This is an example of disrupted chain traceability which may realistically pose a problem if we were dealing with a genuine recall, and which shows the importance of each step recording and transferring information relevant for traceability.

The three case studies presented here have provided invaluable insight into the complexity of the fish distribution network and a picture of the challenges surrounding traceability in the fish industry. The study has contributed with empirical studies of current practices. It is important that food companies and food authorities realize the potential consequences of a recall and that they are aware of the value of a well-constructed traceability system in relation to swiftly finding the fault and initiating a recall. The affected batch may be spread far and wide within a relatively short time and even more so if batch mixing has taken place. In general, companies in the fish distribution networks are recommended to be attentive to using batches of appropriate sizes, avoiding mixing of batches, and employing unique batch identifiers that at all times will link the batch to a record of the processes acted on the batch and the locations of the batch. An alternative to the latter is to keep records of and transfer as much data as possible that can be used for traceability purposes. In addition, it could also be relevant to consider transferring data that could be used for other purposes, such as logistics, quality assurance, production management, and consumer information.

Although no recalls were performed in this study, the results indicate that the following factors may influence the direct recall costs and the steps are therefore recommended to consider them:

- The time needed to discover the fault causing the recall,
- The granularity of the traceability system (i.e. batch sizes),
- The ability of the traceability system to identify and locate the affected batches, and
- The value of the product.

Likewise, the steps are recommended to take into account factors that may influence the time needed to perform a recall:

- The ability to identify a product batch,
- Records of the processes, including transformations, and locations of the batch,
- Accessibility to these records by at least one person from the staff at all times,
- The possibility to contact the company at all times, in case the company may have received or forwarded a product which may be part of a recall operation, and
- The complexity of the distribution network, since the recall time may be prolonged the more companies to be contacted and the more processes and transformations the fish batch has undergone.

In future studies, it would be useful to investigate further the information exchanged among the steps in the distribution networks and the use of the information. This can also be investigated in relation to the type of data carriers used or in connection with optimal batch sizes in the fish supply chains.

5. Conclusion

It was possible to trace the three investigated fish products back to the fishing vessels that caught the fish. In two of the three cases, it was possible to identify the single specific fishing vessel that had caught the fish, while in the last case, the last traceable step could only be narrowed down to 11 identified fishing vessels.

To the extent that companies were willing to provide the necessary information, we may conclude that it was possible to locate the end destinations of the batches of fish when tracking forward and that all steps comply with the one step forward, one step back requirement of EU Regulation 178/2002 (the General Food Law).

The study demonstrated the complexity of modern-day food distribution networks and the need to discover a fault as early as possible to minimise the amount to be recalled and the recall costs. In addition, each step in a supply chain must carefully consider their method of batch identification as well as their batch sizes in relation to the costs of a recall, the value of the product and the costs of implementing smaller batch sizes.

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Paper IV

Randrup, M. & Bech, A.C. Systematic use of stimuli in in-depth interviews to uncover the information flow in supply chains. (Manuscript submitted to *Food Quality and Preference*)

Systematic use of stimuli in in-depth interviews to uncover the information flow in supply chains

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Abstract

In a supply chain involving several companies, it can be a challenge to uncover the information flow throughout the chain. Semi-structured personal in-depth qualitative interviews combined with visual stimuli may be used as a method of inquiry for this purpose. The visual stimuli, consisting of cards to be categorized by the respondent, provide a systematic way of collecting data about the flow of information through one company and through a whole chain of companies. The advantages of this technique are illustrated using interviews of six companies making up two fish supply chains as cases. The cards proved useful to manage the large amounts of data, to encourage active participation of the respondents, and to ensure that the same information types were reflected upon in each of the interviews, thereby creating coherence in the data collected from the companies throughout a chain.

Keywords

In-depth qualitative interview, business interview, visual stimuli, supply chain, information flow, fish

1. Introduction

In a supply chain involving various types of companies from the source to the retailer, there will be a risk that relevant information is not forwarded in the chain. The companies may have different understandings of what information is useful and therefore, points of information loss may arise. It can be a challenge to uncover the information flow in a chain of companies.

Semi-structured personal in-depth qualitative interviews combined with visual stimuli may be used as a method of inquiry for this purpose. In-depth qualitative interviews are suitable for providing insight and understanding about the opinions, attitudes, and feelings of a few respondents about a certain topic (Malhotra & Birks, 2007). Such interviews may be explorative, letting the respondent speak freely. Thereby, the respondents will most often talk about what is important for them and what occupies their thoughts about the subject.

Visual stimuli, consisting of cards to be categorized by the respondent, can be employed as a systematic way of collecting data about the flow of information through one company and through a whole chain of companies. The use of such cards can give a better overview over the flow of the information types and can give structure to the comments and thoughts that the respondents express about the information types.

There is limited literature on the use of cards for categorization. Crilly, Blackwell, & Clarkson (2006) discuss the use of diagrams as elicitation stimuli in an interview study while Umoquit, Dobrow, Lemieux-Charles, Ritvo, Urbach, & Wodchis (2008) present a comparative study on the efficiency and effectiveness of using researcher-prepared diagrams versus participatory diagramming (where the respondent creates a diagram) in collecting data. Törrönen (2002) proposes different strategies for choosing stimulus objects for encouraging interview respondents to speak about a research topic.

The approach using cards for categorization was applied in a study of the flow of information in fish supply chains. The Danish fresh fish sector has experienced declining sales to the European market over the last decade (The Danish AgriFish Agency and Statistics Denmark, 2012). In an attempt to strengthen the competitive edge of this sector,

several aspects of the supply chains were studied to gain knowledge on current practices and be able to suggest changes that could improve operations in the chain and thereby increase the value of the chain.

One of these aspects was the flow of information about the fish (e.g. catch date, catch method, vessel ID) in the chain and the use and importance of the information exchanged in the chain. Two auction-based fish supply chains were chosen as case studies in order to shed light on the information flow in the chain and thereafter, to uncover demands and wishes regarding the flow of information and to suggest improvements. The supply chains consisted of a short chain with four companies and a long chain with five companies. Three of the companies were common to both chains, giving a total of six companies.

Another method that can be used to analyze the material flow, information flow, and information loss in food supply chains is the traceability process mapping method developed by Olsen & Aschan (2010). In this method, data is collected systematically through the use of up to nine forms per company. As published in the present form, the method does not encourage explorative inquiry, e.g. having the respondents expound on the information types that they find significant. Quantitative surveys have also been developed to collect the characteristics of the traceability status and the information flow in companies in the fish sector (Mai, Bogason, Arason, Arnason, & Matthiasson, 2010; Frederiksen, 2002).

The objective of this article is to show the systematic and extensive use of visual stimuli in eliciting responses from respondents in personal, in-depth qualitative interviews. Investigations of the information flow and importance of information types in fish supply chains are used as case studies. Thus, the results and discussion section will deal with the results of the case studies as well as issues relating to the interview method. The results of the case studies were used to provide a background upon which to establish suggestions for changes in the current practices of the companies. The method presented in this article has been applied in both a M.Sc. thesis and a Ph.D. thesis.

2. Materials and Methods

2.1 The cases

The cases dealt with in this paper comprise two fish supply chains (Fig. 1). The chains have the auction, processor, and retailer in common and therefore, they will be denoted Chain 1-1 and 1-2. Chain 1-1 will be the main focus of the paper.

[Figure 1]

Fishing vessel 1 is a trawler under 30 m in length. They seapack the fish, meaning that they grade the gutted fish according to species and size onboard before packing the fish in ice in fish boxes. At the auction, the fish is classified into freshness categories. Then, the fish is sold to the highest bid among the registered buyers at the auction. The processor buys fish at this auction, among other places, and may head, skin, and fillet the fish, but also has wholesaler activities, in which the fish is resold whole. One of the processor's customers is the retailer, which is a fresh fish counter at a supermarket.

In Chain 1-2, Fishing vessel 2 is a small vessel under 10 m whose fishing gear is bottom gillnet. Fishing vessel 2 delivers all its fish to the collector ashore, who grades the fish according to species, size, and freshness category, before the fish is ready to be auctioned off.

2.2 The interview method

Qualitative personal in-depth interviews of representatives of each company in the fish supply chains shown in Fig. 1 were conducted. The study used a multiple case design (Yin, 2009) though in a limited form since three of the companies were the same for both chains.

The respondents were interviewed one at a time and in a quiet setting at the respondents' work places. Though, the fishing vessel owners were interviewed in the meeting room of the office of the local fishermen's association. Each interview was audio-recorded on two digital voice recorders.

Pilot case studies of three fishing vessels, a collector, and a fish auction were performed. These interviews contributed to increasing the interviewer's knowledge about the operations of these types of companies and about which data collection methods would be appropriate. Thereby the pilot cases were formative, since they were instrumental in refining the subject matter and the data collection procedures (Yin, 2009). However, a pre-test, which is a test of the final interview guide (Yin, 2009), was not performed. This could have been useful in order to make final corrections to the interview guide and to the procedures to be followed by the interviewer with regards to the categorization of the cards. Ideas for additional information types or categories might also arise. Moreover, a pre-test provides training in interviewing.

2.3 The interview guide

Interview guides were used to direct the course of the interview and ensure that all the topics were covered. An interview guide was prepared for each type of company in the chain, taking into consideration the position of the company in the supply chain and the type of company's special characteristics. For example, in the interview guide for the fishing vessels, questions referring to suppliers were omitted and questions about the reception of information were modified to be about the generation of information. Similarly, the information type *size grade of fillets* was not offered to the fishing vessel or the auction since it was prior knowledge that these companies did not handle filleted fish.

Aside from the introductory and concluding remarks, the interview guides contained four main sections corresponding to four subject areas. The interview guide was arranged such that the two long main sections were at the beginning while the last two main sections were short.

The case study results reported in this paper stem from main section 2 of the interview and therefore represent only some of the data acquired through the interviews with each company in the supply chains. The remaining results may be found in Randrup (2012).

2.4 Use of visual stimuli

The section of the interview dealing with information flow and importance of information types was based on the use of small credit card-sized cards. The number of cards used varied from 16-21, depending on the number of information types relevant for the type of company. One information type related to fish and fish catch was printed on each card

(Fig. 2). The respondents were also given blank cards on which they could write information types that were not shown on the pre-printed cards.

[Figure 2]

Given the set of cards, the respondents were asked to categorize them as shown in Fig. 3. After stage 2, the respondents were asked why the information type is important for them and what they use the information type for. After stages 3 and 4, respectively, the respondents were asked supplementary questions, e.g. what do they think of the quality of the information, how interested are their customers in the information, the frequency that they receive/forward the information, when they receive/forward the information in relation to the point in time that they receive/forward the fish, if it would be an advantage to receive/forward the information earlier, and in what way they receive/forward the information (on a paper slip, on an invoice, through an electronic database, etc.).

[Figure 3]

2.5 Techniques used in the interviews

Laddering is an interview technique used in marketing research that is designed to produce insight into consumers' underlying personal motivations for choosing a product (Reynolds & Gutman, 1988; Malhotra & Birks, 2007). Initially, attributes that distinguish similar products from each other are derived during the interview. Thereafter through probing by the interviewer, the respondent discloses the consequences of an attribute and eventually arrives at a personal value that reflects the respondent's choice of that product. The probing questions are e.g. why is X important?, what is the benefit of X?, and why do you do X? (Reynolds & Gutman, 1988).

The categorization method used with the cards incorporates an element of the laddering interview technique in so far as the respondents were asked to assess which information types are important for him/her and why they are important for him/her (Reynolds & Gutman, 1988). Thus, the attribute of interest is pre-determined by the interviewer. Since this study is not consumer research, the consequences and personal values associated with a product were not relevant to pursue. Therefore, the data analysis methods associated with laddering (Reynolds & Gutman, 1988) are not applicable either.

Aside from adding variation to the interview setup, the use of the cards helps to keep the respondent's focus since he/she actively has to take part in categorizing the cards. As discussed in Bech (2009), the use of visual stimuli encourages the respondents to talk and discuss from their point of view, thereby minimizing the influence of the interviewer.

The cards also provide the respondent with a better overview of which categories he/she placed the information type in and that way, he/she can better recall, if needed later during the interview, what he/she earlier said about the information type. This means that the interviewer easily can pose supplementary questions that otherwise would be rather complex to ask if it was not possible to refer back to the cards.

2.6 Interviewer training

It is always preferred that the interviewer has some training in conducting qualitative interviews, since certain skills are desirable. These are e.g. the ability to ask good questions, listening skills, the ability to be adaptive and flexible, and to know how to avoid bias (Yin, 2009). In addition, it is highly beneficial to be knowledgeable of the matter under investigation (Yin, 2009). Further explanation of techniques and skills of interviewing are also found in Seidman (1991) and Kvale & Brinkman (2009). According to Kvale & Brinkman (2009), interviewing is a craft, thus requiring extensive training to acquire the skills and judgments that are essential for high-class qualitative interviews.

2.7 Data processing

The interviews were transcribed as verbatim as possible using transcription playback software (Express Scribe v. 4.31, NCH Software, Canberra, Australia) to facilitate the playback of the recording while typing. Processing of the data from the interviews was conducted in several phases: (1) condensing each transcript into a list of topics, each detailed with bullet points, (2) collecting the statements of each respondent about the same topic in a table, and (3) creating figures, flow diagrams, and tables to present the acquired data in a structured manner.

3. Results and discussion

3.1 The results of the case studies

For each company in the chains, a diagram (not illustrated) was constructed showing which types of information were generated and received by the company and which of these were subsequently forwarded or not forwarded by the company. Adjoining these diagrams of the four companies in Chain 1-1 resulted in Fig. 4, which shows the flow of information about the fish in the supply chain. In both chains, the same three types of information are always passed through the chain (from they were generated until the retailer): size grade of whole fish, size grade of fillets, and sales weight of auction box. The landing date and the catch method of plaice are sometimes received by the retailer. Of these five information types, the landing date, the catch method of plaice, and the size grade of whole fish are sometimes communicated to the consumers.

[Figure 4]

The landing date and the catch method are part of what the retailer denotes *bonus information*. The bonus information makes it possible for the retailer to tell a good story to the consumers. The retailer presumes that the consumer will tell the story at home and come back to the retailer again to hear another good story. The catch method of plaice is especially mentioned compared to the catch methods of other species because there is a local agreement that plaice sold in the auction in this chain must be labeled with the catch method. This arrangement was made in an effort to raise the price of plaice.

The retailer uses the size grade of whole fish as an indication of the structure of the fish meat. His customers prefer a size 3 cod (2-4 kg/fish) because of the fine-textured meat. He says the consumers are not interested in the size grade of the whole fish, but he may inform the consumers of the size grade anyway.

The six investigated companies always either generate or receive almost all the information types that they consider very important and important (Table 1). The size grade of whole fish and sales weight of the auction box are the only information types which are considered very important throughout the chain. Because this information is considered essential for trading by all the companies, the information is always received

and forwarded as long as the fish is still whole and is in the box it was sold in at the auction. Details of the companies' use of the information types and their importance may be found in Randrup (2012).

[Table 1]

There are six information types that the companies do not or only sometimes receive even if they consider them very important or important (Table 2). The auction checks the weight of random samples from each batch in the auction hall because only ± 5% weight deviation is permitted; if this is exceeded, the auction may be fined by the authorities. Therefore, the actual weight of fish in the boxes is important to the auction, and it would be beneficial for the auction to know this information. With regards to the more specific catch area, the auction believes that more detailed information on the catch area is gaining ground and is beginning to be important. This information is not needed now to sell the fish at the auction, but the information may become required by future traceability legislations.

[Table 2]

The processor would like numbers on the fish boxes or batches of fish boxes at the auction for traceability purposes, such that he easily can link the fish with the intended customer. The retailer considers the catch date as a measure of freshness while the landing date and the catch method are, as previously mentioned, bonus information used by the retailer for storytelling. The companies make do without this information, but these information types would be useful to have for their operations.

In addition to the information types in Table 2, sustainability information is important, but not received by the auction and the retailer, but since sustainability information in this chain in effect means whether the fish is MSC-certified or not, and Fishing vessel 1 does not catch MSC-certified fish, this information type is not listed in Table 2.

Aside from the information which is considered important or very important but not received, there are also some information types that the companies do not necessarily think are important but which they eye a benefit in receiving (Table 3). Likewise, the

296 authors have suggested some information types which could be advantageous for specific
297 companies to receive (Table 3). Table 3 also includes the information types in Table 2.
298 The supposed effects of receiving the various information types are indicated in Table 3.
299
300 [Table 3]
301
302 With regards to the suggestions that contribute to the assessment of freshness/quality, the
303 information about the fish will provide a better foundation for the buyers and subsequent
304 wholesalers and processors on which to base a quality assessment. This consequently
305 influences the potential use of the fish and the decision to buy the fish. The various
306 information types can also be used by the retailer and even the final consumer if given the
307 information. The suggestions that save time are to be carried out by the companies in the
308 chain prior to the auction and the processor.
309
310 The effect of storytelling/marketing refers to the use of information about the fish to
311 enhance the value of the fish towards the consumer. This purpose must be regarded in
312 conjunction with the suggestions that improve traceability, since traceability is a tool to
313 identify and keep track of the product through the chain. In other words, it is through
314 traceability that the information to be used for storytelling/marketing will reach the
315 consumers.
316
317 The auction buyers' access to the desired information about the fish is expected to build
318 up the buyers' confidence in the consistent high quality of the fish. Together with the
319 suggestions within the other topics of the interview guide, it is hoped that these initiatives
320 will improve the operations of the chains and contribute to making fish landed in
321 Denmark more attractive on the European market.
322
323 **3.2 Reflections on the methodology**
324 **How the interviews proceeded**
325 The use of the cards was a practical way to gather data about the importance, use, and
326 flow of the various information types that can be generated about fresh fish in a supply
327 chain. The cards were categorized systematically, thereby making the data processing and
328 analysis easier. Using the same cards in each interview made it possible to compare the
329 flow and use of the same information types among all the companies throughout the

chains, which established coherence in the data. The cards generally gave structure to the immense amount of data generated through the interviews. Notwithstanding, statements and opinions about an information type sometimes had to be gathered from different parts of the interview, since the respondent referred back to the information type during different points in time.

If these interviews had been performed without the use of the cards, it is predicted that the course of an interview and indeed the resulting data would be rather disorderly and muddled. The distinction between the groupings of the information types would not be so clear.

One may claim that if the respondents were not given the information type (either on individual cards, in a list on a piece of paper, or orally), but just asked to tell the interviewer about the information types that they receive and forward, then the respondent would naturally think of the information types that that person regarded as important or very important. Due to their importance, the information types would probably be mentioned rather quickly, too. However, it would perhaps not be so manageable for the interviewer to follow what is being related by the respondent. The interviewer might have a tendency to write down the information types that the respondent mentions, which means that the interviewer cannot devote his/her entire concentration to the statements of the respondent. Some structure will be lost. Furthermore, the respondent may forget some information types and it may also be interesting to hear their views on the information types that they regard as not important. As mentioned in Section 2.4, the respondents were given blank cards, but none of the respondents had any information types to add, though.

Since the division of the cards according to importance was done one after the other, the respondents tended to compare the significance of the information types to each other. On some occasions, a respondent regretted the placement of a card in a category and moved the card to a new category. Whether this was because the respondent was faced with a new information type that he/she thought was more/less important or whether the respondent had reflected on the placement could not be determined. The fact that the information types via the cards were physically visual meant that the respondent could go back to an information type and see in which category he had placed it. That way, there

was no doubt about where he had placed the card and it was not a matter of memory. We believe that the fact that the respondents were able to compare the importance of the information types visually meant that the respondents gave the subject more thought.

Sometimes a respondent would start talking about the information type on a card at the same time that they were categorizing the card. In such situations, one must decide whether to let the respondent continue speaking (which is usually desirable) or to interrupt the respondent and ask him to wait with the explanation until all the cards have been categorized. In subsequent interviews, the interviewer has the opportunity to include this aspect when explaining "the rules of the game" before giving the respondent the cards to be categorized. However, it is a balance between whether the respondent should be able to relate his thoughts at the moment he sees the information type or whether the interview should be kept more structured and the respondent must wait until it is time for him to express his thoughts. As mentioned, the advantage of the latter is that the interview is more structured, but a disadvantage is that the respondent's spontaneous thoughts may not come across later when he is "given permission" to speak.

Another decision to be taken by the interviewer prior to performing the interview is whether to inform the respondent that the cards classified as important are to be divided again (into very important and important). Sometimes if a respondent expressed doubt (e.g. by saying that the information type was not *not important*, but it was not as important as some of the other information types) or if they made a new category, the interviewer decided to tell the respondent that after dividing the cards into *important* or *not important*, the respondent would be asked to classify the cards from the important category into *very important* and "just" *important*. This information made them more comfortable in placing the card in the initial important category. New categories that the respondents created were e.g. *could be important in the future*, *bonus information*, and *essential information*.

Another issue to be aware of when using cards or other visual stimuli together with audio-recording is that the respondents tend to point to a card and say "that one" or "this information" instead of saying what is printed on the card. Such situations call for a little detective work when analyzing the transcripts. Usually, though, it is possible to decipher what was printed on the card from the context.

The impression of the interviewer was that because the cards required the active participation of the respondents, the respondents were more involved in the interview. However, there was one respondent who became tired during the end of the questioning about the important information types, and therefore consideration was taken and the respondent was not asked to elaborate on the not important information types. However, the respondent got tired about 1½ hours through the interview since, as mentioned in Section 2.3, there were other topics that were covered during the interview. As discussed below, the interviews were probably too long and should probably have been conducted on two occasions or combined with a follow-up over the telephone.

Duration of the interviews

The time used for the whole interview (i.e. including all four main sections) varied from 81-184 min., while the main section about information flow took 17-48 min. to complete. The expected time frame for the whole interview was 60-90 min. Only two of the six interviews kept within this time frame. Even if approximate time periods for each main section were made beforehand, the interviewer is placed in a dilemma of whether to go on to the next main section when the time period for the current main section has been reached or to let the respondent speak freely and use longer time than estimated.

Seidman (1991) recommends that an interview session should be around 90 minutes long. This gives the respondent time to relate their experiences and reflect on them. Most respondents do not regard this as a long time; on the contrary, the time frame makes them confident that they are being taken seriously (Seidman, 1991). In this study, it was the interviewer's impression that all the respondents felt that they were treated respectfully. Otherwise, they probably would not have spent that much time on the matter.

An option could have been to conduct the interview over two days. This way there is less chance of the respondent getting tired and losing his/her concentration during the interview. In addition, the interviewer has time to "digest" the information obtained during the first part of the interview and perhaps ask clarifying questions during the second part of the interview. The categorization of the cards gives an advantage on such occasions because one can readily recreate the distribution of the cards. One would expect that this would make it easier to continue the line of thought from the previous interview

session. Though, interviews conducted over two days demands more financial resources for travel and board on the part of the interviewer if the respondents are located a long distance away. In such cases, it is also difficult to make two appointments with the same fishing vessel owners since the fishermen seldom know when they will be ashore.

The experiences in this study illustrate that it is recommendable to estimate how long the interview will take and decide how to tackle situations in which the time allotted for a section is exceeded. Will one continue in the same pace and allow the respondent to speak freely and perhaps digress or will one speed up the interview by not allowing "stories" and perhaps skipping some questions? One may also choose to decide on this issue in cooperation with the respondent before the interview.

Reliability

The reliability of a study is the extent to which the operations of a study – such as the data collection procedures - can be repeated with the same results (Yin, 2009; Malhotra & Birks, 2007). In this regard, documentation of the case study method is necessary (Yin, 2009). This documentation could be a case study protocol and a case study database. A protocol, detailing the background of the project, the objectives of the case studies and the interviews as well as the target group and the time frame was prepared prior to the interviews. A case study database including the audio recordings, the transcripts, interviewer's notes, and tables structuring the data about the information types was also assembled. On the basis of these types of documentation, we consider the case studies as highly reliable if another interviewer were to repeat the case study of the same respondents at the same point in time. New legislation has been enacted which may change the viewpoints of the respondents if they were interviewed at a later point in time.

3.3 The next step

A quantitative study may be carried out after a qualitative study in an attempt to generalize some of the findings or prove/disprove hypotheses that the qualitative research has given rise to (Bech, 2009). For a quantitative study, a larger number of respondents are necessary. For this study, it could perhaps be relevant to choose certain information types which were considered very important or which in some way could give a significant change if received and find out the access to the information type, the frequency of the reception, and importance among a broader range of companies. The

information types could be the catch date, which the retailer considers very important but which he does not receive, or they could be all the information types that are shown in Table 3 as useful for marketing the fish at the retailers. As there are fewer than 10 collectors and fish auctions in Denmark, a quantitative study of these types of companies would be conducted as a survey of the entire population in which a questionnaire would be sent to all collectors or all fish auctions. An alternative could be to collect the data by a structured telephone interview in order to maximize the response rate.

After or parallel to a quantitative study, a mathematical simulation model may be constructed in order to get an indication of whether the suggestion has the desired effect or not in the company or chain. The last step is the implementation of the suggestion in the relevant companies and subsequently, a study of the significance of the change.

4. Conclusion

The study showed that cards for categorization can be used as a systematic method to uncover the information flow in supply chains. The cards made it possible for the respondents and the interviewer to handle and manage large amounts of data in a structured manner. The cards also proved useful to ensure that the same information types were reflected upon in each of the interviews, thereby creating coherence in the data collected from the companies throughout a chain. The technique also made it possible to obtain the respondents' reasons for their categorization and to let them expound on the topic.

The categorization of cards is advantageous in situations in which an interviewer would like the respondents to provide the same kind of information about numerous matters. This technique could be considered when planning qualitative interviews with such characteristics but in other contexts.

Acknowledgement

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Figure captions

Fig. 1. The companies in the fish supply chains and their supplier-customer relation.

Fig. 2. Examples of the cards used in the interview. (translated from Danish: salgsvægt = sales weight; fangstmetode, fx trawl, snurrevod = catch method, e.g. trawl, Danish seine)

Fig. 3. The respondents' assessment of the importance of each type of information took place in two stages (1 and 2). Thereafter, the respondents divided each type of information into the subsequent categories (stages 3 and 4). Supplementary questions were asked during the process.

Fig. 4. The information flow in Chain 1-1, which starts with Fishing vessel 1. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species. [a]Fish that is traded whole. [b]Sales weight of the box of fish sold at the auction when that box is traded untouched.

550 Figure 1
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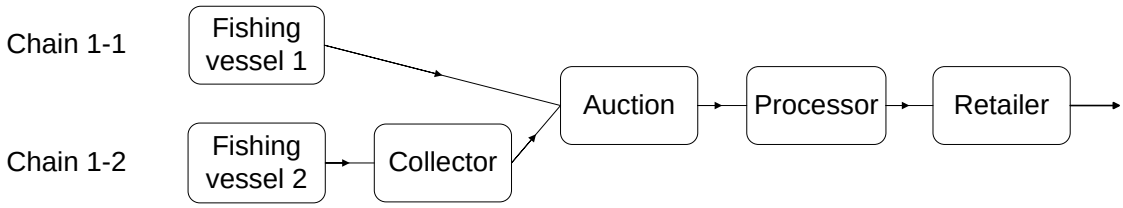

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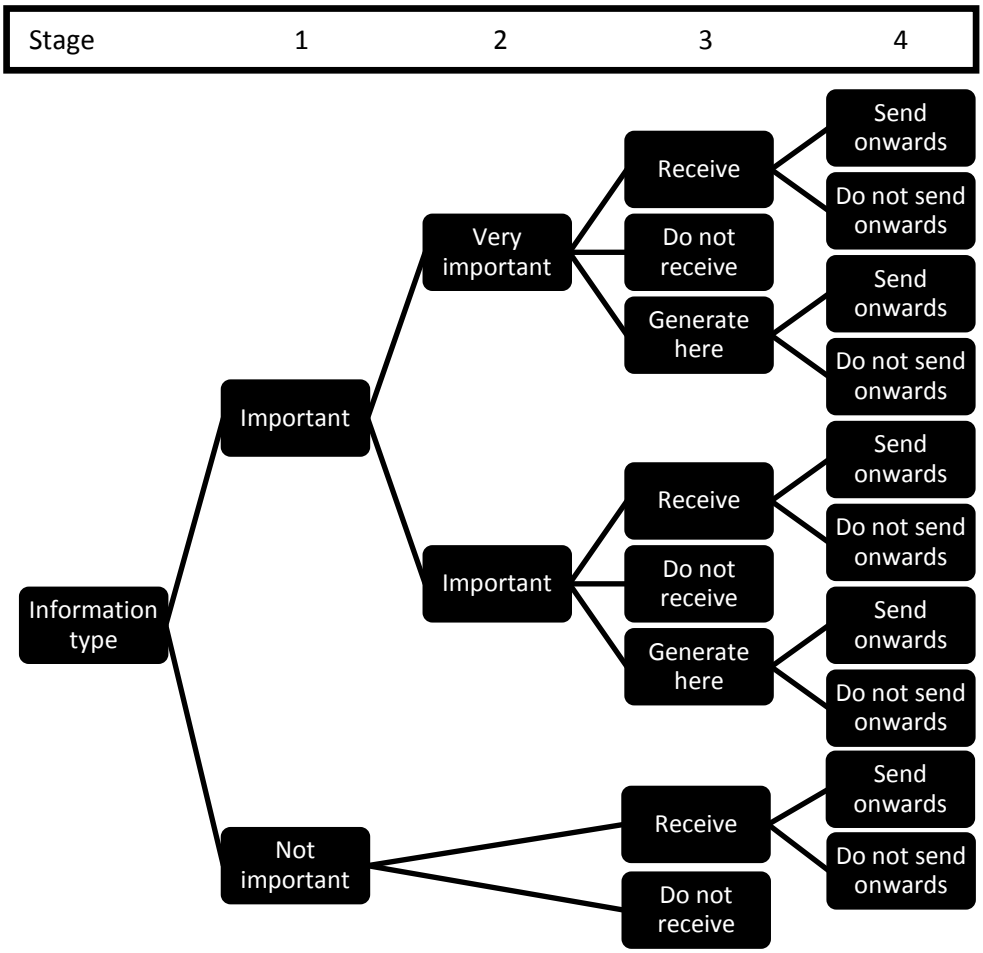

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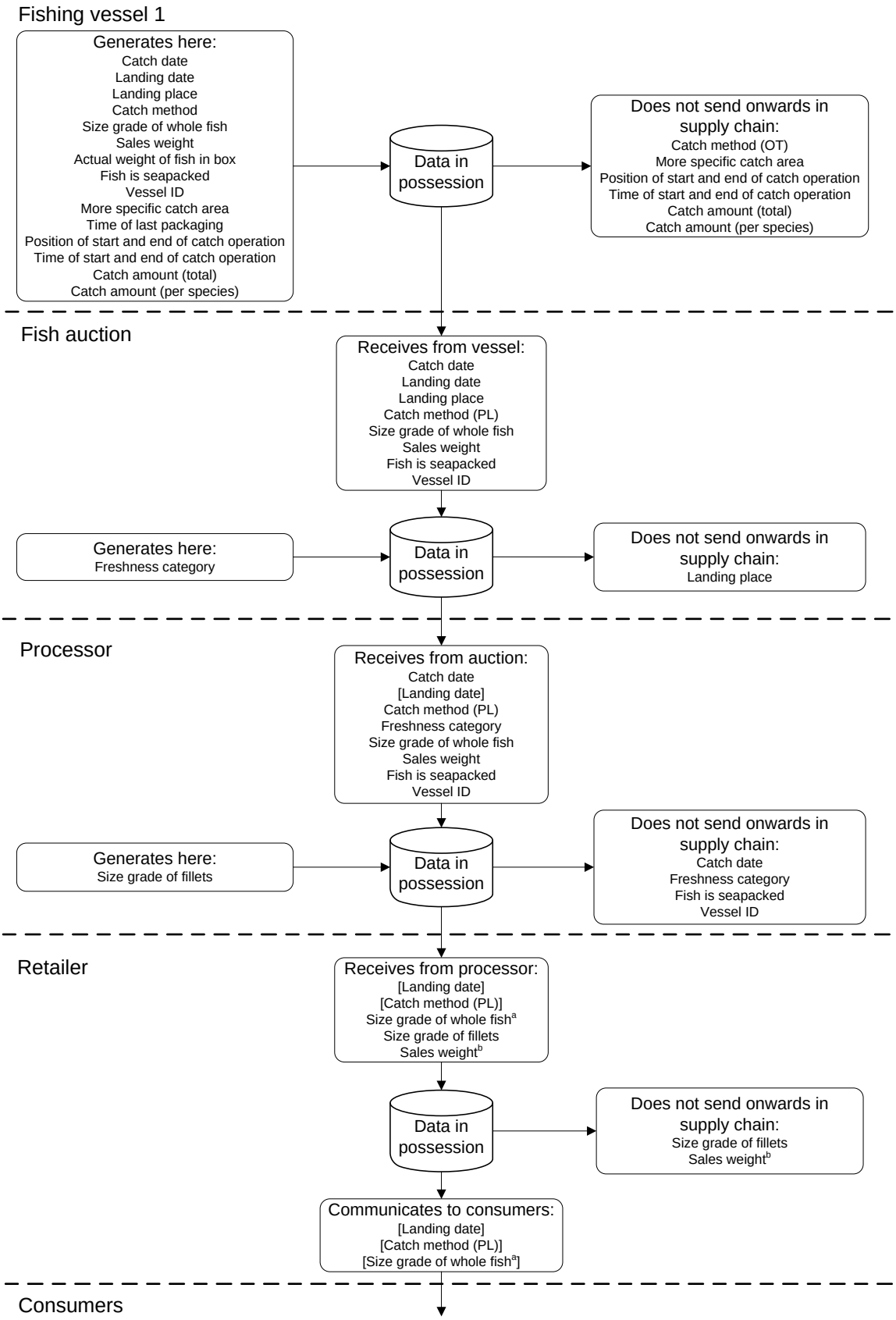

566

Table 1. Importance of the different types of information for the companies in chain 1-1. (Two filled symbols = very important, one filled symbol = important, one unfilled symbol = not important, n.a. = not applicable[a]. ▲ = information that the company generates itself, ■ = the information is always received, ◆ = the information is received only sometimes, ● = information that the company does not receive. Reception/generation of the information is shown according to Figure 4.)

Information types	Companies			
	Fishing vessel 1	Auction	Processor	Retailer
Catch date[b]	▲▲	□	■	●●
Landing date	▲	■■	◇	◆
Landing place	△	■■	○	○
Catch method[c]	△	■	■	◆
Freshness category	n.a.	▲▲	□	○
Size grade of whole fish	▲▲	■■	■■	■■
Size grade of fillets	n.a.	n.a.	▲▲	■■
Sales weight[d]	▲▲	■■	■■	■■
Actual weight of fish in box	▲▲	●●	○	○
Fish is seapacked	▲▲	■■	■	○
Sustainability information	n.a.	●●	○	●
Vessel ID	▲▲	■■	□	○
More specific catch area	△	●	○	○
Fish box no.	○	○	●	○
Time of last packaging	▲▲	○	○	○
Temperature records	n.a.	○	○	○
Former company in the chain is quality certified	n.a.	○	○	○
Position of start and end of catch operation	▲▲	n.a.	n.a.	n.a.
Time of start and end of catch operation	▲▲	n.a.	n.a.	n.a.
Catch amount (total)	▲▲	n.a.	n.a.	n.a.
Catch amount (per species)	▲▲	n.a.	n.a.	n.a.

[a]n.a. covers situations in which the information type is not available for the company because the information is produced later in the chain and situations in which the interviewed company has deemed the information type irrelevant.

[b]Importance is shown in general. Reception/generation of the information is shown according to Figure 4 (seapacked fish).

[c]Importance is shown in general for all species. Reception/generation of the information is shown according to Figure 4 (catch method in general for Fishing vessel 1; catch method for plaice for the rest of the chain).

[d]Importance is shown for the sales weight of the boxes of fish for sale at the auction for all companies except the retailer. Importance for the retailer regards the sales weight of the boxes of fish that he receives from his suppliers which may be comprised of different species of fish. Reception/generation of the information is shown according to Figure 4 (i.e. sales weight of the auction box for all companies).

586 Table 2. Overview of the information types which the companies consider important and very
587 important but do not receive or do not always receive (the latter in square brackets). Based on data
588 in Figure 4 and Table 1.

Importance of information	Companies		
	Auction	Processor	Retailer
Very important	Actual weight of fish in box		Catch date
Important	More specific catch area	Fish box no.	[Landing date] [Catch method]

589

590 Table 3. Types of information and their supposed effects if they were received.

Information type	Companies that may use the information	Supposed effects			
		Contributes to the assessment of freshness/ quality	Saves time	Story-telling/ marketing	Improved trace-ability
Catch date	Processor[a], retailer	*		*	
Landing date	Retailer[a]			*	
Landing place	Retailer			*	
Catch method	Auction[a], processor[a], retailer[a]	*		*	
Actual weight of fish in the box	Auction		* for auction		
Fish is seapacked	Processor, retailer	*		*	
Sustainability/ MSC information	Processor, retailer[a]			*	
Vessel ID	Retailer			*	*
More specific catch area	Auction[a], processor[a]			*	
Batch number[b]	Processor[a]				*
Temperature records	Processor[a]	*	* for processor		
Length of towing time	Processor[a]	*			

591 [a]The companies themselves have expressed a wish to receive the information.
592 [b]Considered as a replacement for fish box number.

Paper V

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National Food Institute

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Technical report

Case studies of quality, quality assurance, and traceable information in auction-based fish supply chains

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Kgs. Lyngby, March 2012

Abstract

Due to increasing competition from for example Norway and Iceland regarding sales of fresh, whole fish to the European market, there is a need for Danish fish supply chains to enhance the appeal of their products and services. The competitiveness of the fish supply chains can be boosted by improving the traceability at each step and in the chain, ensuring proper handling and storage of the fish, establishing quality assurance procedures at the steps, optimizing the use of information about the fish, and improving the confidence among the steps in the chain. Case studies of two Danish fish supply chains were performed in order to find out what the current practices are regarding the handling and storage of fish onboard the fishing vessels and at the recipients ashore, to map the information flow in the chains, to uncover wishes for more information in the chains, to take a look at the traceability systems at work, and to find out the status for trust and cooperation in the chains. The case studies were conducted as qualitative personal in-depth interviews of representatives of each of the six steps in the fish supply chains. Based on the results of the interviews, simple quality assurance procedures concerning the handling and storage of fish were compiled and suggestions that may improve the operations of the steps and the chains are proposed. These initiatives are expected to contribute to increasing the value of the fish supply chains and ultimately, to raise the demand for Danish fish on the European market.

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Chapter 1 Introduction

1.1 BACKGROUND AND OBJECTIVES

Denmark has traditionally been a strong player in the European market for fresh fish. However, the value of fresh, whole saltwater fish (excluding pelagic fish) exported to the European Union (EU) has been declining (Figure 1.1), although there has been an increase from 2009 to 2010. Due to increasing competition from for example Norway and Iceland regarding sales of fresh, whole fish to the European market, there is a need for Danish fish supply chains to enhance the appeal of their products and services. The competitiveness of the fish supply chains can be boosted by increasing the value of the whole fish chain. The value of the fish chain may be increased by, among other things, improving the traceability at each step and in the chain, ensuring proper handling and storage of the fish, establishing quality assurance procedures at the steps, optimizing the use of information about the fish, and improving the confidence among the steps in the chain.

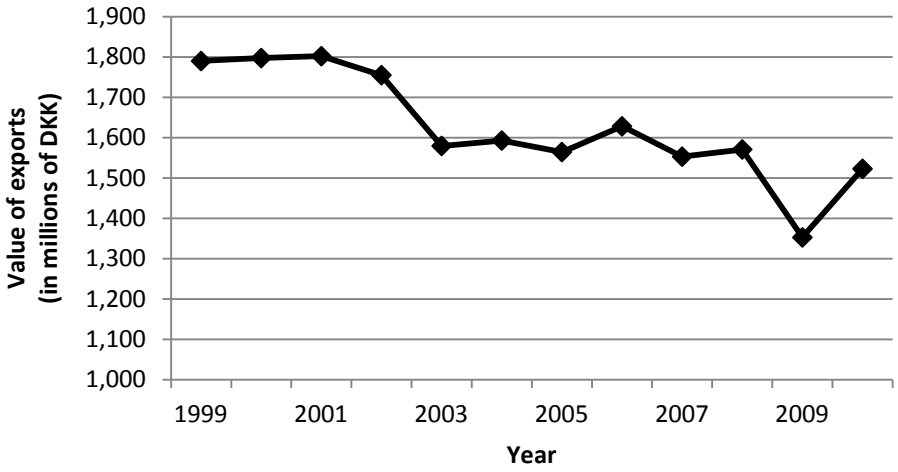

Figure 1.1. Value of exports of fresh, whole saltwater fish (excluding pelagic fish) from Denmark to the European Union from 1999-2010 (in millions of DKK (Danish kroner)). Calculated from data from the Danish AgriFish Agency and Statistics Denmark, 2012.

A fish supply chain comprises a series of companies from the fishing vessel to a distribution channel, i.e. a number of companies that deliver to each other and that are each other's customers. The steps in a fish supply chain can be divided into two groups. The first group can consist of a fishing vessel, a collector, and an auction. In this group, the fish is still a raw material and the steps may be denoted as the raw material steps. The other group can consist of a buyer, a processor, a wholesaler, and a distribution channel (supermarket/fish monger/restaurant). In this group, the fish is a more or less processed product.

The current practices in the fish supply chains must be investigated first before being able to provide suggestions for improvement. Two supply chains based on Danish steps were chosen as case studies to shed light on these circumstances. The objectives of this report are:

- For the raw material steps:
  - To find out what the current practices are regarding the handling and storage of fish onboard the fishing vessels and at the recipients ashore.
  - To develop simple, effective quality assurance procedures concerning the handling and storage of fish in order to maintain the quality of the fish, reduce the variation in the quality of fresh fish, and to improve the buyers' confidence in the quality of the fish.
- For the whole chain:
  - To gain insight into the steps' criteria for assessing quality, their experiences with quality variation and their awareness of quality assurance.
  - To map the information flow in the chain as a whole as well as uncovering wishes for more information in the chain.
  - To take a look at the traceability systems at work and to find out the status for trust and cooperation in the chain.
  - To provide a list of suggestions within the above-mentioned topics that may improve the operations of a step or the whole chain.

1.2 SCOPE

The type of fish that is the primary focus of this report is white fish caught at sea. However, some of the companies that are interviewed also include farmed fish and pelagic fish in their range of products. The supply chains in the study do not include the consumer step.

The data presented in this report is based on interviews conducted in 2009. Thus, the data gives a momentary picture of the status of practices and opinions in the steps as they were at the time of the interviews. Since then, new legislation has been enacted which presumably has changed some of the routines carried out in the steps. If the steps were interviewed now, they would most likely have given other answers to some of the questions. However, the discussion and suggestions for changes in this report are based on the status at the time of the interviews.

In this report, cod refers to *Gadus morhua* and plaice is *Pleuronectes platessa*. The Latin names of other fish species are stated within the report.

To avoid any misunderstandings, a buyer in this report is any person or company registered to be able to place bid at a specific auction. Buyers may for example be

wholesalers, processors, agents, or retailers. In the chains studied in this report, the processor is a buyer at the auction.

1.3 STRUCTURE OF THE REPORT

Chapter 2 provides a theoretical background on traceability of fish, freshness and spoilage of fresh fish, and various classifications of fish at an auction. In Chapter 3, the steps in the investigated fish supply chains are presented as well as a description of the interview method used to collect data for this report. The results obtained through the interviews are revealed and discussed in Chapter 4, which is brought to a close with a summary of ideas that are expected to improve the operations of the steps and the chains. Finally, the report is concluded in Chapter 5 along with ideas for future work.

1.4 ACKNOWLEDGMENT

The six companies studied in this report are gratefully acknowledged for their time and willingness to participate in the interviews.

Chapter 2 Theoretical background

2.1 TRACEABILITY OF FISH

2.1.1 Background, concepts, and drivers of traceability

2.1.1.1 Background and definition of traceability

The occurrence of various food scandals in the 1980's and 1990's set off an amplified interest in traceability in the food chain in order to assure food safety, public health, and consumer confidence in the food supply. The food scandals include the BSE/nvCJD (Bovine Spongiform Encephalopathy/new variant Creutzfeldt-Jakob Disease) crisis in the UK beef industry, the dioxin contamination of fat used in animal feed in Belgium, and outbreaks of *Salmonella* and *E. coli* contamination as well as listeriosis (Shears, Zollers, & Hurd, 2001; Knowles, Moody, & McEachern, 2007). Such events have demonstrated to food business operators that deficiencies in the traceability of products in the food supply chains can have detrimental effects, as the companies may not be able to account for which batches have been contaminated and which batches are not contaminated. This will lead to the necessity of recalling all their products from the market.

Definitions of traceability according to current standards and legislation are shown in Table 2.1. It is interesting to note how parts of one definition can be found in another definition, although none of the definitions are exactly identical. The ISO 22005:2007 definition shares the first sentence with the CAC definition, while the second sentence resembles some of the ISO 9000:2005 definition. The ISO 9000 standard encompasses all types of products, while ISO 22005 is specifically for food and feed, thus suggesting a reason why the ISO 9000 definition cannot be re-used in the ISO 22005 standard.

Table 2.1. Definitions of traceability from various documents.

Document	Definition
EU Regulation 178/2002 laying down the general principles and requirements of food law (EU, 2002b)	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.
Codex Alimentarius Commission (CAC) Alinorm 04/27/33A (Codex Alimentarius Commission, 2004)	Traceability/product tracing – the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.
ISO 9000:2005 Quality management systems - Fundamentals and vocabulary (ISO, 2005b)	The ability to trace the history, application or location of that which is under consideration. When considering product, traceability can relate to the origin of materials and parts, the processing history, and the distribution and location of the product after delivery.
ISO 22005:2007 Traceability in the feed and food chain (ISO, 2007)	The ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution. Movement can relate to the origin of the materials, processing history or distribution of the feed or food.

The definition in EU Reg. 178/2002 and the CAC definition also in part resemble each other. However, it is worth noting that the definition in EU Reg. 178/2002 involves following the product through *all* stages of production, processing, and distribution, while the CAC and the ISO 22005 definitions only state that the product shall be traceable *through specified stage(s)* of production, processing, and distribution. CAC has chosen this wording to provide some flexibility, especially with regard to the specific conditions of the primary production sector in developing countries (Codex Alimentarius Commission, 2004). Any CAC guidelines for specific applications of traceability will have to identify the specified stages further. In addition, the term "production" may include feed, food-producing animals, fertilizer, and other items depending on the specific application of traceability (Codex Alimentarius Commission, 2004). In this way, the products covered by the CAC definition are similar to those covered by the EU definition.

The definition in EU Reg. 178/2002 (Article 3) does not indicate through how many companies a single food business operator is required to be able to follow a food product. The requirement in this respect is stated in Article 18 of the same regulation and will be further elaborated in Section 2.1.2.1.

2.1.1.2 Concepts in traceability

Step and chain

In the following, Moe's (1998) definitions of step and chain will be used:

- A *step* refers to some discrete operation or location at which some task or process is performed on the product.
- A *chain* is composed of the sequence of these steps.

When *step* is used to describe a location, it is oftentimes equivalent to a specific company. *Step* does not describe a type of company. For that use, *type of step* will be employed. An example of a chain consisting of five steps is shown in Figure 2.1.

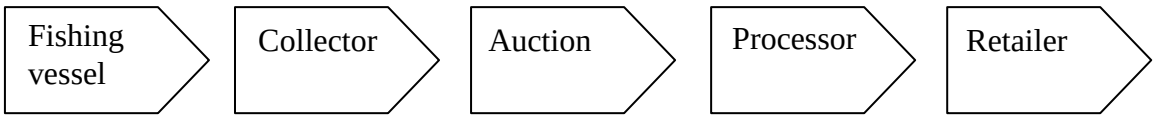

Figure 2.1. An example of a fish supply chain. The arrows show the direction of the product flow.

Recall and withdrawal

It is worth noting that *withdrawal* refers to the removal of goods before they are delivered to consumers, while *recall* refers to the removal or return of goods when the goods already are available at the retail level (EU, 2002a).

Internal and external/chain traceability

Following the movement of a food product can be done both internally (within a company) and externally (between two companies), which is illustrated in Figure 2.2. Internal traceability deals with the ability to connect the identification of a product as it enters the company as an input (raw material) with the identification(s) of the product as it is transformed within the company and the identification of the product when it is ready to leave the company as an output (final product). External traceability is the ability to connect the identification of a product leaving one company with the identification of the product when it enters another company (Food Standards Agency - Food Chain Strategy Division, 2002).

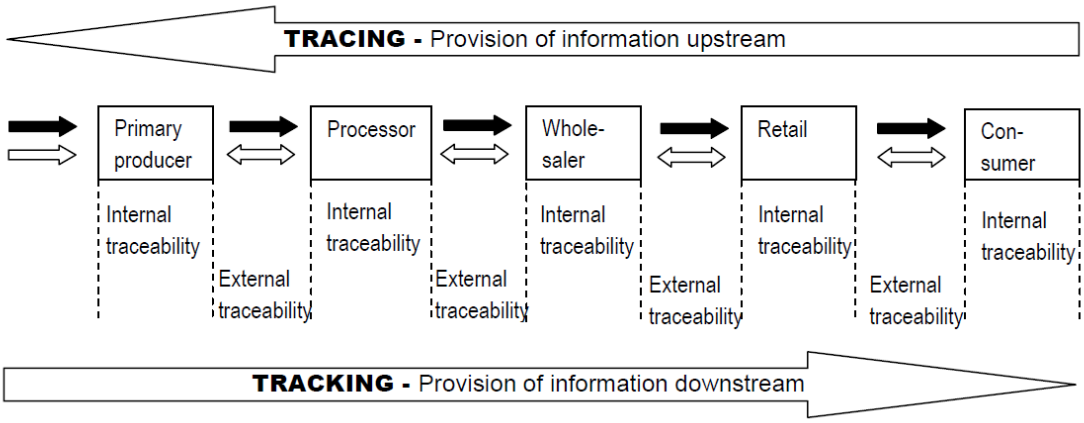

Figure 2.2. Illustration of traceability concepts in a food supply chain (Randrup *et al.*, 2008). Filled arrows show the product flow; open arrows show the information flow.

There is an inconsistency concerning the definition of chain traceability, as it may be the same as external traceability (Randrup *et al.*, 2008) or it may be defined as the ability to follow the movement of a product through the whole chain (CIES - The Food Business Forum, 2005). The latter would also require some form of internal traceability in each step. In a sense, the definition of traceability in EU Reg. 178/2002 actually describes traceability throughout a whole supply chain. However, this is not part of the requirements to the individual food business operator (see Section 2.1.2.1).

In this report, the term external traceability will be interchangeable with the term chain traceability.

Tracing back and tracking forward

Traceability encompasses both tracing and tracking (Figure 2.1). As explained in Table 2.2, tracing is following the movement of a product upstream *against* the flow of the product and towards the source, while tracking is following the movement of a product downstream *with* the flow of the product.

Table 2.2. Definitions of tracing and tracking.

Term	Definition
Tracing (back)	the ability to identify the origin of a particular item or group of items by reference to records held upstream in the chain (Ekman, 2002; Schwägele, 2005)
Tracking (forward)	the ability to follow the path of a particular item or group of items as it moves between trading partners downstream through the supply chain from the beginning to the end (EAN·UCC, 2002; Schwägele, 2005)

Tracing is used during product recall situations in order to find the origin of the recalled product. The terms "trace-back" or "to trace back" can be used. Once the origin is found, tracking is performed to find the rest of the batch of products that have been recalled. Thus, when tracking a large batch of products, one may have to follow many paths in order to find the destinations of all the products in that batch. The term "tracking" is commonly used with "forward" as in "to track forward."

Sometimes the term "trace" is used alone, and in this case, it is unspecified and may mean to follow the movement of a product in both directions.

2.1.1.3 Drivers for traceability

The motivation to implement higher levels of traceability can come from different sources. Food safety has traditionally been the main driver for improving the traceability of products in, through, and out of a company. Traceability facilitates product withdrawal and recall by making it possible to trace a product back to the source, to identify other products affected and to locate the products in question. Risk management and the ability to perform targeted recalls successfully contributes to limiting the damaging effect of a recall and enables brand protection (Coff, Korthals, & Barling, 2008; Dupuy, Botta-Genoulaz, & Guinet, 2005; Golan *et al.*, 2004).

From the EU legislators' perspective, the primary purpose of traceability is to ensure food safety. Though, there is also legislation requiring certain information about the fish (see Section 2.1.2.2) to be available throughout a supply chain, including to the consumers. Compliance to this requirement would be difficult without some form of traceability. In this case, the legislators' purpose was to provide consumers with a minimum amount of information about the fish on which the consumers may base their purchasing decisions (EU, 2000). Another legislative purpose is seen in the U.S., where the purpose of the implementation of the one up, one down traceability requirement in the Bioterrorism Act, Section 306, is to be able to address health or death threats to humans or animals (Randrup, 2007).

Aside from ensuring food safety and legislator-based reasons to implement traceability in a company, many other drivers for traceability have been identified (Fig. 2.3).

Figure 2.3. Drivers for implementing higher levels of traceability in the food industry. (Modified after Olsen, 2009.)

Traceability can also be used to add value to food products by providing information about the food which could differentiate one food product from the other (Ekman, 2002; Danish Ministry of Food, Agriculture and Fisheries, 2004). This information may include the origin of the food, catch date, and catch method in the case of seafood, processing methods, environmental impact, animal welfare, etc. The target groups of this information are all the actors in the supply chain from the auction market, exporters, and processors to wholesalers, retailers, and consumers. Such information can be used as additional factors to assess the freshness and quality of a food by the steps in a chain, and can also be used for storytelling/marketing towards the consumer.

If the information about the quality of the food product is passed on through the chain, the individual steps in the chain do not need to waste time by making quality inspections, since that has already been carried out earlier. However, this requires good mutual trust and cooperation between the steps in the chain (Frederiksen & Gram, 2003).

Another role of traceability in the food supply chain is to provide information to aid in managing and controlling processes, stocks, and quality (Food Standards Agency, 2004). Traceability may also assist in the prevention of fraud and in the authentication of labeling claims by making it possible to prove the product's origin, processing steps, etc. (Derrick & Dillon, 2004).

A certain level of traceability is required in order for a company to be certified against various quality and food safety management standards such as ISO 9000 (ISO, 2008) , ISO 22000 (ISO, 2005a), BRC Global Standard for Food Safety (British Retail

Consortium, 2008), and IFS Food (International Food Standard, 2007). A traceability system is also required to document sustainability in order to achieve certification against another type of standard, namely the Marine Stewardship Council's standard for sustainable fishing (see Section 2.1.3).

2.1.2 Legislative requirements for traceability

2.1.2.1 One up, one down traceability

Article 18 in EU Regulation 178/2002 (EU, 2002b), known as the General Food Law, requires the traceability of food to be established at all stages of production, processing, and distribution. Food business operators shall be able to identify any person who has supplied them with a food and the businesses to which their products have been supplied. This is known as one step up, one step down traceability. However, food businesses are not required to be able to identify the final consumer of their products. Food businesses must have systems and procedures in place that allow for this information to be made available to the authorities on demand. Furthermore, food placed on the market shall be adequately labeled or identified to facilitate its traceability.

The requirements in Article 18 call for the establishment of a certain level of external traceability, but not internal traceability within a company. However, in order to reap the full benefit of the existing one step forward, one step back requirement, it is essential to set up in-company traceability. More information on the requirements of this article may be found in Randrup (2007). Article 18 in EU Regulation 178/2002 became effective on January 1, 2005.

The lot requirement for traceability of fisheries products

The traceability requirements for fisheries products became more stringent upon the enactment of the new Control Regulation in 2009 (EU Regulation 1224/2009) (EU, 2009). Some of the requirements of Article 58 of EU Reg. 1224/2009 bear a resemblance to the requirements of Article 18 of EU Reg. 178/2002:

- that the food should be traceable at all stages and adequately labeled to ensure traceability,
- that food business operators must have systems and procedures in place to identify any operator who supplied them with food products and any operator to whom they supplied food products, and
- that such information shall be made available to the authorities on demand (EU, 2009).

However, a significant difference in the Control Regulation is that the fisheries products must be "put into lots prior to the first sale" (Articles 56 and 58, EU Reg. 1224/2009), and thus, the requirements mentioned above are valid for lots, or batches, of fisheries products. Moreover, EU Reg. 1224/2009 is specifically for fisheries and aquaculture products.

2.1.2.2 Product information that must be available at each step of the fish supply chain

There are certain types of information specifically about fish and fish products which must be available at each step in a supply chain. Those required by Article 4 of EU Regulation 104/2000 (EU, 2000) and EU Regulation 2065/2001 (EU, 2001) have been in effect since January 1, 2002, while those required by Articles 56 and 58 of EU Regulation 1224/2009 and Article 67 of EU Regulation 404/2011 (EU, 2011) are effective as of January 1, 2012.

EU Regulation 104/2000 and EU Regulation 2065/2001

Article 4 of EU Regulation 104/2000 and EU Regulation 2065/2001 stipulate that certain information about fish and fish products must be indicated to the consumer upon retail sale of the product in the EU. These requirements may be seen as a labeling program, but traceability throughout the supply chain is a necessary tool in order to fulfill the requirements.

EU Regulation 2065/2001 requires that the commercial name of the fish species, the production method, and the catch area of the fish must be indicated on the label or other marking upon retail sale. In addition, the aforementioned information together with the scientific name of the fish species must be available at each stage of marketing of the product (Table 2.3). The production method refers to whether the fish was caught at sea, caught in freshwater, or farmed. The catch area for fish caught at sea must, as a minimum, be expressed as a FAO catch area (see Appendix 1), but a step may indicate a more precise catch area. The permitted expressions for the required information are specified in

Table 2.3. Information types that each step in the chain are required to be made available according to the indicated legislation.

Legislation	**Information types**
EU Reg. 104/2000, Article 4 and EU Reg. 2065/2001, Article 8	Fish species (commercial name[1] and scientific name[2]) Catch area Production method (caught or farmed)
EU Reg. 1224/2009, Article 58 and EU Reg. 404/2011, Article 67 (the information requirements are for each lot)	Identification number of each lot[3] Identification number and name of the fishing vessel[3] FAO alpha-3 code of each species[3] Date of catch or the date of production[3] Quantities of each species in kg[3] Name and address of the suppliers[3] Whether the fisheries products have been previously frozen or not[1] Information to consumers as stated by Article 8 of EU Reg. 2065/2001[1]

[1]Must also be available to the consumers.
[2]The scientific name was not required to be indicated upon sale to the final consumer according to EU Reg. 2065/2001, but became mandatory to provide to the final consumer according to EU Reg. 1224/2009.
[3]Not applicable for fish products imported into the EU with catch certificates submitted in accordance with EU Regulation 1005/2008.

EU Regulation 2065/2001. The requirements of Article 4, EU Regulation 104/2000 and EU Regulation 2065/2001 are discussed further in Randrup (2007).

The objective of these requirements is to provide consumers with additional information on which to base their purchasing decisions. Due to the broad variety of fishery products available, it has become essential to provide consumers with a minimum amount of information on the main characteristics of products (EU, 2000).

EU Regulation 1224/2009 and EU Regulation 404/2011
The Control Regulation (Article 58) along with EU Reg. 404/2011 (Article 67) also specifies certain information about the fisheries products that must be registered for each lot (Table 2.3). These must be provided at the moment that the products are put into lots and no later than the first sale. Operators must update the information if the information changes because the lots have been merged or split. If products from several fishing vessels are mixed, operators must be able to identify each lot of origin, as a minimum via the lot identification number, and must be able to trace the lots back to the catching stage (i.e. the fishing vessel). Article 67 of EU Reg. 404/2011 includes further requirements on how the information may be affixed to the lots.

It is specified in Article 67(9), EU Reg. 404/2011 that the catch date may include several calendar days or one period of time corresponding to several catch dates. Thus, one may state the catch dates as the total period of time in which a vessel was at sea during a fishing trip (Jacobsen, 2011).

The product information to consumers as specified by Article 4 of EU Reg. 104/2000 and EU Reg. 2065/2001 are included as requirements in Article 58(5) of EU Reg. 1224/2009, but herein specifically for *lots* of fisheries products. In addition, the term “relevant geographical area” has replaced the term “catch area” since, according to Article 67(13), EU Reg. 404/2011, a body of water smaller than the FAO catch areas must be registered for catches of stocks subject to a quota and/or a minimum size in EU legislation. More information on the relevant geographic area is found in Article 4(30) in EU Reg. 1224/2009.

Where EU Reg. 178/2002 put forth the concept of one up, one down traceability and did not have any requirements that made internal traceability a necessity, the traceability requirements in EU Reg. 1224/2009 and EU Reg. 404/2011 seem to be approaching both chain traceability and a certain extent of internal traceability. In addition, the two recent regulations require more product information about the lots to be registered by the steps and also narrow down the designation of the catch area to a smaller body of water than a FAO catch area. However, the next significant step would be to make at least some of this additional product information, such as the catch date(s) and the fishing vessel(s), available to the final consumer.

2.1.3 Standards for traceability of fish

There are several standards for traceability of fish. In the following, ISO 12875:2011 Traceability of finfish products - Specification on the information to be recorded in captured finfish distribution chains (ISO, 2011) and the Marine Stewardship Council's Chain of Custody (MSC, 2011) will be briefly presented. In addition, ISO 22005:2007 Traceability in the feed and food chain – General principles and basic requirements for system design and implementation (ISO, 2007) will be presented, although this standard not only covers fish traceability, but food traceability in general.

ISO 12875:2011 specifies the information to be recorded in marine captured finfish supply chains in order to establish the traceability of the fish and derived fish products. The document specifies how the fish are to be identified and which information should be generated and recorded by each of the steps that handle the fish through the supply chains. The standard includes not only information types that can be used to identify and trace the products through the supply chain, but also information about what has happened to the products along the way. A related standard, ISO 12877:2011, exists for the traceability of farmed finfish. Both standards are non-certifiable.

Certification against the MSC Chain of Custody standard confirms that a company has established adequate product identification and segregation systems to ensure that products from fisheries certified to the MSC environmental standard for sustainable fishing are not mixed with products from non-certified fisheries and that the products can be traced from their suppliers and tracked to their buyers. Records shall be held showing that volumes of certified batches in is equal to volumes of batches out.

ISO 22005:2007 is a non-certifiable standard that specifies the principles and basic requirements for the design and implementation of a food traceability system. It is applicable by any step in a food supply chain. The traceability system can be modified to conform to one's objectives and can be used to determine the history or location of a product. ISO 22005:2005 may also be applied by steps in feed supply chains.

Although the three standards presented above all deal with the traceability of fish (or food in general), they do so in different ways. ISO 12875:2011 lists precise information to be recorded about the fish in a standardized manner. The MSC Chain of Custody and ISO 22005:2007 may resemble each other, but the former is specifically about securing the traceability of MSC-certified fishery products, while the latter is broader in scope and includes other aspects in the design of a traceability system.

2.1.4 State of traceability in the fish industry

Several studies have investigated the status of traceability in the fish industry based on the ability to trace a product bought at a retailer back to the origin (a fishing vessel, a breeder, or a fish farm). Three studies in the Nordic region revealed that it was only possible to trace 31-55% of the purchased fish products back to the origin (Karlsen & Senneset,

2006; Randrup *et al.*, 2008; Karlsen, Donnelly, & Dreyer, 2009) due to batch mixing and loss of information.

Using the same method Randrup, Wu, and Jørgensen (2012) were able to trace two out of three fish products back to a single fishing vessel. However, in one of the two cases, even if the originating fishing vessel was known downstream in the chain, one of the steps had not recorded a lot code, thereby not making it possible for a previous step to provide information on the batch in question (e.g. batch size, reception date). The origin of the third product could only be narrowed down to 11 identified fishing vessels, thereby showing the effect of pooling fish batches both by the collectors and by the processor. Information about the contributing vessels is not lost, but when the last traceable step consists of 11 vessels, the resulting batch in case of a recall can be rather large. The batches which the fish products originated from were also tracked forward as far as possible to their end destinations, although this part was hampered by some of the companies' reluctance to find and share information.

Other studies also found that information about the products and processes is lost both internally in a step and externally between steps in seafood supply chains (Pálsson et al, 2000; Frederiksen & Bremner, 2001; Frosch, Randrup, & Frederiksen, 2008; Donnelly & Karlsen, 2010; Karlsen, Donnelly, & Olsen, 2011). Furthermore, there is a need for unique identification of the batches.

Concerning the implementation of traceability systems in the steps in the fish industry, Frederiksen, Popescu, and Olsen (1997) developed an Integrated Quality Assurance System for the fishing vessels, which used bar codes to carry information about the fish in the box, for example the species, the size category, the vessel number, the catch date, and the weight of the fish in the box. However, this system was only used in the first step of the chain (on the vessel) and the information was not transferred further in the chain. A similar system is described by Denton and Meyers (2003) and is common in the UK fishing fleet. Later, Szulecka (2009) reports about a successful implementation of electronically-based internal traceability at a fish processing plant based on GS1, ISO 12875, and barcodes.

Frederiksen *et al.* (2002) demonstrated the "Info-fisk" traceability system for the whole fish supply chain, from the vessel to the retailer. This system also used barcodes to carry data along the chain. In 2007, Senneset, Forås, and Fremme describe the challenges encountered upon implementing electronic chain traceability in a complete supply chain of farmed salmon consisting of eight steps. A freezing trawler fishing in the North East Atlantic has implemented electronic traceability with standardized data formats enabling its customers to access relevant product and catch data stored in the database (TraceTracker, 2010). The above-mentioned studies indicate that there is ongoing development and implementation of advanced traceability systems in the fish industry currently.

In Denmark, a traceability system covering all types of steps in the fish supply chains has been developed to meet increased demands about traceability and documentation of sustainability from the consumers and the retailers as well as demands from legislation (e.g. the Control Regulation 1224/2009) and foreseen changes to the quota system involving increased demands about different types of data to document a catch (SIF, 2012). Due to the large amounts of data to be collected and distributed, the system, called SIF (Sporbarhed i fiskeriet = Traceability in fisheries), is electronically-based (Figure 2.4). Data is collected from several systems, including the fish boxes with affixed RFID tags, the fishing vessels' computers, and the fish auctions' systems. All data is stored in a central database, from which all the steps, including consumers, can access relevant data, e.g. the catch area and catch method of a box of cod (Lyngsoe Systems, 2012). After pilot studies, the system began functioning in February 2012.

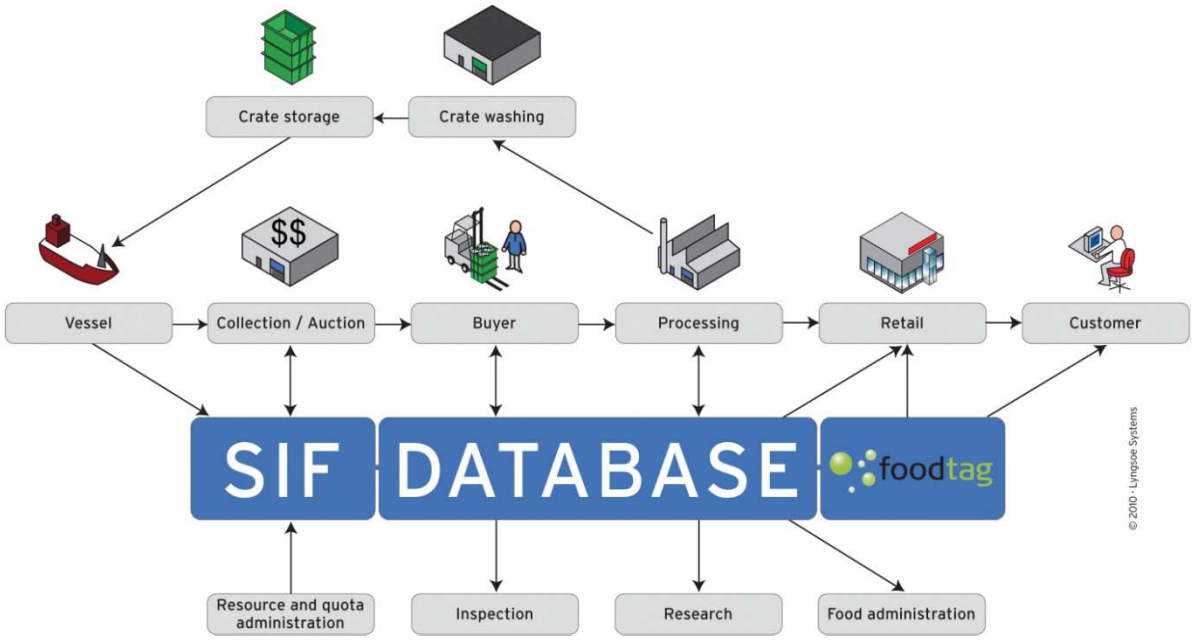

Figure 2.4. Overview of the SIF (Traceability in fisheries) national traceability system for fish. (Source: Lyngsoe Systems, 2012)

It must be mentioned that the RFID-tagged fish boxes described in the SIF system were brought into use after the interviews described later in this report were carried out.

2.1.5 Data carriers

In the following text, the most common types of data carriers will be described. Although an RFID tag to be attached to individual live fish has been developed and tested (Hsu, Chen & Wang, 2008), traceability of fish products is highly dependent on placing a marker, or data carrier, on the fish box or packaging material. A result of this is a risk of substitution in open fish crates (Goulding, 2002). Aside from the data carriers presented below, other data carriers include (a) optical data carriers such as two-dimensional bar codes (in the form of multi-row bar codes or matrix bar codes) (Furness, 2006) and Optical Character Recognition (OCR) (Trienekens & Van der Vorst, 2006), (b) magnetic

data carriers such as a magnetic stripe (Trienekens & Van der Vorst, 2006), (c) electronic data carriers such as touch memory (Furness, 2006) and smart cards (Trienekens & Van der Vorst, 2006).

2.1.5.1 Paper-based

As the name says, information in a paper-based traceability system is written on paper that follows the raw material through processing to retail. This is easy to use when dealing with large products of high value and in small quantity. However, when it comes to relatively small products which are produced in large quantities, it may be too expensive labor-wise to use a paper trail (Frederiksen & Gram, 2003). Moreover, it may take longer time to trace the product when using a paper-based system rather than a computerized system (Morrison, 2003).

2.1.5.2 Bar codes

Linear bar codes placed on the packaging material are the most used data carriers and have been in use since the beginning of the 1970's. Bar codes consist of bars and spaces, both of differing widths. The pattern of the bars and spaces encodes data. Bar codes are read using a beam of red light which detects changes in the amount of light reflected from the surface, on which the bar code is printed. These changes are converted to a digital signal, which in turn is decoded by a computer, thereby determining the information stored in the bar code. Bar codes can store a limited amount of data (Furness, 2006). Bar codes must be in the reader's line of sight and not more than a few centimeters away from the reader (Trienekens & Van der Vorst, 2006).

Many bar code symbologies have been developed. Among the most well known are EAN-8 and EAN-13 (for trade items), EAN-128 (for logistic units), and RSS (reduced space symbology for items with a small surface area) (Furness, 2006). Bar codes are traditionally printed on packaging materials, but Nightingale and Christens-Barry (2005) are researching on the possibility of placing bar codes directly onto food products.

2.1.5.3 RFID tags

Due to the use of radio frequencies, RFID (radio frequency identification) tags placed on items can be read even if the reader and the tag are not in line-of-sight. This means that it is possible to use RFID tags in wet and harsh conditions, which are unsuitable for the reading of bar codes. An RFID tag can be either read-only or both readable and writeable. Furthermore, RFID tags are either passive, semi-active (battery-assisted) or active, depending on how they are powered. Passive tags are powered by the reader, active tags are powered by their own battery, while semi-active tags have a battery, but are also dependent on power from the reader (Furness, 2006; Brody, 2006; RFID Centre, 2006; Cavoukian, 2004).

Passive tags have the longest lifetime and are also the cheapest, but they have a shorter read range than active tags (Tajima, 2007). RFID tags can store larger amounts of data than bar codes. However, RFID tags can also be used solely to store a unique

identification number, which then is linked via the internet to a database, where practically indefinite amounts of data can be stored. This is the principle employed in the SIF system mentioned in Section 2.1.4, which involves RFID-tagged fish boxes.

Aside from traceability and supply chain applications, RFID tags may be coupled with temperature sensors that log the temperature at defined intervals or that monitor the temperature and integrate it over time to predict the remaining shelf life of the food product (Kumar *et al.*, 2009). Abad *et al.* (2009) have developed RFID smart tag prototypes that can store product data as well as record the temperature and humidity; the tags were validated in fresh fish supply chains. Other applications as well as benefits and the challenges faced in implementing RFID technology, such as the influence of water and metal on the readability, are described by Kumar *et al*. (2009), Kelepouris, Pramatari, and Doukidis (2007), Jones *et al*. (2005) and Rollo and Gnoni (2010).

2.2 QUALITY OF FRESH FISH

2.2.1 Degradation processes in fish

Shortly after a fish is caught, the degradation processes begin. For cod, autolytic changes are responsible for the quality loss until around 6 days of storage on ice (Figure 2.5). Thereafter, bacterial activity causes the quality changes in the cod and the gradual spoilage.

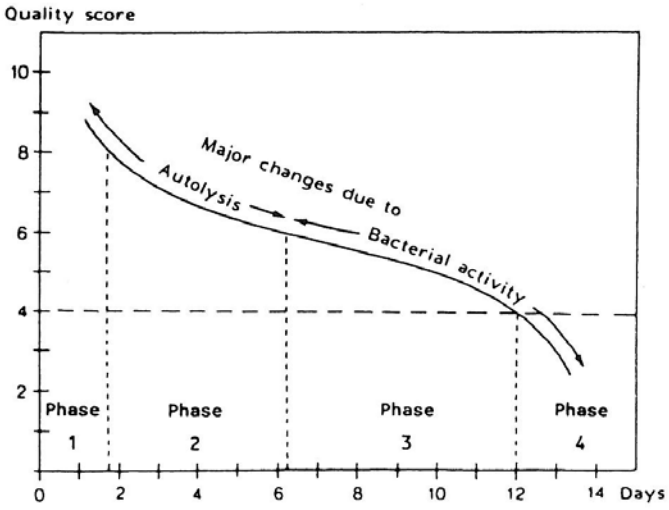

Figure 2.5. Changes in the eating quality of cod stored on ice (0°C) (adapted from Huss, 1995). The quality score scale is from 0-10 where 10 = absolute freshness, 8 = good quality, 6 = neutral, tasteless fish, and 4 = rejection level. The quality score is based on a sensory evaluation of cooked fish.

Autolytic changes

The autolytic (i.e. self-digestive) changes that occur in fish are due to the enzymes present in the fish itself. Among the enzymes that cause changes in chilled fish are glycolytic enzymes, proteases, and lipases. Glycolytic enzymes are involved in processes leading to *rigor mortis*, whereas an effect of the proteases is the subsequent softening of the muscle tissue. Special proteases, collagenases, play a role in the gaping of fillets because they, under certain conditions, break down the connective tissue between the "flakes" of muscle tissue (Huss, 1995).

Fish lipids may hydrolyze due to the presence of lipases. Lipid hydrolysis is most intense in ungutted fish than in gutted fish, probably because digestive enzymes include lipases (Venugopal, 2005). Lipids do also undergo oxidation early postmortem and can be both enzymatic and non-enzymatic. The secondary products of lipid hydrolysis and oxidation contribute to the off-odors that arise after some days' storage on ice (Sikorski & Kolakowski, 2010). As expected, fatty fish are more prone to lipid degradation, and especially oxidation takes place even at temperatures well below 0°C (Huss, 1995).

Bacteriological changes

Upon catch, the fish muscle is sterile. Bacteria from the fish surface and intestines and from water, equipment, and humans may then contaminate the fish muscle. All the contaminating bacteria do not have the same effect on spoilage of the fish. Specific spoilage organisms (SSOs) are microorganisms that, at certain conditions, grow faster than the rest of the microflora and are those that are mainly responsible for the spoilage (Venugopal, 2005). With time, the SSOs will produce the metabolites that give the off-flavors and off-odors connected to spoilage (Huss, 1995; Venugopal, 2005) For example, the SSO of aerobically stored fresh, iced, marine fish such as cod is *Shewanella putrefaciens* (Gram & Huss, 1996). The level of the SSOs in the fish product is related to the shelf-life of the product, and thus can be used to predict the remaining shelf-life (Huss, 1995; Gram & Huss, 1996).

2.2.2 Freshness criteria and QIM

Most just-out-of-water fish are characterized by having a fresh, seaweedy smell, clear, convex eyes, bright skin with clear mucus, red gills, and a firm texture (Madsen, 2007). An objective method of measuring the degree of freshness of a fish is by using the Quality Index Method (QIM), a sensory analysis method based on the work by Bremner (1985).

QIM consists of a list of sensory parameters that each are scored with 0-3 demerit points (Table 2.4). The scores are summed up and the total score is termed the Quality Index (QI). The lower the QI is, the fresher the fish. The QI is linearly related to the fish's storage time on ice (also known as days on ice) (Hyldig *et al.*, 2010), as illustrated for cod in Figure 2.6.

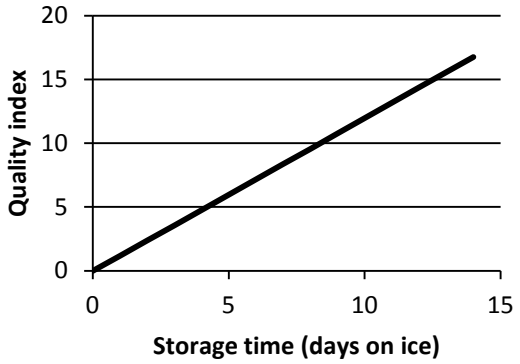

Figure 2.6. The quality index (QI) as a function of the number of days on ice for whole, gutted cod. Calibration curve: QI = 1.20 x days in ice – 0.04 (R^2=0.966) (equation from Hyldig *et al.*, 2010).

Using the obtained QI and the calibrated scheme specific to each species, it is possible to calculate the equivalent number of days that the fish has been stored on ice. If a maximum storage time has been set at which the fish is still considered fit for human consumption, the remaining shelf life can also be predicted (Hyldig *et al.*, 2010). There is an uncertainty of about ± 1 day attached to the estimation of the remaining shelf-life (Jónsdóttir *et al.*,

1993). According to Martinsdóttir *et al.* (2001), the estimated shelf-life on ice for cod is 15 days and for plaice 13 days.

QIM is being used by some auctions in the Netherlands for both training and labeling purposes (Vader *et al.*, 2003). QIM can be used as an inspection tool for spot checks by the authorities, but it is too time-consuming to use as a production management tool (Frederiksen, 2002).

Table 2.4. QIM scheme for whole, gutted cod with descriptions for each parameter and the number of demerit points equivalent to each description. (Adapted from www.qim-eurofish.com)

Quality parameter		**Description**	**Score**
Appearance	Skin	Bright, iridescent pigmentation	0
		Rather dull, becoming discolored	1
		Dull	2
	Stiffness	In rigor	0
		Firm, elastic	1
		Soft	2
		Very soft	3
Eyes	Cornea	Clear	0
		Opalescent	1
		Milky	2
	Form	Convex	0
		Flat, slightly sunken	1
		Sunken, concave	2
	Pupil	Black	0
		Opaque	1
		Gray	2
Gills	Color	Bright	0
		Less colored, becoming discolored	1
		Discolored, brown spots	2
		Brown, discolored	3
	Smell	Fresh, seaweedy, metallic	0
		Neutral, grassy, musty	1
		Yeast, bread, beer, sour milk	2
		Acetic acid, sulphuric, very sour	3
	Mucus	Clear	0
		Milky	1
		Milky, dark, opaque	2
Flesh, fillets	Color	Translucent, bluish	0
		Waxy, milky	1
		Opaque, yellow, brown spots	2
Blood	Color	Red	0
		Dark red	1
		Brown	2
Quality Index			**(0-23)**

2.2.3 Maintaining freshness

The combination of time and temperature are among the most important factors when determining the freshness of fish, defined as the number of days in ice since catch. The freshness of fresh fish (that is not frozen or processed) is maintained best when the fish is just below 0°C, equivalent to the temperature of melting ice (Huss, 1995). This will enhance the chances of the fish achieving a high price at the auction, ensure fish of good eating quality, and provide a longer period of time in which to sell the fish (within the shelf life on ice). Thus, because of economical reasons, cold chain management is important throughout the fresh fish supply chain.

If one has a log of the temperatures of a fish over a period of time, for example from catch until the fish arrives at a processor ashore, then one can use the Seafood Spoilage and Safety Predictor (SSSP) software (Technical University of Denmark, 2009) to obtain an indication of the freshness of the fish expressed as the equivalent number of days in ice as well as to get a prediction of the remaining shelf life of the fish. This way the strains that the temperature profile has placed on the freshness and remaining shelf life can be seen. For example, the effect of storing fish at 2°C after three hours of chilling (after catch) down to the 2°C is that the remaining shelf life after 5.8 days is reduced by around 2.5 days compared to fish that were stored on ice (Frederiksen *et al.*, 2007).

The catch date together with records of the temperature at defined intervals since catch can thus be used by steps along the supply chain to indicate the freshness and remaining shelf life of the fish. The traceability system is the means by which the information can reach the steps. With this kind of information, quality assessment of the fish upon arrival at each step can be cut down and only be performed as random samples. Alternatively, the temperature records can be omitted, but this requires a strong relationship of trust among the steps. It is already seen that some buyers at the auctions prefer to buy fish caught by certain fishing vessels, which they know by experience handle their catch well and thus land high-quality fish. From the buyers and downstream in the chain, the steps often have regular trading partners. They become regular when the customer continuously receives good-quality fish and thereby develops confidence that his supplier delivers the same good-quality fish every time.

Even if the catch date and a temperature log is forwarded with a batch of fish (or is available for example from a central database), there are other factors that influence the freshness of a fish. For example, the fish must be gutted and rinsed properly, leaving no entrails. This reduces the presence of digestive enzymes and intestinal bacteria that could contribute to a higher rate of spoilage. The fish should be handled gently to avoid bruises which may accelerate the spoilage process by causing enzyme substrates to become more accessible (Opara, Al-Jufaili, & Rahman, 2007). It is important at each step in a chain to have fixed procedures on how to handle the fish in order to consistently provide high-quality fish.

2.3 CLASSIFICATION OF FISH AT THE FIRST POINT OF SALE

This section describes the classifications that are made of the fish before they are auctioned off. The freshness and size classification are EU requirements. The seapacked fish and kystfisk classifications are purely voluntary, but they are included here because they also are classifications that must be carried out before the fish is put up for sale at the auction.

2.3.1 Freshness category and size classification

EU Regulation 2406/96 (EU, 1996) lays down common marketing standards for certain fish and certain other seafood upon the first offer for sale of the fish on European Union territory. Among these standards, there are requirements that certain fish must be classified into freshness categories (Article 4) and size categories (Article 8). The fish may be classified into freshness category Extra (also denoted E), A, or B, where category E represents the freshest fish. In addition, the fish may be categorized as "not admitted" (rejected) if it is unfit for human consumption. The classifications are based on assessment of the fish according to the criteria listed in Annex 1 of the regulation. For the group "whitefish," the parameters to be appraised are skin, skin mucus, eye, gills, peritoneum, smell of gills and abdominal cavity, and flesh.

This assessment type resembles the Quality Index Method (QIM), although points are not given for each parameter that is assessed. In addition, the EU freshness classification scheme does not take into consideration the differences between the species, for example within the "whitefish" group. The EU scheme is much faster in use than QIM, but is not as detailed and not as reliable (Hyldig *et al.*, 2010). Freshness category A in the EU scheme covers a wide range of freshness "magnitudes" as measured by QI scores (Table 2.5). This lack of detail means that fish of freshness category A can have a variety of applications, indicating that category A may be difficult to use for production decisions without having a look at the fish. The equivalent storage time for plaice in freshness category B is 13-16 days in ice according to the regression line for plaice: QI = 1.28 x days in ice (Hyldig *et al.*, 2010). It is interesting to compare the equivalent storage time in ice of plaice in category B with the estimated shelf life of plaice on ice (13 days), mentioned in Section 2.2.2.

Table 2.5. A proposed relation between the EU freshness categories and the quality index score as well as equivalent storage time for plaice and cod. Adapted from Hyldig *et al.* (2010).

EU freshness categories	**Plaice (*Pleuronectes platessa*)**		**Cod (*Gadus morhua*)**	
	Quality Index Score	Equivalent storage time (days in ice)	Quality Index Score	Equivalent storage time (days in ice)
E	0-5	0-4	0-4	0-3
A	6-16	5-13	5-13	4-11
B	17-21	13-16	14-16	12-13
Not admitted	>22	>17	>17	>14

The size classification for most of the whitefish is based on the weight of the individual fish. The weight intervals determining the size classification for specific species of fish are listed in Annex II of Regulation 2406/96. The weight intervals are denoted with a number from 1 to 5, although the weight intervals for each fish species varies from two weight intervals to five weight intervals. For example, dab (*Limanda limanda*) may be divided into two weight intervals called size 1 and size 2, while cod may be divided into five weight intervals (from size 1 to size 5). The smaller the size number, the heavier the fish is. Some auctions, including the auction in this study, operate with an additional weight interval, denoted size 0, for a few species such as cod and hake (*Merluccius merluccius*).

As far as the chains in this study are concerned, the classification into freshness category and size category is done by different steps depending on whether the fish is seapacked or not. For seapacked fish, the fishing vessel grades the fish according to the weight intervals, while the auction classifies the fish into freshness categories. Non-seapacked fish is landed to a collector to be graded and packed, and thus, the collector classifies the fish into both freshness category and size category.

The terms quality and freshness are sometimes unfortunately used interchangeably. In this report, freshness is used to describe the state or condition of the fish in relation to the time and temperature that it has been stored at since catch. Freshness is a part of quality. Quality includes many aspects of the fish. The type of catch method used may affect a certain person's opinion about the quality of the fish, since some catch methods may give the fish bruises or stress the fish while other catch methods do neither of these. The catch area is another aspect that may influence the quality of the fish. For example, cod from the Baltic Sea is darker than cod from the North Sea. For consumers in Southern Europe, the color, and hence the catch area, is an important aspect of the quality of the fish since they want light-colored cod (Frederiksen, 2002).

The respondents interviewed for this report generally used the Danish term for quality ("kvalitet") and rarely freshness ("friskhed"). In addition, the term used in Danish for "freshness category" is "kvalitetsklasse," i.e. quality classification. The author has made an attempt to distinguish between quality when used to mean freshness and quality when used to describe the assessment of fish based on many descriptors. However, sometimes both terms are mentioned if it is unclear what the respondent had in mind when they used the term "kvalitet."

2.3.2 Seapacked fish

Fishing vessels may choose to seapack their fish. This means that they grade the fish according to species and size onboard before packing the fish with ice in fish boxes. The fish boxes are then labeled, as a minimum, with the species and the size. Some seapacking vessels label the boxes of fish with the catch date, while others simply put handwritten slips of paper in the boxes reading "day 1," "day 2," "day 3," etc. so it is

possible to see the order of the catch but not the actual date of the catch (Auction[1], personal communication). Other vessels have a setup with an electronic scale connected to a label printer, which prints out a sticker label for every box of fish (Figure 2.5). The label may show many types of information, such as the species, the size, and the catch date, as mentioned, as well as the name or number identification of the vessel, the sales weight, the actual weight of fish in the box, and the catch area.

Figure 2.5. Examples of seapacking labels on fish boxes. Plaice (left) and monkfish (right).

The advantage of seapacking is that the fish can be delivered directly to the auction. This means that the fish does not have to be handled once more at the collector and that the owner of the fishing vessel saves on the cost of grading by the collector.

In theory, all vessels may seapack their fish (Auction, personal communication). For example, even small jig vessels could seapack their fish since they only catch cod. The problem is that if all the jig vessels seapack their fish, then there will be many small batches at the auction. Small batches with incompletely-filled boxes will be sold for a lower price per kg. The jig vessels would get a higher price for their fish if they collected their catches in bigger batches. Filled boxes give a better flow in the auction rather than a half box of one size of cod (for example, size 2 cod) and a three-fourths filled box of another size of cod (for example, size 3 cod). The most common vessels that seapack are big trawlers and other bigger vessels with a certain degree of space onboard.

2.3.3 Kystfisk

"Kystfisk" (literally "coastal fish" in Danish) is a so-called brand given by the collectors in a certain town to fish that fulfils certain criteria. The brand was introduced by a project started by the town's port authority in order to create more value for fish sold at the auction in the town. The port receives a certain duty of the value of the fish sold at the auction, so the port is interested in the fish being of a high quality so that they can achieve as high a price as possible. The use of the brand has been carried on, but unfortunately the criteria are neither documented in writing nor identical at the two collectors in the town (Auction, personal communication; Fishing vessel 2[1], personal communication). Based on

[1] Fishing vessel 2, Collector, and Auction are three of the steps investigated in this report. They are presented in Chapter 3 Materials and methods.

information from the collector and Fishing vessel 2 in this study, some characteristics of kystfisk are outlined in Figure 2.6.

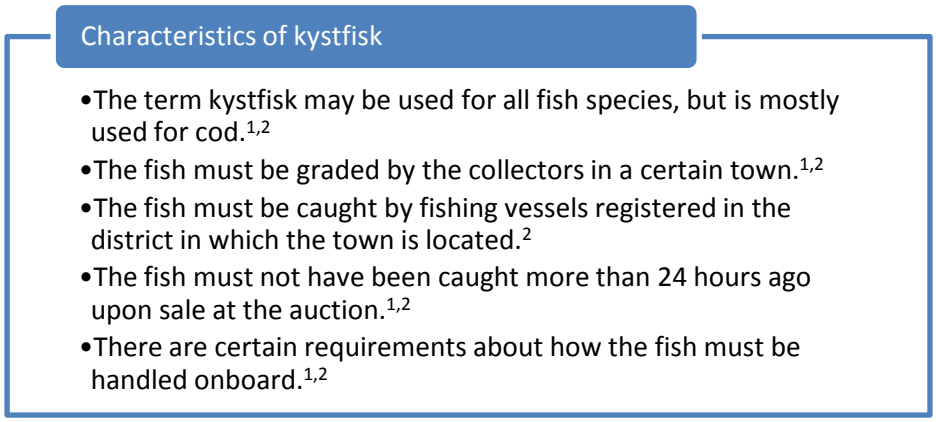

Figure 2.6. Some characteristics of kystfisk. References: [1]Collector, personal communication. [2]Fishing vessel 2, personal communication.

The fish must be handled with care (Collector[2], personal communication), but more specific requirements regarding the catch handling of the fish were not explained because "the fishermen that participate in this scheme know how they must handle the fish" (Collector, personal communication). However, the collector relates that the fish must not lie on the deck for several hours before being gutted. This will influence the appearance of the fish, but not the flesh/meat. Cod will become red in the head (Collector, personal communication). There is a lack of information about whether kystfisk must be caught with specified catch methods. Fishing vessel 2 relates that gill net vessels should handle their catch the same way that he does (see Section 4.2), while small trawlers must not tow the trawl for more than 4 hours.

In order for the fish to be graded as kystfisk, there is a lower limit regarding the amount of kystfisk-suitable fish that must be landed by the fishing vessels in total. Otherwise, it is too expensive and laborious to grade the fish under the kystfisk brand. Moreover, the buyers would not buy the resulting incompletely-filled boxes because the relative transportation expenses and box rental fee would be too costly.

In the following, the term kystfisk will be used to denote such fish as is described in Figure 2.6.

[2] See footnote 1.

Chapter 3 Materials and methods

3.1 THE STEPS IN THE CHAIN

Two fish supply chains consisting of six steps were chosen as case studies (Figure 3.1). The steps will be introduced in the following sections. Each step receives fish from the previous step in the shown chain or delivers fish to the next step, but it is not 100% certain that the retailer receives fish that has been sold by the auction in this chain, although this is highly likely. Similarly, it is unknown whether the processor and the retailer receive fish that is caught by Fishing vessel 1 and/or Fishing vessel 2, since the auction and the processor receive fish from other sources, too. The known relations are indicated in Figure 3.1.

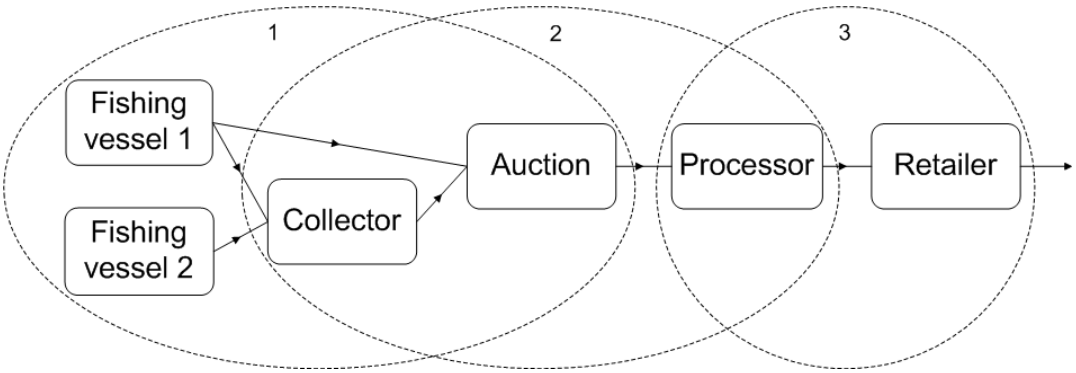

Figure 3.1. The steps in the selected fish supply chain. Arrows show the direction of the product flow. The circles enclose the steps of which it is certain that they receive fish from the previous step or deliver fish to the next step. The relation among the steps in Circle 2 connects the steps in Circles 1 and 3.

3.1.1 Fishing vessel 1

Fishing vessel 1 is a relatively large vessel with a long reach (Table 3.1). It can store 1200 boxes (equivalent to 30 tons) of fish appropriately for a few days. During fishing trips to the Baltic Sea, cod is the main species, while during fishing trips in the North Sea, including the Skagerrak, all types of flatfish and roundfish are caught. The fishing vessel seapacks most of the fish. Sometimes Fishing vessel 1 delivers some of their catch to the collector, for example if they have very small batches of a certain species or if they happen not to have enough boxes onboard to pack the fish in. The vessel sells its fish both directly to one processor and via two auctions to various processors, but these processors are unknown to the fishing vessel.

Fishing vessel 1 mostly has fishing trips of 3-4 days. This means that when their fish is sold at the auction, they have fish that is 0 days old, 1 day old, and 2, 3, and 4 days old. They have become more aware of the quality of the fish compared to some years ago, when their fishing trips could last up to 2 weeks. Their trawl and engine have the capacity to catch a large amount of fish within a short time. This means they can shorten the time

that they trawl and thereby better maintain the quality of the fish, since the fish will be in the trawl for a shorter period of time. They trawl 5-6 times in 24 hours compared to only 2-3 times in 24 hours in the past.

Table 3.1. Characteristics of Fishing vessel 1 and Fishing vessel 2.

	Fishing vessel 1	**Fishing vessel 2**
Type of fishing tackle	Trawl	Bottom gillnet
Length of vessel	Under 30 m	Under 10 m
Staff	5 people	1 person
Length of fishing trip	3-6 days	6-12 hours, rarely 18 hours
Type of fish catch	Flatfish Roundfish	Flatfish Roundfish
Fishing waters	The Baltic Sea The North Sea (including the Skagerrak)	The Skagerrak
Production of ice onboard	Yes	No
Sea packing onboard	Yes	No
Length of time the fishing tackle is in the water	1-5 hours	2-8 hours

3.1.2 Fishing vessel 2

Fishing vessel 2 is a small vessel and can be manned by only one person (Table 3.1). The vessel is a day boat, meaning that the vessel's fishing trips do not last for more than a day. The fish caught consists of flatfish, like plaice and sole, as well as roundfish. Fishing vessel 2 delivers all its fish to the collector to be graded. The fish from Fishing vessel 2 is mixed with fish from other vessels at the collector, but the fish caught with gillnets are most often kept apart from the fish caught with trawl. The owner of Fishing vessel 2 does not know who actually buys his fish.

3.1.3 Collector

Fishing vessels that do not seapack their fish or deliver their fish directly to a processor/wholesaler deliver their fish to a collector, who grades the fish according to species, size and freshness category. This is done in the evening and during the night. The collector places the boxes of iced fish in the auction hall so they are ready for the auction at 7 AM. The collector sends the fish to the auction requested by the fishing vessel. Most of the fish is auctioned off at the auction in this study, but sometimes the fishing vessels want the saithe and Norway lobster sent to other auctions if they think the prices are higher at the other auctions. Information about the collector is shown in Table 3.2.

Table 3.2. Characteristics of the collector.

Ownership	Approx. 80 fishermen though a co-operative system
No. of fishing vessels that land at the collector	Approx. 140 fishing vessels, including non-members of the co-operative system
Grading staff	10-12 casual laborers; depends on the amount of fish landed each day
Fish species accepted	All
Freshness categories accepted	All
Amount of incoming fish per day	2-16 tons; highly depends on the weather

The collector and the auction perform services for the fishermen and/or vessel owners. This means that the fish is legally owned by the fisherman/vessel owners until the fish is sold to a buyer at the auction. The collector and the auction charge a commission for their services. Thus, the higher price the fish is sold for, the higher is the commission for the collector and the auction.

3.1.4 Auction

The role of the auction is to sell the fish for the fishing vessels at the highest possible price. It is a privately-owned company that is licensed by the Ministry of Food, Agriculture and Fisheries to conduct an auctioneering business. The auction is mainly an administrative company, but is also responsible for checking the weight of the seapacked fish (done by taking random samples). There are five people employed at the auction. Most of them are able to freshness-grade the fish.

The auction actually has two types of customers: those who supply the fish to be auctioned off and those who buy the fish. The auction considers its suppliers as customers because they pay the auction to sell their fish. However, if a dispute arises, the auction will support his suppliers compared to the buyers.

On average, the auction is supplied with 40 tons fish per day. The supply varies from 10 to 80 tons per day. Cod and plaice are the most important species, being represented in the largest amounts. The auction receives fish from collectors and seapacked fish directly from fishing vessels. The auction receives fish from Danish as well as Norwegian collectors and fishing vessels. The seapacked fish is classified into freshness categories by the auction while the fish received from the collectors has already been freshness-graded. However, the auction has the overall responsibility for the correctness of the freshness category.

The fish sold at the auction is caught using different types of catch methods (Table 3.3). According to the auction, the industry is becoming more interested in dividing the fish according to the catch method. The value of trawled fish comprises the largest part of the turnover. Trawled fish includes both fish caught by the big trawlers, which fish in the North Sea, and by the small, one-day trawlers. Vessels using gillnets and jigs fish nearest the coast while those using Danish seine are further away from the coast but do not fish in the North Sea or farther out in the Skagerrak.

Table 3.3. The approximate contribution of the value of fish caught by different catch methods to the annual total turnover of the auction.

Catch method	**Approximate percentage of annual total turnover of the auction**
Trawl	50-55 %
Danish seine	30-40 %
Gillnet	10 %
Jig	Up to 5 %

Only registered persons/companies are entitled to buy from the auction. Buyers can only bid when physically present at the auction. It is possible for registered users to follow the sales via internet, but it is not an internet auction. The auction has no plans of making an internet auction since they believe that the buyers must make their own quality assessment of the fish.

Those who buy fish at the auction consist of around 15 so-called buyers and around 3 small retailers. There are no restaurants that buy directly from the auction. The buyers purchase fish for their employer, which can be a processor or a wholesaler, but also for other processors or wholesalers. A couple of the buyers are agents and are not employed by a processor or wholesaler.

The processors include those companies that head, skin, or fillet the fish and/or use the fish in more refined products. The wholesalers resell the fish to other wholesalers, to processors and to retailers. When distributing to retailers, the fish is usually repacked in smaller boxes which may contain different species of fish according to the retailers' specifications. Some companies are both processors and wholesalers. Via the buyers, the fish sold by the auction is distributed both in Denmark and abroad.

Of the auction's buyers, the processors and wholesalers purchase the largest quantities of fish, but the small retailers have a fairly large influence on the price settling. The small retailers, such as fish mongers, can pay a little more for the fish because they do not need such big amounts. Therefore, they give a higher bid at the auction. This causes the fish exporters to panic because they need large quantities of fish, so they must submit a higher bid. Then the small retailers may withdraw, leaving the fish exporters to pay a high price for a large quantity of fish.

3.1.5 Processor

The processor is a buyer at the auction. The processor heads, skins, and fillets fish, but also has wholesaler activities, in which the fish is resold whole. The processor employs 15-20 people and has had great progress during the last few years.

The processor buys fish from six different auctions and from other processors in Denmark, but also buys fish from collectors and wholesalers in Norway, Sweden, and the Faroe Islands. The company's main customers are supermarkets, fish mongers, and catering businesses. They recently started exporting their products to the European market. The fish species that the processor sells in the largest quantity, though in varying amounts per year, are plaice, cod, and salmon.

3.1.6 Retailer

The retailer in this chain is a fresh fish counter at a supermarket. The retailer buys fish from the above-mentioned processor and from another processor. The focus of the retailer is on high quality fish products, but they also buy some lower quality fillets for bargain hunters. An example of a high quality product is large, whole plaice which the retailer

fillets by hand as opposed to industrial machine-filleted plaice, which are of a lower quality, according to the retailer. The retailer's customers are of course the consumers. The retailer's most important fish species in terms of quantity is non-frozen, farmed Norwegian salmon.

3.2 INTERVIEWS

3.2.1 Type of interview

Six qualitative personal in-depth interviews of representatives of each step in the fish supply chain shown in Figure 3.1 were conducted. The interviews were explorative in nature since the purpose was to collect knowledge about the subject area in order to shed light on possible causal relationships and to obtain a deeper understanding of the behavior and motives of the steps in the chain (Bech, 2009; Andersen, 2006). The interviews were used to provide a background upon which to establish suggestions for changes in the current practices. Interview guides were used to direct the course of the interview and ensure that all the topics were covered.

Questionnaires were not used since these are used for quantitative studies and moreover, they do not encourage the respondent to talk and explain the reasons behind their choices regarding the subject area. When a respondent is permitted to speak freely, they will most often talk about what is important for them and what occupies their thoughts about the subject. A quantitative study may be carried out after a qualitative study in an attempt to generalize some of the findings and prove/disprove hypotheses that the qualitative research has given rise to (Bech, 2009). For a quantitative study, a larger number of respondents are necessary.

3.2.2 Interview guide

An interview guide was prepared for each type of step in the chain (see Appendix 2). The interview guides contained four main sections as shown in Figure 3.2. The interview guide for the fishing vessels also contained a sub-section on process steps and fish quality in order to gather information about the handling of fish during the numerous processes onboard.

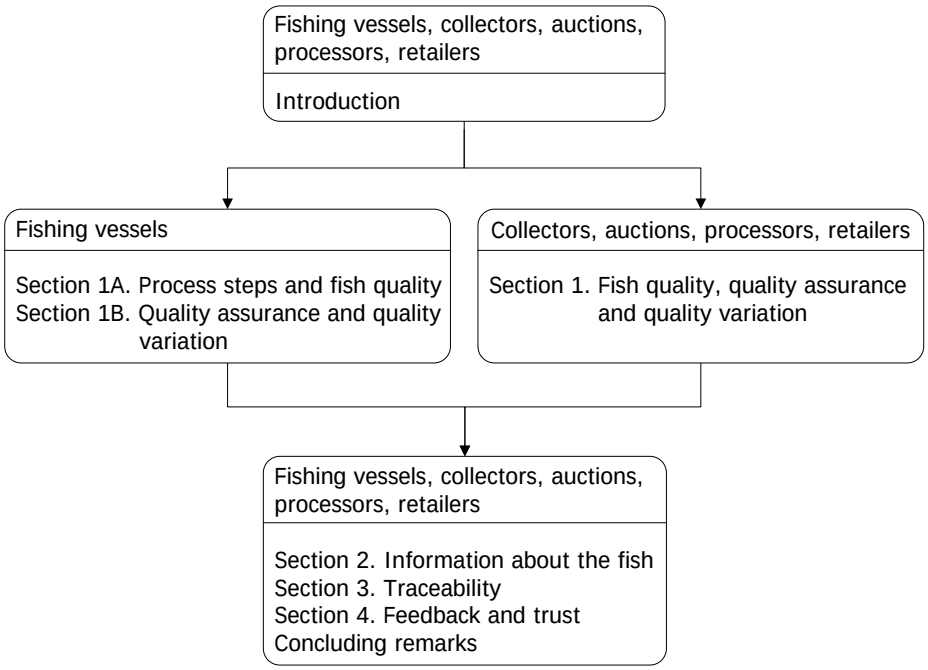

Figure 3.2. The main sections in the interviews. For the fishing vessels, Section 1 is expanded to include questions about the process steps onboard.

3.2.3 Use of visual aids

In all but one of the main sections, visual aids were used. The visual aids consisted of three diagrams, four maps, and up to 32 small index cards (Table 3.4).

Table 3.4. Overview of the index cards used during the interviews.

Section of interview	No. of index cards	Text on index cards	Action required by respondent
1A	11	Process steps on board a fishing vessel	Process steps relevant to the fishing vessel in question were placed in the order in which the process steps take place
2	16-21	Types of information related to fish and fish catch	Types of information were categorized according to importance and whether the companies received/forwarded the information types concerned

The categorization method used in Section 2 of the interview (Figure 3.3) incorporates elements of the laddering interview technique in so far as the respondents were asked to assess which information types are important for him/her and why they are important for him/her (Reynolds & Gutman, 1988).

Aside from adding variation to the interview setup, the use of the index cards in both sections helps to keep the respondent's focus since he/she actively has to take part in ordering or categorizing the index cards. As discussed in Bech (2009), the use of visual aids as stimuli encourages the respondents to talk and discuss from their point of view, thereby minimizing the influence of the interviewer.

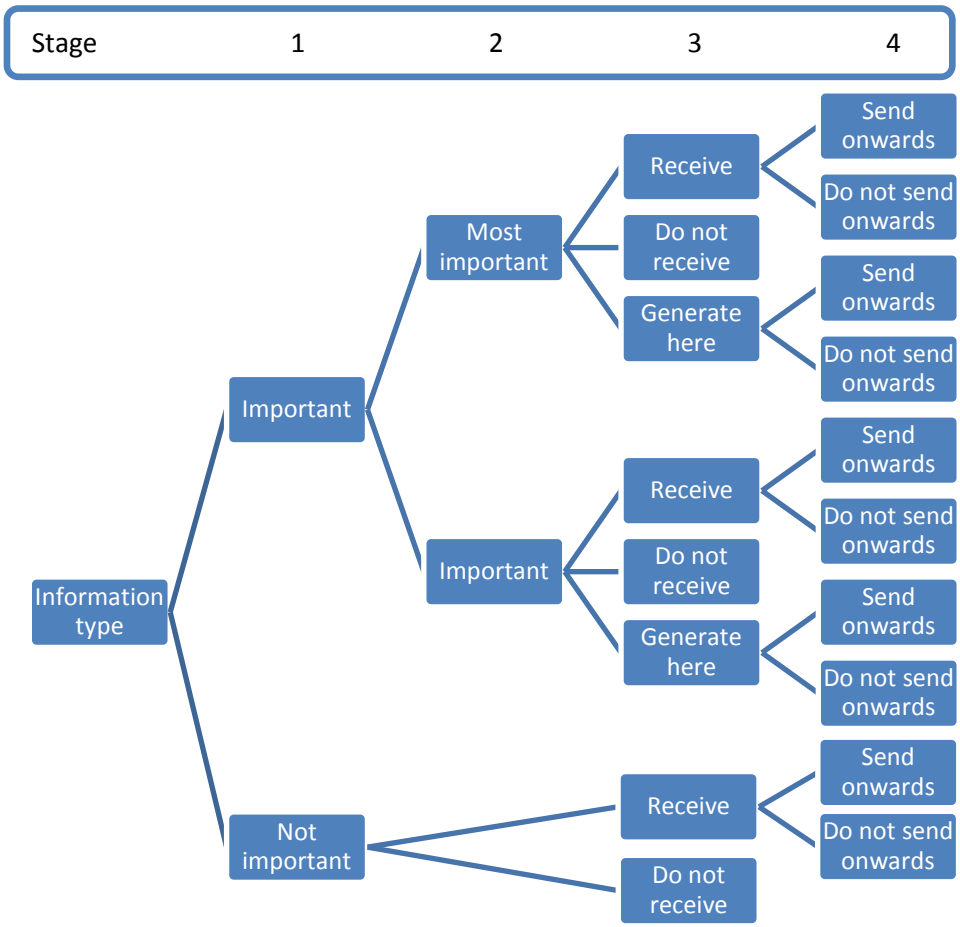

Figure 3.3. The respondents' assessment of the importance of each type of information took place in two stages (1 and 2). Thereafter, the respondents divided each type of information into the subsequent categories (stages 3 and 4). Supplementary questions were asked during the process.

3.2.4 Conducting the interviews

One representative from each of six steps in a fish supply chain was interviewed at a time. Each interview was audio-recorded on two digital voice recorders (one was a backup). The interviews were conducted at the respondents' work places in a quiet setting. Though, the fishing vessel owners were interviewed in the meeting room of the office of the local fishermen's association. Normally, this type of interview ought not to take longer than one hour since the respondent may lose his/her concentration and become tired. However, in this study, all the interviews lasted longer than an hour since it was also important to let the respondent speak freely and expound on the topics in the interview that interested him/her. The interview guide was arranged such that the two long main sections were at the beginning while the last two main sections were short.

3.2.5 Data processing

The interviews were transcribed verbatim as much as possible using transcription playback software (Express Scribe v. 4.31, NCH Software, Canberra, Australia) to

facilitate the playback of the recording while typing. The transcripts of the interviews are to be regarded as the raw data (see Figure 3.4 for an example).

Thereafter, the transcripts were processed in order to organize the information contained therein and to extract important points. Processing of the data from the interviews was conducted in several phases: (1) condensing each transcript into a list of topics, each detailed with bullet points, (2) collecting the statements of each respondent about the same topic in a table, and (3) creating figures, flow diagrams and tables to present the acquired data in a structured manner. Through this process, the information obtained through the interviews became manageable. Examples of these three phases are shown in Figure 3.5 and Table 3.5 below and in Table 4.1 in Section 4.1.1 of Chapter 4, respectively.

Interviewer: What criteria do you use to assess the fish?
Collector: It is simply the appearance of the fish and the gills – if they are fresh.
Interviewer: So the eyes and...?
Collector: It is the eyes, the skin. It is primarily the gills.
Interviewer: Primarily?
Collector: Yes, because you can actually smell how old a fish is. And likewise, the gills. They should be red and you can simply see that the color of the gills fades as the fish becomes older.
Interviewer: So which criterion would you say has the largest significance? Is it the gills?
Collector: It is the gills, yes, it is. And likewise that they are handled properly, gutted well, and things like that. That there are no gut remnants inside.
Interviewer: So you also look for that?
Collector: Yes, we do.
Interviewer: But does that have something to do with the freshness category?
Collector: Yes. If the gills look good, the eyes are clear and the fish is day-caught, primarily, then it's number one.
Interviewer: I meant that whether the fish were gutted properly, the intestines were removed properly… can that affect whether it will be an E or an A fish?
Collector: Not directly. But it depends on whether it is landed the same day as it was caught. Then not so much will happen. But if it is 4 days old, then it is sour, then it will affect the quality.
Interviewer: Ok, so that affects it.
Collector: Yes, it does.

Figure 3.4. An excerpt of the transcript of the interview with the collector (translated from Danish).

Quality criteria

- Eyes: clear
- Skin/appearance
- Gills (largest significance): red (they fade with age)
- Without gut remnants (handled well, cleaned properly). If the fish is landed the same day as it is caught, then it does not matter if there are gut remnants, but it matters if the fish is four days old.
- Gills look good, clear eyes, day-caught fish: no. 1

Figure 3.5. An excerpt of a list of topics (phase 1) from the interview of the collector (translated from Danish)

Table 3.5. An excerpt of a table with the different respondents' answers to the same question (phase 2) (translated from Danish).

Step	**Question: What criteria does the step use to assess the fish?**
Collector	• Eyes: clear • Skin/appearance • The color of the gills is the most important. They must be red. • Without gut remnants (very important if fish is over 4 days old) • The best fish: red gills, clear eyes, caught the same day. Eyes must be clear. Appearance of the skin.
Auction	• Visual assessment o 90% of the cases without touching the fish o Eyes o Shininess – becomes dull, the older it is

Chapter 4 Results and discussion

The information obtained through the interviews will be presented and discussed in this chapter. First, the steps' views on quality and their quality awareness will be disclosed in Section 4.1. Then, Section 4.2 will describe the process steps taking place at the steps in the chain until the first point of sale and what measures may be taken to maintain the quality of the fish at these steps. The information flow in the chains and the importance of information types as well as the traceability systems used to transfer information will be presented in Section 4.3. The state of feedback and relationships of trust will be explored in Section 4.4. Finally, the chapter will be summarized in Section 4.5 with a presentation of suggestions that could improve operations in the steps and in the chain.

4.1 VIEWS ON QUALITY, VARIATION IN QUALITY, AND AWARENESS OF QUALITY

4.1.1 Criteria used to assess the quality of fish

In general, the collector, auction, processor, and retailer use the same criteria to assess the quality of fish. However, they differ in which criteria they regard as most important (Table 4.1). For the collector, the color of the gills is the most important parameter. They must be red. If the fish is over 4 days old, it is very important for the collector that the fish does not have any gut remnants in the abdominal cavity. The auction performs a visual assessment 90% of the times. For the auction, the eyes and the shininess are the most important. The fish become mat the more time passes since the catch. If the auction is in doubt of the quality, they will look at the color of the gills. For machine-gutted fish like saithe and haddock, they will check the abdominal cavity to see if there are any gut remnants. If so, then the freshness category will be A.

Table 4.1. Criteria that the steps use to assess the quality of whole fish. (∗∗ = most important criteria the step uses; ∗ = other criteria the step uses; blank = criteria not mentioned)

	Clearness of the eyes	Color of the gills	Shininess of the skin	Firmness	Gut remnants in the abdominal cavity
Collector	∗	∗∗	∗		∗
Auction	∗∗	∗	∗∗		∗
Processor	∗	∗	∗	∗∗	
Retailer	∗	∗	∗	∗∗	

The processor and the retailer both regard the firmness of the fish as the most important parameter to assess the quality/freshness. For the processor, the fish must be firm when they are going to be transported for two days to Southern Europe. The processor says that he usually determines the firmness of the fish by looking at it. Perhaps he actually uses the other criteria in Table 4.1 to assess the quality of the fish, but with time, he "automatically" correlates the clearness of the eyes, the color of the gills, and the shininess of the skin with the firmness. This would lead to the notion that he can "see" the firmness of the fish. This poses the question whether it is firmness that is most important to the processor or it is the other three criteria mentioned.

The retailer says that the firmness is the easiest way to check whether the fish is fresh. If the fish is firm and stiff, it is fresh. If your finger goes through the flesh or the fish "falls apart," then the fish is not suitable to be eaten. According to the retailer, it can easily be that the eyes are not clear and the gills are brown, but the fillet is still quite firm and fresh and still in rigor. So in his opinion, even if the other criteria are not so good, as long as the fish is still somewhat firm, it is good enough to be sold and eaten.

It is interesting that of the criteria that the auction believes the buyers evaluate when deciding which fish to place a bid on, only two match the criteria that the processor mentions, namely the clearness of the eyes and the color of the gills. Other criteria that the auction believes the buyers use are the quality of the gutting, i.e. if there are any gut remnants left and if the cuts used during bleeding and gutting have been correctly made. The latter has an influence on the potential yield of the fillets. In addition, the auction mentions that if the buyers are in doubt, they will smell the fish. A criterion that is not mentioned by the auction, but which is very important for the processor, is the firmness of the fish. Apparently, the processor emphasizes the importance of firmness much more than the auction is aware of.

According to the auction, before bidding, the buyers check the quality of the fish to see if the quality is good enough for the purpose that the buyer has in mind. The purpose may either be what the buyer himself or the buyer's customers wish to use the fish for. If the fish is marked with freshness category A, the buyers may check the quality of the fish more in depth to decide which part of the A-category the fish belongs (good A or inferior A).

4.1.2 Buyer specifications vs. buyer satisfaction

The processor's quality specifications regarding the fish that he buys are that the fish are very good, there is excess ice in the box of fish, the labeling is correct, and compliance with all legislative requirements. Due to the nature of an auction, these requirements are not directly put forward to the suppliers of the fish that he buys at the auction. In addition to the specifications listed, the processor also requires a lid on the box for the fish that he buys in polystyrene boxes from Norway and the Faroe Islands. In the future, the processor may request that the temperature in the auction hall is low. He would prefer that the temperature of the fish is 0°C, i.e. there is excess ice. If there is no ice in the boxes, then the temperature of the auction hall should be around 2°C, in his opinion.

The processor generally disapproves of the quality of the fish that he can buy from the auction. His main complaints are that there is either not enough ice or no ice in the boxes of fish, that fish of different freshness categories are mixed together, that the fish have lain in the sun, and that the temperature in the collector's reception room and in the auction hall are too high, especially in combination with the shortage/lack of ice in the boxes. The processor says that if there was a sufficient amount of fish available, then he would not care how they handle the fish. Unfortunately, in his opinion, there are no other

fish for him to buy. According to their own check program, the processor should reject fish without ice, but as he says, “We do not have any business if we do not buy the fish without ice.” So their procedure is to chill the fish as soon as they have received it. As he rightly puts it, if the fish was chilled from the start, then the shelf life would be much longer. Aside from having the above complaints remediated, the processor would also like to cool down his own packing room, since it becomes warm during the summer.

The processor has quite a few requirements and corresponding complaints, but the question is whether he has proposed his ideas/criticisms to the relevant steps (collectors, auction, or the fishermen’s association). This may well be the case since at least the collector states that the buyers do not place demands that the collector cannot fulfill. The collector does not place demands on the fishermen about the quality of the fish, either. The reason for this, according to the collector, is that no one is more interested in raising the quality of the fish than the fishermen themselves, since it affects their revenue.

Upon being asked if they have quality specifications from the buyers, the owner of Fishing vessel 1 replies negatively and adds that the buyers can see the fish: If the fish is not first-rate, then they just pay less. If the fish beside his fish is fresher, then the buyer will buy that. With this reaction, it might seem to be a difficult job to change the way Fishing vessel 1 handles the fish. However, based on what Fishing vessel 1 otherwise relates, it may also indicate that Fishing vessel 1 knows that his fish is top of the line and that he is confident that the buyers do not need to either pay less or avoid buying his fish. In addition, it seems like Fishing vessel 1 has already changed the way they handle the fish, or they have at least realized that the length of a fishing trip has an effect on the quality of the fish they land. Fishing vessel 1 says that previously when they had fishing trips of 10-14 days, they got complaints about their fish from the buyers (via the auction), while they do not receive any complaints now. In other words, the buyers must be satisfied with their fish at present.

Fishing vessel 2 mentions that the buyers have requested that some fish be packed with only one layer of fish in the box, leading to a lower sales weight per box. The buyers have requested this because mucus from one fish may be transferred to another fish, which is not desired for shiny fish. The collector and auction have accommodated this request. A request which they have not granted is the division of the size intervals into smaller size intervals, for example grading fish into the intervals 2-3 kg and 3-4 kg instead of 2-4 kg. This request was made because some buyers have a market for fish of 3-4 kg, but not necessarily for fish of 2-3 kg.

Fishing vessel 2 explains that the buyers have sometimes become rather annoyed if some errors have occurred, for example if the fish has been upgraded to a better freshness category, if a certain amount of fish is missing compared to the sales weight, if there are injured fish, or if a small quantity of fish of semi-good quality has been mixed with a greater quantity of fish of excellent quality.

The quality of fish wanted by the retailer is specified at the first meeting with the new supplier. The retailer indicates the desired quality by showing the supplier the fish that is already in the sales counter. The quality of the fish in the counter is the quality level that the retailer requires, but he would of course like to receive a better quality for the same price.

To summarize, the processor is not very satisfied with the fish they can buy at the auction. Fishing vessel 1 has not received any complaints and therefore, their buyers must be satisfied. Fishing vessel 2 mentions some mistakes that have happened which have made the buyers annoyed. If these mistakes occur regularly, it is understandable that the processor is dissatisfied with the quality of fish at the auction. However, it is hard to believe that these mistakes, as well as some of the complaints mentioned by the processor, take place very often. At least the fish delivered by Fishing vessel 1 ought to live up to the expectations and requirements of the processor.

As mentioned earlier, it is not known whether the processor has communicated his requests to the appropriate receivers such that they can improve their handling of the fish and thereby, hopefully attain satisfied buyers. However, the processor's accusations are so serious that the processor ought to convey his negative experiences to the fishermen's organization, to the collectors, and to the auction. Finally, the processor could buy his fish at other auctions if the quality is so poor at the present auction.

4.1.3 Freshness categories and variation therein

The major part (80%) of the fish graded by the collector belongs to freshness category A (Figure 4.1). Within this category, 90% is "good A" and the rest is "inferior A." If some category A fish is exceptionally good or exceptionally inferior, the fish is placed apart from the other fish. The good A and inferior A divisions are not marked, so officially the A category is not divided into more categories. It is up to the buyers to determine the quality of the fish within each of the three freshness categories (E, A, and B). The

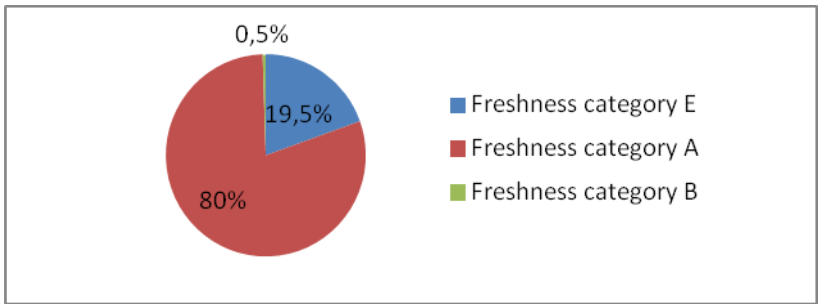

Figure 4.1. The average distribution of freshness categories of the fish graded by the collector in this study. All percentages are approximations.

collector does not believe there is any point in dividing the fish into more quality categories. The buyers have not made any requests about that. The buyers know the quality of fish that the fishing vessels supply and they know which fishing vessels have

landed fish on a specific day. According to the owner of Fishing vessel 2, more categories would not be manageable and would require a larger auction hall.

The auction knows that category A is very broad and that there is a variation in the quality of the category A fish. They believe the buyers must determine by themselves whether the fish is a good category A fish or an inferior category A fish. The auction knows that the variation is important because it affects the use of the fish. However, category A cod is divided further in that some fish are marked "halvblank," meaning half-shiny. The rest of the category A cod is left up to the buyer to assess. The good category A cod can for example be used for fillets while the inferior category A cod can be used for a salted product. The top quality, very shiny cod of freshness category E is exported whole to Southern Europe.

Because the auction does not receive much category B fish, the task is primarily to determine whether the fish belongs to category E or A. According to the auction, it is quick and easy to see whether the fish is so new and fresh that it can be labeled as category E fish. They look at the eyes and the shininess. For example, jigged cod caught by day boats (i.e. boats that are at sea for less than a day) are the most beautiful and the freshest cod possible. According to the owner of Fishing vessel 2, there can be a big difference in the quality of the fish in category E, but all the E fish has to be good enough to be classified as E.

As mentioned, the auction does not receive much category B fish. Most of the category B fish is classified as such because the fish is injured or has a physical deformity, not because they are not fresh. The fish may become injured if they have been squashed in the trawl. This demonstrates that when the fish are divided into the freshness categories, the freshness (i.e. equivalent to the number of days on ice) is confounded with other indications or types of quality. The legislation concerning the EAB classification system (EU Regulation 2406/1996) does not mention how to classify fish with deformities. With regards to injuries, the regulation states that none of the three freshness categories may include fish with blemishes or bad discoloration. Fish in freshness category E must be free of pressure marks and injuries, while slight pressure marks and superficial injuries are tolerated in a very small proportion of the fish in freshness category A, and more serious pressure marks and superficial injuries are tolerated in a small proportion of the fish in freshness category B.

The processor points out that the freshness categories are only used at the auction and are not used further in the supply chain. A problem is that the information that is available about the fish at the auction is not passed on by the buyers. So the freshness category as well as any catch date or packing date (from other buyers/wholesalers) is not sent on. As the processor says, "Everything that is bought at the auction is transformed to super duper quality when it is being sold."

The processor is of the opinion that there is a lot of variation in the quality of the fish within each of the freshness categories. The variation is of great importance because then the fish must be used in another way. The processor is not satisfied with the way that fish of different freshness categories are mixed together. The processor grades the fish according to use when he receives the fish at his production site. The fish is divided into that which will remain as a whole fish, that which will be headed and that which will be filleted.

The processor says that a source of error is the handling of the fish at sea. A fish that has lain in the sun at 22°C for 4 hours is not good even if the fish is caught within the last 24 hours. The processor would like to have a QIM system implemented.

The retailer does not use the freshness categories when he orders fish from the wholesalers. He says that over time, his suppliers ascertain which quality he wants. The retailer experiences once in a while that he receives some fish which is not of the desired quality. He believes that it is the fault of the person who packed the fish for him, since the salesman over time should know that the retailer does not want that kind of quality. If the received products are not of the desired quality, then the retailer will contact the wholesaler and complain. If the product is of an extra good quality, the retailer also sometimes contacts the wholesaler to praise them.

The auction thinks it could be a good idea to assess the fish with the QIM method, but he finds the method too comprehensive and too lengthy. It would also mean that he should have a few more employees. But he finds it a good method and says that people who have not tried it before obtain the same result. If the auction was an internet auction, then he would consider hiring people to assess the fish using the QIM method because in such a case, it is not possible for the buyers to judge the quality of the fish themselves.

The retailer is of the opinion that a system in which points are given for each characteristic takes too long time. Thus, the auction and processor both think highly of the QIM method, though the auction and the retailer agree that it is too time-consuming. However, it would be advantageous for the processor and the retailer if their respective suppliers stated the quality indices (QI) of the fish batches. The processor and retailer could then use the QIs (together with the date on which the QIM-assessment is performed) as a basis on which to make a purchasing decision.

The auction mentions that he would appreciate a logo which stands for both sustainability and freshness because a sustainable fish “may be completely rotten” and he would like the freshness of the fish to be emphasized, too. Along the same lines, the collector remarks that sustainability information has nothing to do with the quality/freshness of the fish, and that some people are fooled by that. That is, they think that as long as the fish is marked as sustainable, then it must be fresh and of high quality, too. The auction’s suggestion would be difficult to implement because a sustainable fish becomes less fresh as time goes, just like any other fish. Moreover, it would be preferable that the buyers

learned to distinguish between sustainability and freshness. Perhaps the auction should focus on promoting and explaining freshness and the freshness categories instead.

4.1.4 Views on the quality of kystfisk and seapacked fish

Fishing Vessel 1 is of the opinion that kystfisk is not better than other fish. He concedes that kystfisk is caught and landed on the same day. Yet Fishing vessel 1 also believes that the fish is stored in the sun without ice the whole day, since the day boats do not have a roof over their storage area and do not have space to bring ice onboard. To make up for this, the fish might be covered with sacks, in his opinion.

Fishing vessel 2 does not know if the price per kg fish is higher for kystfisk-fish than for other comparable fish of freshness category E. Fishing vessel 2 remarks that another collector than the one in this study labels fish that are two days old as well as fish from bigger trawlers as kystfisk, although such fish are not kystfisk in the opinion of Fishing vessel 2.

The collector's comment on kystfisk is that the exporters know that kystfisk-fish can "survive" the trip to France because they are not burdened by several days' storage. In other words, because the fish is not older than 24 hours, it is fresh enough and of a high enough quality to be exported to France and still be of an excellent quality upon arrival.

The auction is not satisfied about the fact that the rules concerning kystfisk are unwritten. The rules have not been put in writing because there is a disagreement about the precise criteria for kystfisk. The auction is satisfied with which fish the collectors include in the kystfisk category, but the auction would like to post the requirements for kystfisk on the auction's website along with a list of the vessels that may land kystfisk. The auction indicates on the invoice to the buyers which of the fish they have bought is kystfisk.

Based on the information from the collector, supplemented with the auction's comment that kystfisk is of superb quality, the opinion of Fishing vessel 1 regarding the storage conditions for kystfisk must be based on either misinformation or antiquated knowledge. Fishing vessel 1 ought to go on a fishing trip on a vessel that lands kystfisk. Aside from the difference in opinion between Fishing vessel 1 on one hand and Fishing vessel 2, the collector, and the auction on the other hand, none of the steps mentioned any variation in the quality within kystfisk.

The processor believes that fish that has been seapacked is better than non-seapacked fish from the same catch date (i.e. non-seapacked fish has been graded and re-packed by the collector). Seapacked fish is just as old as other fish, but it has been handled better. Though, the processor experiences that he may be misled by the appearance of seapacked fish because they may look shiny, but they may not be as firm to the touch as he would expect based on the shininess.

4.1.5 Development of quality awareness over time

Fishing vessel 1 has become more aware of maintaining the quality of the fish from hauling in till landing. Thus, their fishing trips nowadays are 3-6 days long in contrast to up to two weeks in the past. Additionally, they do not tow the trawl for a long time any longer, but instead they tow the trawl more often (5-6 tows/24 hours now in contrast to 2-3 tows/24 hours previously).

Fishing vessel 2, the collector and the auction agree that, in general, the quality of the fish landed has improved and the fishermen are more aware of keeping the cold chain unbroken. The initiatives taken by the fishermen include: shorter trips, more thorough gutting, and quicker chilling of the fish. The collector says that nine out of ten fishermen are fantastic at handling the fish properly and they are observant of maintaining the quality of the fish. They only deliver poor quality fish if an unfortunate event has occurred (e.g. the vessel engine breaks down while there are fish to be gutted). The fishermen know that if they want a high price for their fish, then they have to deliver high quality fish.

In addition, according to the collector, many fishermen are starting to seapack because the less a fish must be thrown around and repackaged, the fewer bruises it will receive. When fish is seapacked, the fish is moved under a roof, gutted, and iced immediately. In the collector's opinion, the more options you have on board, the better your fish will always be. A new vessel has significantly more space and processing capabilities than a 30-year-old vessel.

The auctioneer agrees that the new vessels emphasize maintaining a high quality throughout the fishing trips. They have ice-manufacturing machines onboard so they can pack the fish in ice. Some also have slush-ice manufacturing machines onboard so they can put the fish directly in slush-ice after emptying the trawl. This way the fish is cooled down immediately and the fish are kept cool while other fish are being gutted. Quick chilling is of great significance for the quality of the fish.

The auctioneer says that there has been a great development during the last 25 years. The vast majority of fishermen today think about what they can do to maintain the quality of the fish as much as possible. Because they pay for their own fish quotas, they must make sure that their fishing business is profitable. This can be done by landing the best quality fish all the time. The fishermen are forced to think differently now, and they also need to make budgets together with their financial advisors. Smaller fish quotas mean that the fishing vessels must focus on supplying fish of a higher quality. The auction generally does not receive any fish of freshness category B. No one today will use their quota to land category B fish, when they can land category E fish with some effort. In earlier times, the fishermen could be on fishing trips of 2-3 weeks in the North Sea. The fish were stowed close together and most of it was of category B quality. Now, most fishing trips are maximum 1 week long and there is not much category B fish. The auctioneer is of the opinion that the fishermen increasingly consider how they can maintain the quality

of the fish so well that the fish can be classified as category E upon landing even if the fishing trip lasted for several days.

Despite this, there are a few vessels that fail to treat the fish properly according to the auction. They may be found within all types of vessels. The longer the fishing trip, the larger is the significance of inferior catch handling. Often many days pass before one can see the effects of the inferior catch handling on the fish, so this is not of such a big significance for the jig fishermen and the gill net fishermen. (However, the auction recommends that the gill net fishermen do not have so many gill nets in the water that they cannot overcome removing the fish from the nets, gutting, and chilling the fish.) In contrast, trawlers that are away for a long time must handle the fish properly from the moment they catch the fish.

The retailer seems to be satisfied with his own level of quality awareness and the routines that he applies to maintain the quality of the fish. The retailer maintains the quality of the fish by keeping the temperature low (i.e. keeping the fish on ice), by placing greaseproof paper in between the fish and ice for the sake of preserving the color of the fish, and by ensuring a certain turnover of the fish, such that it will not dry out. Ice is also placed on top of whole fish, but in limited quantities, so the fish will not dry out. The retailer puts ice on top of the fish every 2-3 hours in order to keep the fish cold, both in the core and on the surface.

When it comes to other retailers, the retailer does not approve of fishmongers who rinse fillets and whole fish and that they rinse them with fresh water. He is equally appalled that they also teach this practice to their apprentices. The retailer presumes that they rinse the fish to prolong the shelf life, but he says that this practice actually shortens the shelf life. He thinks it is embarrassing that some retailers wash fish that have developed an odor to prolong the shelf life an extra day. The fish have a layer of mucus on the skin which may have very little ammonia odor in the beginning. The mucus can be rinsed off with running water. According to the retailer, some retailers wash all their fish each day and then place them in the sales counter in the morning. In addition, the retailer does not approve of spraying fillets with a water spray to prevent the fillets from drying out and to make the fillets look completely fresh. He says that what will happen is that the water will evaporate, leaving white calcium residues visible on the fish.

It is encouraging that the collector and auction have observed a generally positive development in the quality awareness of the fishermen and that the consequences of this are perceptible. In contrast, it is lamentable that the retailer has noted that some other retailers engage in inappropriate practices to attempt to improve on reality.

4.1.6 Acquisition and continuance of quality awareness

Fishing vessel 1, the collector, the auction, the processor, and the retailer have statutory own check programs. The procedures outlined in these programs as well as peer-to-peer training assist in shaping the workers' quality awareness.

The own check programs of the collector and auction are based on the guidelines on good hygiene practice laid down by the Association of Fish Auctioneers (Foreningen af Fiskeauktionsmestre i Danmark, 2005). From the steps' comments and examples of the content of the own check programs (Table 4.2), it is seen that the own check programs for example cover temperature checks of both the fish and the storage area and whether cleaning has taken place.

Table 4.2. The steps' descriptions of their own check programs. Fishing vessel 2 does not have an own check program because he is not required to have one. No information is available for the collector.

Step	**Examples of the content of their own check programs**
Fishing vessel 1	This program is about the temperature in the hold, cleaning of the hold, etc. They record the temperature in the hold once every day or every other day. The temperature in the hold is also displayed in the wheelhouse.
Auction	There is only one table (about cleaning) that has to be filled out every day. There are other tables that must be filled out if there is a problem. The auction fills out the required tables. None of the procedures are about quality assessment of the fish. According to the auction, the guideline on good hygiene practice laid down by the Association of Fish Auctioneers (Foreningen af Fiskeauktionsmestre i Danmark, 2005) indicates which circumstances to be aware of, but not what to do if these circumstances occur.
Processor	There are procedures for "everything from reception to departure." There are triviality limits, e.g. they write in the own check program if they throw out half a box of rotten lemon soles, but not if they throw out two lemon soles.
Retailer	Among other things, the retailer takes a random spot check each month, wherein they check a whole delivery from one of their suppliers. They check the temperature of the received fish, which should be less than 2°C. They check that the fish are packed correctly, e.g. that the fish is not placed directly on ice, but that there is something in between the fish and the ice.

The steps' comments on their peer-to-peer training in connection with quality awareness are shown in Table 4.3. The owner of Fishing vessel 1 adds that if the workers perceive that a new procedure will make a difference regarding the quality of the fish, then they are not so conservative about trying out or implementing the new procedure. In other words, if a change in procedures will result in a higher price for the fish or a decrease in the cost of production, then they have no problem in changing their usual procedures.

The auction and the processor were asked whether they thought it was a good idea to have access to temperature records of the fish on its way from catch to the auction and processor, respectively. The auction did not entirely dismiss the thought of printing out a record of the temperature in the hold of the vessels to show that the temperature always was 2-4°C. The auctioneer said this could be ideal, but that there is a long way to go. He added that pelagic fishing vessels already record the temperatures at various points on their vessels.

Table 4.3. Comments from the steps on peer-to-peer training. Fishing vessel 2 is manned by only one person. No information is available for the retailer.

Step	Comments on peer-to-peer training
Fishing vessel 1	Fishing vessel 1 uses peer-to-peer training when new workers are onboard the vessel.
Collector	The approach to quality assurance is by peer-to-peer training. Many of the workers who grade the fish have been fishermen themselves. The workers are self-governing and will correct each other if one of them grades the fish incorrectly. Now and then the employees together review the criteria for how they should assess the quality of the fish.
Auction	The auction does not require any training or skills since they train the quality assessors internally.
Processor	Quality awareness is acquired through apprenticeship or peer-to-peer training. The peers tell each other how things should be. There are notes which show how the fish should be upon arrival, in case the workers are in doubt. For example, if there is no ice or no label in the box then the fish must be rejected. The workers always have to bear in mind whether the fish is of such a quality that they can deliver the fish to the customers.

The processor would not trust only the freshness category and a printout of the temperature over time. He says he would probably always use his senses to assess the fish. As he says, “Whatever system you have, then it is not good enough to just close your eyes.” However, he knows that the smaller trucks that transport his products to the customers have thermologgers. He has never asked for a printout of the temperatures, but considers this is to be a good idea.

None of the steps are certified against any quality assurance standard. The auction has not had any requests or any buyer’s requirement to be certified against ISO 9000, and they have not considered it, either.

The own check programs as well as peer-to-peer training appear to be factors that help to build quality awareness while the continuing presence of quality awareness seems to be supported by the own check programs, self-government by the workers, and regular reviews of and harmonization of the criteria for determining the quality of the fish.

4.1.7 Summary and suggestions for changes

There is some variation in the ranking of importance of criteria to assess the quality of fish. The collector thinks the color of the gills is most important, the auction places emphasis on the clearness of the eyes and the shininess of the skin, while the processor and retailer regard the firmness as most significant.

The processor has a number of requirements regarding the quality and handling of the fish that he buys at the auction, but it appears that these requirements are seldom fulfilled. Among other things, the processor is dissatisfied about the variation of the quality of fish within freshness category A. The collector and auction are aware that freshness category

A covers a broad range of degrees of freshness, but point out that the buyers are responsible for assessing the freshness of the fish and for determining the use of the fish. However, the processor has also experienced that fish of different freshness categories has been mixed in the same batch.

Over the years, all the steps seem to have become more aware of maintaining the quality of the fish.

Based on the steps' opinions on the quality of the fish, as presented and discussed in Sections 4.1.1- 4.1.6, the wishes of the steps within this topic may be outlined as shown in Table 4.4.

Table 4.4. Wishes from the steps with regard to quality and handling of the fish.

Wish	**Proposed by**
Smaller size intervals at the auction	Buyers in general
A logo which stands for both sustainability and freshness	Auction
Excess ice in all boxes	Processor
Sufficient labeling	Processor
Compliance to legislative requirements	Processor
Temperature in auction hall should be low: fish 0°C, room 2°C	Processor
No mixing of fish of different freshness categories	Processor
Cool down his own packing room	Processor
Improvement of catch handling (at sea)	Processor
QIM at the auction	Processor

Aside from the wishes expressed by the steps, there are other suggestions within the quality viewpoint that might improve the operations of the chains and that might reduce the variation of the quality within the freshness categories (Table 4.5).

Table 4.5. Suggestions, with regard to quality and handling of the fish, which may be advantageous to implement.

Suggestion	**Involved steps**
Divide freshness category A into more categories	Collector, auction
More careful quality assessment by the collectors	Collector
Better labeling of fish at the collector	Collector
Written rules for kystfisk which all parties can agree on	Fishing vessels, collectors, auction
Seapacking by more vessels	Non-seapacking fishing vessels in general
Shorter fishing trips	Fishing vessels in general
Access to temperature records from catch to processor	Fishing vessels, collectors, auction, processor
Better reviews of criteria for quality assessment among the packers at the processor	Processor

The collector and the auction know that the quality of the fish that is classified in freshness category A is very broad and encompasses various degrees of freshness. They are also aware that the quality determines the use of the fish for the buyers. When buying fish at the auction, the processor is discontented with the large variation in quality within the freshness categories. Although the EU legislation that regulates the division of the fish

into freshness categories only states three freshness categories, it would be a good idea to divide the fish into more freshness categories. Other auctions currently practice this. Since freshness category A seems to cover a wide range of qualities, the collector and auction could start by dividing that category into two, and later three, subcategories. Fishing vessel 2 mentions that there also is a big difference in the category E fish, so the next step could be to divide this category into, for example, two subcategories.

Alternatively, the collector and auction could keep the three freshness categories they have now and additionally, convey the catch date of the fish. Provided that the buyers are confident that the fish has been stored on ice since catch, the catch date can be used as an indication of the freshness.

"More careful quality assessment by the collectors" is listed as a suggestion in part due to the mistakes that Fishing vessel 2 mentions that occasionally occur at the collector and in part due to the dissatisfaction of the processor when he finds that fish of one freshness category is mixed into a batch of fish of another freshness category. These findings indicate that the collector perhaps ought to be more attentive and scrupulous when they grade the fish and likewise, when they label the fish.

Since the collectors that decide which fish may be classified as kystfisk apparently use differing criteria for this, it would be a good idea for them to harmonize their criteria and put them in writing such that the buyers are not in doubt of what the kystfisk brand stands for. With clearcut requirements, it would be easier to market the brand to the steps further in the chain. This might make it possible to demand a higher price for kystfisk fish if the steps' customers are able to differentiate the characteristics of kystfisk from other fish. Kystfisk is also used to denote fish that is caught close to the coast, but which do not necessarily live up to the requirements of the kystfisk brand from this auction. Therefore, if the brand is to be used after the auction, its characteristics must be clearly defined and publicized, for example on the auction's homepage.

To avoid extra handling of the fish, vessels that currently deliver their fish to the collector could begin to seapack. To be considered seapacked, the fish must be packed according to species, size grade, and the applicable sales weight. However, this requires that the vessels have space for a scale and the extra boxes that probably will be necessary. Perhaps only the big vessels will have space for the extra boxes. Thus, perhaps seapacking is a possibility for the big vessels that currently have their fish graded by at the collector, but not for the small vessels such as those under 10 m.

The shorter a fishing trip is, the fresher the fish is when it is for sale at the auction if the fish has been stored on ice. Additionally, the fish may be able to achieve a high price. The experiences of Fishing vessel 1 also show that shorter fishing trips reduce complaints about the quality of the fish. Thus, it is beneficial to shorten the length of the fishing trips, although this must be compared to the time it takes to sail to the fishing grounds and the price of the fuel needed. This issue has been explored by Nielsen (2010), whose results

from a simulation indicated that decreasing the length of a fishing trip from 10 to 5 days could increase the profits.

Having access to trustworthy records of the temperature of the fish since the catch, one may be reassured that the cold chain has not been broken. If the catch date is known as well, one could be able to calculate the remaining shelf-life by using the Seafood Spoilage and Safety Predictor (SSSP) software (Technical University of Denmark, 2009). Even without this program, one is able to better assess the freshness of the fish.

In order to lessen the risk that the processor's packers send fish of a worse quality than ordered to a customer, the processor is recommended to regularly review the criteria for assessing the quality of the different species of fish with his packers. The packers have occasionally had problems in distinguishing the different qualities of the fish. The retailer has also experienced such problems with the fish he has received from this processor. Such reviews, for example conducted by external consultants, will serve to heighten the packers' awareness of quality.

4.2 MAINTAINING THE QUALITY OF FISH ON THE VESSEL, AT THE COLLECTOR, AND AT THE AUCTION

In this section, the process steps involving fish will be described for each of the two fishing vessels as well as the collector and the auction. At these steps, the fish is still a raw material and has not been sold at the auction. Identified measures that are taken during these process steps to maintain the freshness and quality of the fish will be presented. Thereafter, recommendations on other measures that can be taken to assure the quality of the fish will be listed. This includes measures which the step most probably already takes, but which they did not mention during the interview. In the second part of Section 4.2, the measures taken and the recommended measures are collected to form quality assurance procedures for Fishing vessels 1 and 2, the collector and the auction.

4.2.1 Process steps and recommendations to maintain quality

4.2.1.1 Fishing vessel 1

The process steps during catch handling onboard Fishing vessel 1 are shown in Figure 4.2. It takes about 2 hours to process a catch equivalent to 100 boxes from the catch is hauled in until the whole catch is gutted, rinsed, graded, and packed. The time it takes from the first fish is gutted until the first box of fish is packed in ice is about 5 min.

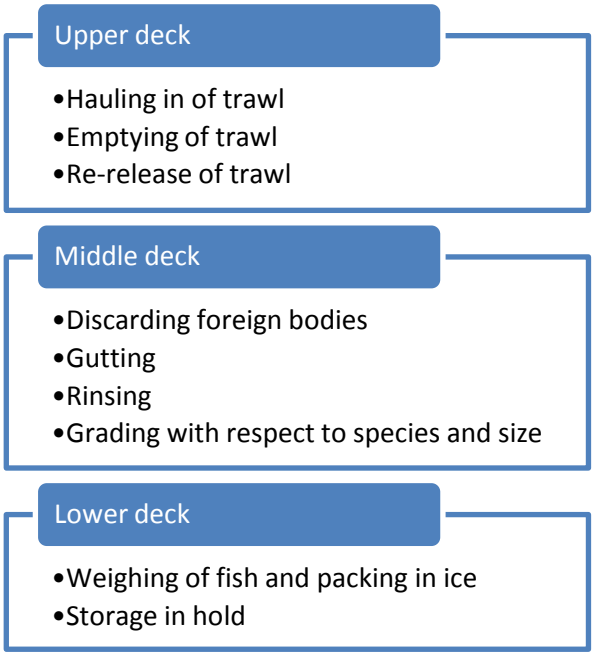

Figure 4.2. Catch handling process steps onboard Fishing vessel 1.

Upper deck

Hauling in of trawl

On the trawl, there is a sensor which measures how full the trawl is. This information is shown in the wheelhouse. The trawl is hauled in when it is full, but 7 hours is the maximum length of a trawl tow. In terms of fish boxes, the quantity of the catch varies from 2-200 boxes. More than 200 boxes is not preferable for this vessel because then they

will not have time to gut, rinse and pack the fish before (1) the quality deteriorates (the fish becomes soft) or (2) the next tow is ready to be hauled in.

Emptying of trawl

As soon as the trawl is hauled in, the fish are removed from the trawl. From the upper deck, the fish are deposited into a receiving tank on the middle deck. The receiving tank contains seawater, which is continuously replaced.

Re-release of trawl

The trawl is immediately released into the sea again. If a problem arises so the re-release of the trawl is delayed, one person attends to the problem and the rest begin to gut and rinse the current catch. An example of a problem is if the trawl mesh is broken and needs to be repaired.

Process steps on the upper deck

Measures taken to maintain quality:

- The fish are placed under a roof as quickly as possible.
- The fish are deposited in a receiving tank with cold seawater.
- The seawater is renewed continuously to maintain the temperature.
- If there is a problem related to the re-release of the trawl, one person will attend to the problem while the rest of the staff will begin to gut the newly-caught fish.

Recommended measures to take to maintain quality:

- Ensure that the time the fish are in the fishing gear is limited in order to avoid stressed fish. Optimally, the towing time should not be more than 4 hours.
- Ensure that the catch size corresponds to the fishing vessel's catch handling capacity.
- Ensure that the fish are not squashed in the trawl cod end for example by fishing more frequently, but for a shorter time, with small cod ends.
- Ensure that the fish are removed gently from the trawl.
- Ensure that the fish are not thrown or stepped on.
- It is optimal to use slush-ice in the receiving tank to chill the fish quickly.
- Optimally, the fish should be chilled to just below 0°C as soon as possible after catch.
- Ensure that the fish are protected from contamination, strong winds, and strong heat and cold.
- If the upper deck has been warmed up by the sun and the catch is placed here, ensure that the deck is washed down with cold water or that there is ice on the deck before removing the fish from the trawl.

Fishing vessel 1 is aware of the advantage of using slush-ice to chill the fish, but they have chosen not to implement this because of the costs.

Middle deck

Discarding foreign bodies

A conveyor belt in the receiving tank transports the fish and any foreign bodies out of the tank. The fish are removed from the conveyor belt to be gutted while the foreign bodies remain on the conveyor belt and are collected to be thrown out. Examples of foreign bodies are starfish and stones.

Gutting

The fish are either gutted manually or by a machine. The gutting machine can gut approx. 1200 kg saithe or cod per hour (30 boxes of 40 kg each per hour). Haddock is also gutted by machine while plaice and monkfish are gutted by hand.

Rinsing

The gutted fish are placed in an aerated rinsing tub. Air is blown into the water and the water is circulated. The tub contains about 2000 l seawater, which is continuously renewed. Seawater is constantly pumped into the tub and when the tub is full, the water runs off the sides of the tub. A conveyor belt at the bottom of the tub transports the fish up and out of the tub.

Process steps on the middle deck

Measures taken to maintain quality:

- The seawater in the rinsing tub is continuously replaced, so it is always clean and cold. The water is aerated, which promotes rinsing.
- The workers check that all the blood and intestines are removed and that the fish is rinsed adequately.

Recommended measures to take to maintain quality:

- Ensure that injured and dead fish are discarded.
- Optimally, the fish should be gill cut and bled. Ensure that bleeding takes place while the fish is still alive.
- Ensure that the fish is chilled until it is gutted.
- Ensure that the correct belly cut is made and that neither the fillet nor the entrails are cut into.
- Ensure that other fish are not contaminated with the removed entrails.
- Ensure that the tub is not overfilled so the fish rub against each other.
- Ensure that sand is removed from the gills.

Grading with respect to species and size

Workers remove the fish from the conveyor belt and place them in compartments corresponding to their species and size. The workers check that the fish is properly rinsed and that all the blood and intestines are removed. If the workers are in doubt about the size interval that the fish belongs to, they have a board with a ruler, so they can quickly check the length of the fish.

There are approx. 10-12 compartments, which each have a species/size assigned. The species/size assigned to each compartment may be different for each catch, since this

depends on the content of the particular catch. Species that they only have a small quantity of, like hake, are placed on a table, so they can be taken down to the packing table later.

Lower deck

Weighing of fish and packing in ice

The compartments lead down to the hold. At the bottom of the compartments, there is a hatch. Upon opening the hatch, the fish flows out onto a table, from which 1-2 workers pack the fish with ice in fish boxes. There is a scale beside the packing table so the workers can weigh the fish in the boxes. After packing, the fish box is rolled on a conveyor belt through the hold and is stacked.

Two to three shovelfuls of ice are placed at the bottom of the boxes and the fish are then placed on top of the ice. Ice is not put directly on top of the fish. Instead, a box with ice but no fish is placed on top of every stack of boxes in the hold. When the ice in the top box melts, the meltwater will drip down on the fish underneath, thereby chilling the fish.

Storage in hold

The hold is refrigerated and has a temperature of around 3°C. This means that the ice will melt slowly such that the meltwater will maintain the temperature of the fish at around 0°C. The ice in the fish boxes is not replaced, since there is still adequate ice in the boxes when they land the fish after 4-6 days.

Process steps on the lower deck

Measures taken to maintain quality:

- The fish is packed in ice.
- Ice is not placed on top of the fish, but underneath the fish.
- Empty boxes with ice are placed on top of the stacks.
- The temperature of the hold is measured and is displayed in the wheelhouse.
- There is an alarm if the meltwater level in the hold is above a pre-defined level.

Recommended measures to take to maintain quality:

- Ensure that the fish is chilled with ice quickly after gutting and rinsing.
- Ensure that each day's catch is labeled with the catch date.
- Ensure that the fish is packed nicely and that they are not bent.
- Ensure that the boxes are not overfilled.
- Ensure that shiny cod are arranged belly-side down. Ensure that flatfish are placed with the white side upwards.
- Ensure that sufficient ice is placed at the bottom in boxes with cod and at the bottom, in the middle and on top of the fish in boxes with flatfish.
- It is optimal to have an alarm if there is a rise in the temperature in the hold.

In the wheelhouse, the temperature in the hold is displayed, but there is no alarm. The workers must keep an eye on whether the temperature rises. There is an alarm that responds when the meltwater level on the floor is too high, so that the workers must drain the water.

At the quay

Unloading

The boxes are lifted out of the hold 12 at a time, placed on a pallet, and transported by a forklift directly into the cold auction hall. This operation takes around 2 minutes.

Fishing vessel 1 always tries to land the fish before or around midnight. Since they fish during the day, they can sail out again and reach the fishing grounds by daytime. Moreover, they always land the fish from Sunday to Thursday, so the fish can be auctioned off the next morning (the auction is only open from Monday to Friday). This way, the fish will never have to be stored in the auction hall for 1-2 days before they can be sold. According to the fisherman, it is better for the fish to be stored in the hold of the vessel than in the auction hall. It is not good for the fish to be exposed to the outdoor temperature between the hold and the auction hall.

Process steps at the quay

Measures taken to maintain quality:

- They land the fish from Sunday to Thursday so that the fish will be in the auction hall for the shortest possible time.
- They land the fish in the evening. Although the reason is that this fits best with their fishing schedule, this also ensures that there is no sun and that the outdoor temperature is low.

Recommended measures to take to maintain quality:

- Ensure that the fish does not get contaminated during landing and transport.

4.2.1.2 Fishing vessel 2

The process steps during catch handling onboard Fishing vessel 2 are shown in Figure 4.3. All the catch handling steps take place on the only deck on the vessel, part of which is covered by a roof.

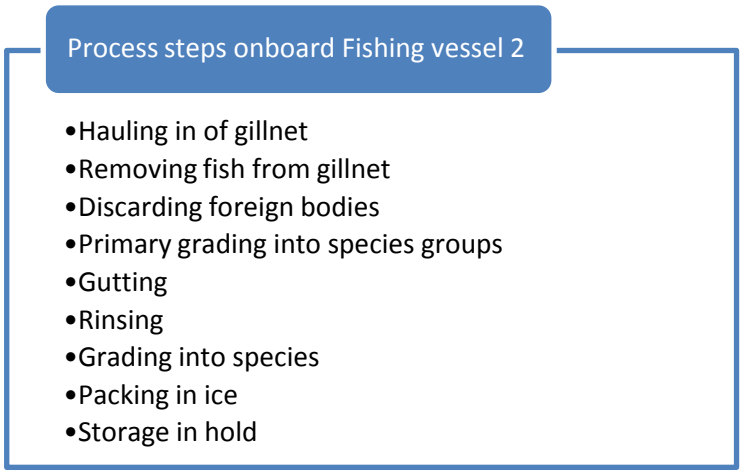

Figure 4.3. Catch handling process steps onboard Fishing vessel 2.

Hauling in and removing fish from gillnet

While the net is hauled in, the fisherman removes the fish from the net. This is done in a way that does not damage the fish. For example, the fisherman would rather rip some of the mesh of the net to remove the fish instead of pulling the fish too much and risking an injury on the fish.

If some of the mesh of the nets has been damaged, the fisherman will continue removing the fish and will complete the catch handling operations. He will not repair the net on the vessel. After one year's use, the fisherman replaces the nets with new nets.

Process steps: Hauling in and removing fish from gillnet

Measures taken to maintain quality:

- The fisherman avoids injuring the fish when removing them from the net. If necessary, he will break the mesh.
- If the fisherman discovers that the net is damaged, he will continue the catch handling operations instead of repairing the net.
- The fisherman replaces the nets every year.

Recommended measures to take to maintain quality:

- Ensure that the time the fish is in the fishing gear is limited in order to avoid stressed fish.
- Ensure that the catch size corresponds to the fishing vessel's catch handling capacity.
- Ensure that the fish are not thrown or stepped on.
- Ensure that the fish is placed in baskets, boxes or small tubs so they cannot slide back and forth.
- Ensure that the fish is protected from contamination, strong winds, and strong heat and cold.

Discarding foreign bodies

When the fisherman pulls up the net, he removes any foreign bodies that may be in the net. Foreign bodies may include pieces of wood or plastic bags.

Primary grading into species groups

Primary grading in species groups is done while the fisherman removes the fish from the net. Cod and other roundfish are placed in one box while plaice and other flatfish are placed in another box. When putting the fish in these boxes, the fisherman takes care to avoid bruising the fish.

During the summer there may be ice in these boxes. Usually this process of hauling the net in and removing the fish does not take more than 30 minutes.

Process steps: Discarding foreign bodies and primary grading (including chilling)

Measures taken to maintain quality:

- The fisherman avoids handling the fish roughly when placing fish in boxes during primary grading.
- Ice is used in the boxes during the summer.

Recommended measures to take to maintain quality:

- Ensure that injured and dead fish are discarded.
- Optimally, the fish should be chilled to just below 0°C as soon as possible after catch, especially during the summer and during particularly large catches.

Gutting

The roundfish, especially cod, are gutted, rinsed, and packed first because the roundfish are so delicate compared to flatfish. After hauling in and removing fish from one row, the fisherman will gut the roundfish. Meanwhile, the flatfish remain in a box underneath a table for 2-3 hours. After hauling in and removing fish from 4 rows of nets, the fisherman will gut the flatfish. I.e. the flatfish are gutted max. 3 hours after being removed from the net.

The fisherman guts the fish manually and then places the gutted fish in a tub of water. The fisherman is careful about cutting the fish correctly, not cutting into the meat, and removing all the guts. He is aware that the buyers inspect these aspects because a wrong cut could lead to a reduction in yield.

Process step: Gutting
Measures taken to maintain quality:

- The roundfish are gutted before the flatfish because the roundfish are more delicate.
- The fish are cut correctly to minimize waste and contamination.
- The fisherman takes care to remove all the guts.

Recommended measures to take to maintain quality:

- Optimally, the fish should be gill cut and bled. Ensure that bleeding takes place while the fish is still alive.
- Ensure that the fish is chilled until it is gutted.
- Ensure that other fish are not contaminated with the removed entrails.

Rinsing

The fish is rinsed and bled by lying in the water. The fish remains in the tub until the fisherman has hauled in the next row of nets and removed the fish from the nets. The fish lie in the tub of water for 30-35 min. Then he will remove the fish from the tub and pack them in boxes with ice.

There can be around 500 liters of water in the tub, and the water is changed for every row of fish. Water is pumped into the tub via a spray hose and emptied from the tub via a hatch.

Process step: Rinsing
Measures taken to maintain quality:

- The rinsing water is changed for every row of gillnet that the fisherman removes fish from.

Recommended measures to take to maintain quality:

- Introduce some movement in the rinsing water to promote rinsing.
- Ensure that the fish is rinsed gently but thoroughly.
- Ensure that the tub is not overfilled so the fish rub against each other.
- Ensure that blood and gut remnants are rinsed away and that sand is removed from the gills.

Grading into species

The fisherman divides the fish according to species, but does not grade the fish into size intervals. This means that different sizes of the same species may be packed in the same box.

Since the catch usually consists of a large quantity of cod and plaice, respectively, these species are packed in boxes without other species. Other species of roundfish and other species of flatfish, respectively, are packed together. The fisherman does not have enough space on his vessel to pack these species in separate boxes.

Packing in ice

The fisherman packs the fish in ice in plastic boxes. During the summer, the boxes are filled halfway up with ice (1½ shovelfuls), while during the winter, only one-fourth of the box is filled with ice (¾ shovelful). The fisherman uses ice the whole year round even if the surrounding temperature is below 0°C because otherwise, he cannot arrange the cod correctly on its belly in the box. A layer of ice is needed on the bottom for this purpose.

Placing the cod on its belly will retain the natural shininess and glow of the skin of fresh cod. The shininess fades away if the skin of the cod is placed on the ice. For this reason, there is only one layer of cod in each box. According to the fisherman, the shininess of cod that has been placed skin-side on ice beforehand cannot be regained later even if the collector arranges the cod on its belly. The shininess will have diminished significantly and cannot be "recovered." According to the fisherman, the buyers at the auction spot the cod which shine and look inviting. The cod look good because they have been treated properly.

In general, the fisherman does not put ice on the sides or on top of the fish. The meltwater from the ice in the box above drips down on top of the fish below, thereby chilling the fish. During the summer, the fisherman puts ice on top of the flatfish, but never on the cod. Instead, he puts a box with ice but no fish on top of the uppermost box of cod, so the meltwater of the ice can chill the cod.

Process steps: Grading and packing

Measures taken to maintain quality:

- The fish is packed in ice.
- Cod is arranged on its belly.
- There is only one layer of cod per box.
- During the summer ice is placed on top of flatfish and a box of ice is placed on top of the uppermost box of cod.

Recommended measures to take to maintain quality:

- Ensure that the fish is chilled with ice quickly after gutting and rinsing.
- Optimally, each species should be packed in separate boxes.
- Ensure that the fish is packed nicely and that they are not bent.
- Ensure that the boxes are not overfilled.
- Ensure that shiny cod are arranged belly-side down. Ensure that flatfish are placed with the white side upwards.
- Ensure that sufficient ice is placed at the bottom, in the middle and on top of the fish in boxes with flatfish.

Storage in hold

The fisherman makes sure that the fish is stored as cold as possible on board his boat. The fisherman stores the boxes of fish under a shelter deck at the front of his vessel. This roof prevents rain and sun from spoiling the fish and melting the ice. In addition, it also hinders contamination from birds. According to the fisherman, there is still plenty of ice left in the boxes when he comes back to the harbor. He says that the system could not

work if he was away for several days. In such a case, he would have to put new ice in the boxes at least twice a day. This is because the storage room on the vessel is not refrigerated and is not closed off.

On the vessel, the floor of the storage room slopes slightly, so the meltwater can be collected and drained.

Process step: Storage
Measures taken to maintain quality:
- There is a roof over the storage area.

Recommended measures to take to maintain quality:
- Ensure that the fish is protected against wind and frost.
- Optimally, the surrounding temperature in the storage area should be 2-4°C.

Unloading

At the quay, a crane on land lifts out the fish boxes three at a time from the vessel. The fish boxes are placed on a pallet which is transported by a forklift into the refrigerated storage room. The fish is stored here until the grading begins by the collector in the evening. The forklift operator provides the fisherman with clean, empty boxes and ice, since the vessel does not produce ice onboard. The ice is stored in two insulated boxes with lids and does not melt before the next day's fishing trip.

Process step: Unloading
Measures taken to maintain quality:
- The fish is stored in a cold store until grading.

Recommended measures to take to maintain quality:
- Ensure that the fish does not get contaminated during landing and transport.

4.2.1.3 Collector

The process steps involving the fish at the collector are shown in Figure 4.4.

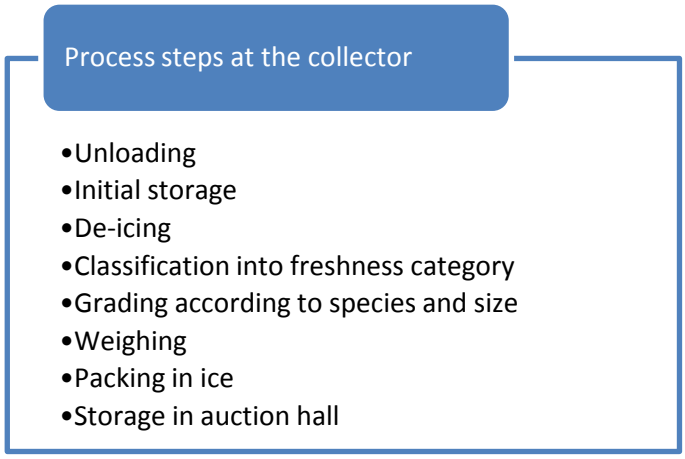

Figure 4.4. The process steps at the collector.

Unloading and initial storage

When a vessel has unloaded its fish, the collector transports the fish into a storage room (3°C). The fish remains here until the grading begins in the late evening (normally at 10 PM).

De-icing, classification and grading

The temperature in the grading room is not as cold as in the storage room, since it must be tolerable with regards to the working environment.

The fish and ice are separated and thereafter each fish is assessed individually. Fish from each vessel is divided into species, classified according to freshness, and graded according to size. For each species, there are three freshness categories and from 2-6 size intervals depending on the species. The freshness categories are also denoted as quality categories.

When grading into sizes, the collector grades the fish of the best quality first, then the next best quality, etc. If they come upon a fish which is deformed or has been squashed, then they remove the fish and place it in a basket so that it can be graded with the other fish of a lower freshness category.

While some workers grade the fish, other workers pack the fish that is already graded. As far as possible, fish from one vessel is not mixed with fish from another vessel. However, this is unavoidable when the batch sizes from the vessels are small (such as all other species than cod and plaice from Fishing vessel 2) and when there is less than a boxful of fish left in a specific category. Such “leftovers” are set aside and mixed with leftovers from another batch of fish of the same specifications.

Kystfisk are also quality-assessed during the grading procedure. Although kystfisk are not over 24 hours old, certain circumstances may cause the fish to be degraded to a lower freshness category than E. Circumstances which may have a negative effect on the appearance, and thereby the quality assessment, of the fish may be inappropriate arrangement of the fish in the box and improper gutting, e.g. due to a large catch and subsequent lack of time.

The collector takes care to assess the quality of the fish correctly. The buyers become disconcerted if the collector does not remove the fish of deviating quality and place it in the freshness category where it belongs. This is harmful to the reputation of the collector.

Weighing and packing in ice

The fish is packed in ice in plastic boxes. Usually ice is placed on top of some of the flatfish. The collector does not put ice on top of cod because the ice can make unwanted marks on the cod.

Storage in auction hall

When the fish has been graded and packed, it is immediately moved into the refrigerated auction hall. There is one auction hall per collector. Because the time until the auction starts is short, there will still be sufficient ice in the boxes when the auction starts. Therefore, the collector does not place a box of ice on top of the stacks of boxes in the auction hall. However, if the fish is graded on a Friday evening, they will put a box of ice on top of the stacks because the next auction takes place on Monday morning. Otherwise, there will not be sufficient ice left until the auction starts.

Process steps at the collector

Measures taken to maintain quality:

- The initial storage area is refrigerated (3°C).
- The fish is packed in ice.
- Ice is not placed on top of cod.
- A box of ice is placed on top of the uppermost box in the stacks if the fish has to be stored from Friday to Monday.
- The graded fish is stored in the refrigerated auction hall.

Recommended measures to take to maintain quality:

- Ensure that the fish is protected from external contamination when transporting the fish outdoors.
- Ensure that each fish is graded according to species, freshness category, and size.
- Ensure that the fish is handled gently.
- Ensure that the fish is separated according to the fishing vessel that caught the fish and the catch date.
- Ensure that the fish is packed in clean boxes with sufficient ice.
- Ensure that shiny cod is packed belly-down on ice.
- Ensure that the fish is stored on sufficient ice in cold stores before and after grading.
- Optimally, the grading room should be refrigerated.

4.2.1.4 Auction

The process steps involving the fish at the auction are shown in Figure 4.5.

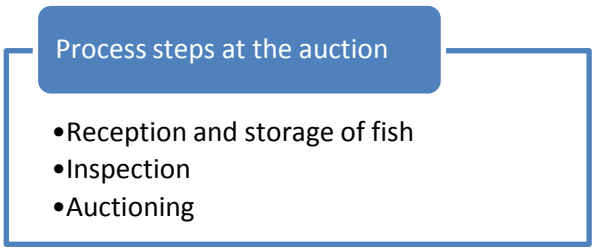

Figure 4.5. The process steps at the auction.

Reception and storage of fish

Fish is received directly from the vessels, from the collectors or delivered by truck from vessels and collectors in other cities. The area on the quay from the vessel to the collector and auction hall is covered by a roof in order to avoid excrements from birds. Received fish is stored packed in ice in plastic boxes in the refrigerated auction hall. The boxes are stacked 6-7 boxes high.

Inspection

The size grading of the fish is inspected as well as the presence of sufficient amounts of ice in the boxes to maintain a temperature of just below 0°C in the fish. Seapacked fish is also classified according to freshness. Furthermore, the weight of the total amount of fish per box is inspected by random spot check for each batch of seapacked fish.

Auctioning

The fish is auctioned off and the ownership of the fish is now transferred from the vessel owner/fisherman to the buyer. The palletized fish boxes are transported with forklifts to the trucks.

The collector and the auction are located in the same building, which is situated on the quay where the vessels unload their fish. This means that the fish is transported as short a distance as possible, both from the vessel to the collector and from the collector to the auction. The rectangular building is constructed so that the collector is located in one side of the building, the auction halls are in the middle, and the loading bays for the refrigerated trucks are on the other side. The area where the loading bays are located is refrigerated, meaning that the cold chain is not broken from the auction to the trucks.

Process steps at the auction
Measures taken to maintain quality:

- The area from the vessel to the collector/auction is covered by a roof.
- The auction checks that the fish has been iced properly, e.g. that there are sufficient amounts of ice and the ice is placed correctly in the box in relation to the fish.
- The auction hall is a cold store.
- There is an unbroken cold chain from the auction hall to the trucks.

Recommended measures to take to maintain quality:

- Optimally, there could be an alarm if the temperature in the auction hall exceeds a specified temperature.
- Ensure that a box of ice is placed on top of stacks of boxes with fish during prolonged storage.

4.2.2 Quality assurance procedures

An underlying principle in maintaining the freshness of (non-frozen) fish is to ensure that the temperature of the fish is always just below 0°C, equivalent to the temperature of melting ice on the fish. Thorough removal of the fish entrails further plays a role in delaying the degradation processes caused by the digestive enzymes of the fish. Additionally, gentle handling of the fish reduces the risk of bruises that may accelerate the rate of degradation. Classification and labeling of the fish at the collector and auction calls for carefulness in order to be reliable. Moreover, a division of freshness category A into well-defined subcategories to overcome the broadness of the “qualities” encompassed by category A would be valuable. Labeling the fish with the catch date would, provided that the fish has been handled appropriately and stored on ice since catch, give the best indication of the freshness. Adherence to these efforts will lead to an improvement in the maintenance of fish freshness and less variation in the quality of the fish within the category or subcategory, and ultimately, to a more trustworthy product and buyers that are more confident in the quality of the fish.

An additional aspect necessary in this regard is that those who handle the fish have an awareness and understanding of quality assurance during all the process steps involving the fish. This includes an omnipresent goal of continual improvement in all the fish operation processes and carefully prepared preventive actions to preclude the occurrence of potential problems.

Based on the measures already taken by the steps as mentioned in Section 4.2.1 as well as the recommendations for practices that serve to maintain the quality of the fish until the first point of sale, a list of procedures can be created for improved handling of the fish onboard the fishing vessels, at the collector, and at the auction. The following is intended as a manual of procedures for quality assurance of the fish raw material.

References consulted during preparation of the manual include Huss (1995) and Huss, Ababouch & Gram (2003) as well as Madsen (2007), Larsen (2006), Konsumfisk (2011) and Danish Fishermen's Producers' Organization (2011).

4.2.2.1 Quality assurance procedures for Fishing vessel 1

Process step: Catch operation

- Limit the time the fish is in the fishing gear to the shortest time practically possible. The fish become stressed if they are in the fishing gear for too long time. Stressed fish are more susceptible to degradation processes. The onset of rigor mortis will occur faster if the fish is stressed. A fish in rigor mortis is difficult to handle during the gutting, bleeding, and packing processes. In addition, the meat of stressed fish that have died of exhaustion will become soft and be prone to gaping.

- Adjust the size of your catch to the capacity available for good catch handling. Prioritize proper catch handling operations rather than catching a large quantity of fish. Reduce the quantity of fish caught by towing the trawl for a shorter time. If you have caught a quantity of fish which exceeds your catch handling capacity, be sure that the fish is chilled with ice while doing the catch handling operations.

- Do not tow the trawl for more than 4 hours. Long trawl tows may wear the scales and skin of the fish in the trawl. If there are many thorny skates in the catch grounds, the tow time should be reduced since the pointed spikes of the thorny skates can scratch the fish in the trawl.

- Make the fishing trip as short as possible. The earlier the fish is landed, the fresher it will be. This increases the chance that it will be sold for a high price at the auction.

Process step: Hauling in, emptying and re-release of trawl

- Ensure that the fish are not pressed too much against each other in the cod end of the trawl. Use small cod ends and do not fill them more than 60-70%. Fish more frequently with small cod ends. This prevents bruising the fish. Exposing fish to a large amount of pressure can result in blood stains in the fillet. The gut contents may also be squeezed out of the fish and can contaminate the rest of the catch.

- Gently remove the fish from the trawl so the fish will not be bruised or unnecessarily squashed.

- Refrain from throwing or stepping on the fish. This can result in bruised fish.

- If the upper deck has been warmed up by the sun, either wash down the deck with cold water or put ice on the deck before removing the fish from the fishing gear.

- Place the fish in baskets, boxes, or small tubs before proceeding to the gutting process. If the fish is left on the deck itself or is placed in large tubs with water, they will slide back and forth, which wears the fish.

- Protect the fish from external contamination, strong winds and from strong cold and heat by covering the fish or placing the catch under a roof. If the temperature is under the freezing point, the fish should be covered with insulating mats or transferred to the middle deck right away. Upon exposure to temperatures below -1.5°C, cod will become gray and lose the shiny appearance and the eyes will become sunken. To protect the fish from heat, the fish can be placed under a roof, sprayed with cold water, or mixed with ice. Dehydration is detrimental to the quality of the fish.

- Only release the trawl into the sea again if the previously caught fish is chilled or there is available staff that is able to ensure chilling of the fish.

Process steps: Chilling the fish and discarding foreign bodies

- Chill the fish to just below 0°C as quickly as possible after removing them from the trawl. Place the fish in a tub with a mixture of ice and water or in a tub of slush-ice. Slush-ice is a mixture of ice, air, and water. Slush-ice cools the fish to 0°C quicker than normal flake ice. If chilling in boxes is preferred, for example in order to maintain the shininess of cod, the following procedure can be used:
    - Shiny cod can be placed belly-down on a bed of 2 shovelfuls of flake ice and with a limited amount of slush-ice in between the fish. Too much slush ice on the cod will make unwanted marks on the skin.
    - Flatfish can be chilled similarly on a bed of 2 shovelfuls of flake ice, but with slush ice in between and on top of the flatfish.

- Discard injured and dead fish.

Process step: Gutting

- Gill cut the fish as soon as possible after hauling in the fish. Bleed the fish in a tub of water while the fish is still alive. This ensures that the fillet will be white and free of any blood stains. If the fish dies before the gill cutting, it cannot be bled properly and discolorations may occur in the fillet.

- Ideally, all fish should be gill cut and bled, or at least roundfish.

- Gill cutting and bleeding fish before gutting them gives a better quality of fish than gill cutting and subsequent gutting without bleeding the fish. However, the former method is more time consuming and more difficult.

- Gut the fish by making a belly cut from the vent to the gills. Thereafter, remove the entrails thoroughly. Make sure there are no gut remnants left in the abdominal cavity. Use the necessary time to ensure that you make the correct belly cut.

- If the gutting of the fish is delayed, an off-flavor from the bile and the stomach can penetrate the fillet of the fish. Be sure to chill the fish until it is gutted.

- If you cut into the fillet, bacteria may contaminate the fillet, resulting in a shorter shelf-life. If you have cut into the fillet, place the fish apart from other fish.

- Do not cut into the fish's stomach, intestines, or gall bladder.

- Collect the removed guts in a container and throw them overboard. Prevent contamination of other fish while removing the guts.

Process step: Rinsing

- Rinse the fish in a tub of water. Do not use a spray hose to rinse the fish. Rinse the fish gently. Avoid bruising the fish.

- Change the water often. Bloody and dirty water can contaminate the fish and increase the rate of degradation.

- Do not put too many fish in the tub, so that they rub against each other. This wears the scales and the mucus off the fish.

- Ensure good circulation of the water, so that the fish can be rinsed properly.

- Ensure that blood and gut remnants are rinsed away and that sand is removed from the gills.

- Chill the fish as soon as possible after gutting and rinsing. This maintains the quality and the shelf-life of the fish better.

Process steps: Grading, weighing and packing

- Carefully grade the fish according to species and size.

- Pack the fish in clean boxes. Use chilled boxes so that the ice will not melt too quickly.

- Comply with the rules on the correct weight of fish in the boxes. Do not overfill the box so that the box on top might press the fish in the box below.

- During the summer, place a box of ice on top of each stack of boxes to cool the uppermost box of fish. Similarly, a box of ice may be placed at the bottom of the stacks in order to prevent the ice in the boxes above from melting too quickly.

- Arrange the fish systematically and nicely in the boxes. Do not bend the fish.

- Arrange the shiny cod on its belly, so the ice cannot discolor the skin on its back. Arrange flatfish with the white side facing upwards.

- For boxes of cod, place 2 shovelfuls of ice in the bottom of the box. For boxes of flatfish, the distribution of ice should be: 40% ice in the bottom of the box, 30% ice between the fish, and 30% ice on top of the fish.

- Keep each day's catch apart from each other.

- As a minimum, label the boxes of fish with the following information: species, size, catch date, fishing vessel, unique identification of the batch, and sales weight.

- As far as possible, pack each species separately, since they have varying shelf-lives and can affect each other. At least separate the following when packing the fish in boxes: flatfish and roundfish; fatty fish and lean fish; fish that easily lose their scales and fish that do not easily lose their scales. In addition, common dabs and soles should be packed apart from other fish due to strong secretion of mucus. Likewise, lemon soles, rays, and sharks should be packed separately because they secrete a large amount of ammonia.

Process step: Storage

- Drain the meltwater from the boxes. The meltwater may encourage bacterial growth and thereby, increase the rate of degradation of the fish.

- Protect the fish against rain, wind, sunlight, and frost.

- The optimal temperature in the hold is +2-4°C.

- Check the amount of ice in the boxes regularly during the rest of the fishing trip to make sure if more ice needs to be added.

Process step: Unloading

- Ensure that the fish does not get contaminated when unloading. Cover the fish during landing and transport or ensure that there is a roof over the fish during landing and transport.

- Ensure that the fish is stored in a cold store until it is graded or, for seapacked fish, until it is to be sold at the auction. Protect the fish against dehydration by placing an extra fish box or an insulating mat on top of the fish boxes.

General recommendations for cleaning and hygiene

- After each catch operation: Clean the decks where the fish is hauled in and handled. Make sure that all blood, scales, and fish entrails are removed before the fish from the next catch operation are to be gutted. Inspect the cleaning after each catch operation and before a new fishing trip. There must be no bad odors and all surface areas must feel clean and be visually clean.

- After each fishing trip: Clean the hold thoroughly. There must be no bad odors and all surface areas must feel clean and be visually clean.

- Uphold high standards of personal hygiene and use of clean work clothes and gloves.

- Carry out maintenance of production areas and equipment, including maintaining sharp knives and cleaning of the floor drain.

- Protect the ice against contamination.

4.2.2.2 Quality assurance procedures for Fishing vessel 2

Process step: Catch operation

- Limit the time the fish is in the fishing gear to the shortest time practically possible. The fish become stressed if they are in the fishing gear for too long time. Stressed fish are more susceptible to degradation processes. The onset of rigor mortis will occur faster if the fish is stressed. A fish in rigor mortis is difficult to handle during the gutting, bleeding, and packing processes. In addition, the meat of stressed fish that have died of exhaustion will become soft and be prone to gaping.

- Adjust the size of your catch to the capacity available for good catch handling. Prioritize proper catch handling operations rather than catching a large quantity of fish. Reduce the quantity of fish caught by using fewer gillnets. If you have caught a quantity of fish which exceeds your catch handling capacity, be sure that the fish is chilled with ice while doing the catch handling operations.

Process step: Hauling in and removing fish from gillnet

- Gently remove the fish from the net so the fish will not be bruised or unnecessarily squashed.

- Refrain from throwing or stepping on the fish. This can result in bruised fish.

- Place the fish in baskets, boxes, or small tubs before proceeding to the gutting process. If the fish is left on the deck itself or is placed in large tubs with water, they will slide back and forth, which wears the fish.

- Protect the fish from external contamination, strong winds and from strong cold and heat by covering the fish or placing the catch under a roof. If the temperature is under the freezing point, the fish should be covered with insulating mats. Upon exposure to temperatures below -1.5°C, cod will become grey and lose the shiny appearance and the eyes will become sunken. To protect the fish from heat, the fish can be placed under a roof, sprayed with cold water, or mixed with ice. Dehydration is detrimental to the quality of the fish.

Process steps: Discarding foreign bodies and primary grading (including chilling)

- Discard injured and dead fish.

- Chill the fish to just below 0°C as quickly as possible after removing them from the net. Place the fish in boxes with ice or in tubs with a combination of ice and water.

- Shiny cod can be placed belly-down on a bed of 2 shovelfuls of flake ice and with a limited amount of slush-ice in between the fish. Too much slush ice on the cod will make unwanted marks on the skin. Flatfish can be chilled similarly on a bed of 2 shovelfuls of flake ice, but with slush ice in between and on top of the flatfish.

Process step: Gutting

- Gill cut the fish as soon as possible after hauling in the fish. Bleed the fish in a tub of water while the fish is still alive. This ensures that the fillet will be white and free of any blood stains. If the fish dies before the gill cutting, it cannot be bled properly and discolorations may occur in the fillet.

- Ideally, all fish should be gill cut and bled, or at least roundfish.

- Gill cutting and bleeding fish before gutting them gives a better quality of fish than gill cutting and gutting right after each other without bleeding the fish. However, the former method is more time consuming and more difficult.

- Gut the fish by making a belly cut from the vent to the gills. Thereafter, remove the entrails thoroughly. Make sure there are no gut remnants left in the abdominal cavity. Use the necessary time to ensure that you make the correct belly cut.

- If the gutting of the fish is delayed, an off-flavor from the bile and the stomach can penetrate the fillet of the fish. Be sure to chill the fish until it is gutted.

- If you cut into the fillet, bacteria may contaminate the fillet, resulting in a shorter shelf-life. If you have cut into the fillet, place the fish apart from other fish.

- Do not cut into the fish's stomach, intestines, or gall bladder.

- Collect the removed guts in a container and throw them overboard. Prevent contamination of other fish while removing the guts.

Process step: Rinsing

- Rinse the fish in a tub of water. Do not use a spray hose to rinse the fish. Rinse the fish gently. Avoid bruising the fish.

- Change the water often. Bloody and dirty water can contaminate the fish and increase the rate of degradation.

- Do not put too many fish in the tub, so that they rub against each other. This wears the scales and the mucus off the fish.

- Ensure good circulation of the water, so that the fish can be rinsed properly.

- Ensure that blood and gut remnants are rinsed away and that sand is removed from the gills.

- Chill the fish as soon as possible after gutting and rinsing. This maintains the quality and the shelf-life of the fish better.

Process steps: Grading and packing

- Pack the fish in clean boxes. Use chilled boxes so that the ice will not melt too quickly.

- Do not overfill the box so that the box on top might press the fish in the box below.

- During the summer, place a box of ice on top of each stack of boxes to cool the uppermost box of fish. Similarly, a box of ice may be placed at the bottom of the stacks in order to prevent the ice in the boxes above from melting too quickly.

- Arrange the fish systematically and nicely in the boxes. Do not bend the fish.

- Arrange the shiny cod on its belly, so the ice cannot discolor the skin on its back. Arrange flatfish with the white side facing upwards.

- For boxes of cod, place 2 shovelfuls of ice in the bottom of the box. For boxes of flatfish, the distribution of ice should be: 40% ice in the bottom of the box, 30% ice between the fish, and 30% ice on top of the fish.

- As far as possible, pack each species separately, since they have varying shelf-lives and can affect each other. At least separate the following when packing the fish in boxes: flatfish and roundfish; fatty fish and lean fish; fish that easily lose their scales and fish that do not easily lose their scales. In addition, common dabs and soles should be packed apart from other fish due to strong secretion of mucus. Likewise, lemon soles, rays, and sharks should be packed separately because they secrete a large amount of ammonia.

Process step: Storage

- Drain the meltwater from the boxes. The meltwater may encourage bacterial growth and thereby, increase the rate of degradation of the fish.

- Protect the fish against rain, wind, sunlight, and frost.

- The optimal temperature in the hold is +2-4°C.

- Check the amount of ice in the boxes regularly during the rest of the fishing trip to make sure if more ice needs to be added.

Process step: Unloading

- Ensure that the fish does not get contaminated when unloading. Cover the fish during landing and transport or ensure that there is a roof over the fish during landing and transport.

- Ensure that the fish is stored in a cold store until it is graded. Protect the fish against dehydration by placing an extra fish box or an insulating mat on top of the fish boxes.

General recommendations for cleaning and hygiene

- After each catch operation: Clean the decks where the fish is hauled in and handled. Make sure that all blood, scales, and fish entrails are removed before the fish from the next catch operation are to be gutted. Inspect the cleaning after each catch operation. There must be no bad odors and all surface areas must feel clean and be visually clean.

- After each fishing trip: Clean the hold thoroughly. There must be no bad odors and all surface areas must feel clean and be visually clean.

- Uphold high standards of personal hygiene and use of clean work clothes and gloves.

- Carry out maintenance of production areas and equipment, including maintaining sharp knives and cleaning of the floor drain.

- Protect the ice against contamination.

4.2.2.3 Quality assurance procedures for the Collector

- Ensure that the fish is protected from external contamination when transporting the fish outdoors, e.g. from the vessel to the collector and from the collector to the auction. This can be implemented by either having a roof over the transport area or by covering the uppermost boxes of fish.

- De-ice the fish. Grade the fish according to species, freshness category, catch date, and size.

- Handle the fish gently, including fish in rigor. Do not throw the fish or step on them. Rough handling can bruise the fish and cause unwanted blood stains in the fillet.

- Keep fish from one fishing vessel separate from fish from other fishing vessels.

- Pack the fish in sufficient amounts of ice.

- Pack shiny cod belly-down on ice. Do not put ice on top of shiny cod.

- Place a box of ice on top of the uppermost box of fish in each stack during storage pre-grading and post-grading.

- Use clean boxes.

- Ensure that the grading and storage rooms as well as the production equipment are clean and odorless.

- Store the fish in ice in cold stores both pre-grading and post-grading. Ensure that the temperature in the cold store is 2-4°C.

- It is preferable to have the same temperature in the grading room as in the cold store.

4.2.2.4 Quality assurance procedures for the Auction

- Ensure that the storage rooms are clean and odorless.
- Store the fish in ice in cold stores. Ensure that the temperature in the cold store is 2-4°C.
- Place a box of ice on top of the uppermost box of fish in each stack during storage.
- Ensure that the fish is packed in sufficient amounts of ice.
- Grade the seapacked fish according to freshness.
- Ensure that the fish is properly graded according to species, freshness category, and size. Ensure that the fish boxes are labeled with the species, freshness category, the size, the catch date, the identification of the fishing vessel, and the unique identification of the batch.

4.3 THE INFORMATION FLOW AND THE IMPORTANCE OF THE INFORMATION IN THE CHAINS

Many types of information are generated and transferred among the steps in the investigated fish supply chains. In the present section, the information types are divided into those that are required to be available at each stage of marketing of the species concerned according to EU Regulation 104/2000 and EU Regulation 2065/2001 (see Section 2.1.2.2) and those not required. There may be other requirements attached to the latter, e.g. there may be legislation requiring certain types of information to be delivered to the authorities, but that is outside the scope of this section. The importance and reception of the required information is dealt with collectively in Section 4.3.1. For the information not required, the flow of these information types in each step and in the chains are presented in Section 4.3.2 while the importance and use of the information types are discussed in Section 4.3.3. Thereafter, wishes and suggestions regarding the transfer of information are proposed in Section 4.3.4. In Section 4.3.5, the levels of traceability at the steps are briefly described and finally, the findings of Section 4.3 are summarized in Section 4.3.6.

4.3.1 Importance and use of information required by EU Regulation 104/2000 and EU Regulation 2065/2001

4.3.1.1 Fish species

The two fishing vessels generate this information since they are the starting point of the supply chain. The collector and the auction in a sense also generate this information. At least they do not place much importance on whether they receive this information or not because they can identify the species just by taking a look at the fish. The processor always receives information about the species. The auction, processor, and retailer all send information on the fish species on to the next step. The auction finds it important to send the information onwards. For the processor, this information is the most important of the three types of required information (Table 4.6) since it is important to know which fish species they are offering for sale. Likewise, the retailer believes it is important for the consumers to know what kind of fish they are buying.

Table 4.6. The three information types required by EU Reg. 104/2000 and EU Reg. 2065/2001 ranked in terms of importance by the steps. (∗∗∗ = most important, ∗∗ = second most important, ∗ = third most important. If all three information types were judged as equally important by a step, they are all ranked as most important below. No information is available for Fishing vessel 2.)

Information types	Steps				
	Fishing vessel 1	Collector	Auction	Processor	Retailer
Fish species	∗∗∗	∗∗	∗∗	∗∗∗	∗∗∗
Production method	∗∗∗	∗	∗∗	∗∗	∗∗∗
Catch area	∗∗∗	∗∗∗	∗∗∗	∗∗	∗∗∗

Information about the species of the fish is of course important so that the steps know what they are selling, so the consumers know what they are buying, but also because the fish have different economic values, their nutritional characteristics and taste are

different, etc. As long as the fish is still whole, information about the species is not so important to receive because the steps can identify the species themselves. However, to fulfill the requirements of the EU regulations, it is mandatory to forward the information.

4.3.1.2 Production method: Caught or farmed

Fishing vessels 1 and 2 generate this information since they catch the fish. The production method is not important for the collector (Table 4.6), presumably because they only receive fish caught at sea. The auction must be notified when fish is farmed, since the auction otherwise presumes that all the fish is caught at sea, although the auctioneer claims to be able to determine whether it is caught or farmed by looking at the fish. The processor receives information about the production method from most suppliers; in cases where they do not, the catch area is usually also missing. This information is not important for the processor now, but may become important in the future. The retailer receives the information via the delivery note, but if he is in doubt, he always telephones the supplier. The retailer passes the information on to the consumers through signs placed in connection with the farmed fish.

Thus, information on the production method is in use when necessary. I.e. the collector assumes all his fish is caught, the auction must be notified if the fish is farmed, and the retailer only labels farmed fish with the production method. The processor and retailer receive fish of both production methods, so they do not consider any of the production methods as a "default."

4.3.1.3 Catch area

The catch area is significant for Fishing vessel 1 because once every 24 hours, they must register the catch area in their logbook and, at least when fishing in Norwegian waters, they have to report to the authorities every time they sail into a new zone. Concerning the former, in practice, they record the catch area for every trawl haul. The catch area is recorded as an ICES square, which is much smaller than the FAO catch areas (see Appendix 1). Fishing vessel 2 catches fish in only one FAO fishing subdivision, namely 27IIIaN (Skagerrak) and finds FAO area 27 meaningless since it covers such a huge area. Since Fishing vessel 2 catches fish under a type of license called "Declaration of catch area" ("farvandserklæring" in Danish), he may only fish in the Skagerrak and does not have to keep a logbook.

The collector and the auction find the catch area the most important information among the three information types in Table 4.6. The collector receives the catch area when it is different from subdivision 27IIIaN (Skagerrak) and in such cases, sends the information to the auction. This is so because 90% of the fish that the collector grades are from day boats that cannot sail further away than subdivision 27IIIaN. In the opposite case, the fish is caught by a large vessel and then the fish from that vessel is graded and placed separately in the auction hall.

The auction receives information about the catch area when it is subdivision 27IIId (the Baltic Sea) or when it is different from area 27. The information is also sent on to the buyers through paper notes in the fish boxes and/or on the invoice. The catch area of fish caught in subdivision 27IIId must also be specified further into either the eastern Baltic Sea or the western Baltic Sea. It is important for the auction to receive this information, and he would like fish from these waters to be labeled properly with either the eastern Baltic Sea or the western Baltic Sea. The fish are not always marked and even less so, when the first fish of the year from the Baltic Sea are landed. In the latter case, the fishermen have to be reminded of the process of labeling fish from the Baltic Sea.

The processor receives the catch area from most suppliers. As noted above, in cases where they do not receive the catch area, they often do not receive the production method, either. This information is not important for the processor yet, but in connection with traceability, the catch area can become important as a means to eradicate some of the illegal fisheries.

The retailer receives information on the catch area and communicates the information to the consumers through signs on the fish. The retailer considers the catch area important, although he finds that the FAO fishing areas, such as area 27, are broad concepts. The retailer believes that the consumers might be interested in the catch area.

Similar to the production method, some steps also operate with a "default" value concerning the catch area. The collector and auction receive the area when the area is different from area 27 (not including division 27IIId). This means the collector receives the area when it is different from subdivision 27IIIaN and the auction receives the area if it is division 27IIId or it is outside area 27. This does not apply to the processor and retailer, since they may receive fish from a variety of catch areas.

4.3.1.4 Compliance to the legal requirement

Although it is not within the scope of this study to check whether the steps receive and/or forward the so-called required information, it is interesting that the steps report some problems in receiving some of the information (Table 4.7). This is problematic because it is a legal requirement that these information types must be forwarded independently of whether the steps consider them important or not.

Table 4.7. Information types required by EU Reg. 104/2000 and EU Reg. 2065/2001 to be available at each stage of marketing, but which the steps do not always receive.

Step	Information type
Auction	Catch area: eastern or western Baltic Sea
Processor	Production method; catch area
Retailer	Production method

4.3.2 Information flow at each step and in the chains

4.3.2.1 Introduction

Figures 4.6-4.11 show the flow of information at each of the six steps investigated. The information that each step has in possession, i.e. in a "database" that is neither necessarily electronic nor paper-based, stems from information that the step has generated by themselves or has received from previous steps in the supply chain. From the database, information may be sent to the authorities. Aside from that, the information can either follow the product and be sent to the subsequent steps in the supply chain or not be transferred further in the supply chain. The focus during the interviews was the flow of information in the supply chain. Therefore, the steps may or may not include information sent to the authorities, depending on whether the step mentioned this or not. The information types dealt with in this section are not required to be present at all stages of marketing according to EU Regulation 104/2000 and EU Regulation 2065/2001.

It is important to note that information that is generated, sent on, and received is not necessarily recorded. The information may just be known by the person who generates the information, e.g. the fisherman knows the more specific catch area, but does not necessarily write it down. Similarly, the processor may inform the retailer of a catch method over the telephone, but not necessarily on the delivery note.

Some information types can be deduced from other information types. For example, if a fishing vessel only uses one catch method, the vessel seapacks the fish, and the vessel labels the fish boxes with the name or number of the vessel, then the buyers at the auction may be able to deduce the method used to catch those boxes of fish. As far as possible, this approach is not considered as sending the information onwards. An exception is when it is known that the information must be sent onwards and the only way this is done is by the deduction approach.

Some of the information types are specified by SP or KY in the figures. When an information type is described with SP, the information type is relevant for fish that is seapacked. KY means that the information type regards kystfisk fish. When the same information type is mentioned without SP or KY, then the information type concerns all fish handled by the step. Catch method is shown in three ways: (a) with PL, meaning catch method for plaice, (b) with OT, meaning catch method for other species than plaice, or (c) without PL or OT, meaning catch method in general for all species. This division is made because there is a local agreement that plaice sold in the auction in this study must be labeled with the catch method. This arrangement was made in an effort to raise the price of plaice.

As a default, the information types are shown as being transferred *every time* the fish is sent from one step to the next. When the information types are shown in square brackets, the information is not received or sent every time, but only *sometimes*. When an information type is received sometimes, and the step sends the information type on every time it is received, then the information type is still shown as being sent on sometimes.

4.3.2.2 Fishing vessel 1

The flow of information for Fishing vessel 1 is shown in Figure 4.6. Fishing vessel 1 produces a large amount of information, and submits at least six types of information to the authorities. Four of these are not sent onwards in the supply chain; the catch method for other species than plaice and the more specific catch area are not sent onwards, either. Among the information that is sent to the fish auction, six types (catch date, size grade of whole fish, sales weight, actual weight of fish in box, fish is seapacked and vessel ID) are evident from the seapacking label. The landing date and landing place are either self-explanatory for the fish auction or are transferred by those who unload the vessel. The catch method for plaice must be sent on to the auction (see Section 4.3.2.1), while the catch method for the other species is not sent onwards. However, this does not exclude that the auction or some buyers may deduct the catch method used for fish coming from this vessel, but such situations are not depicted in Figure 4.6.

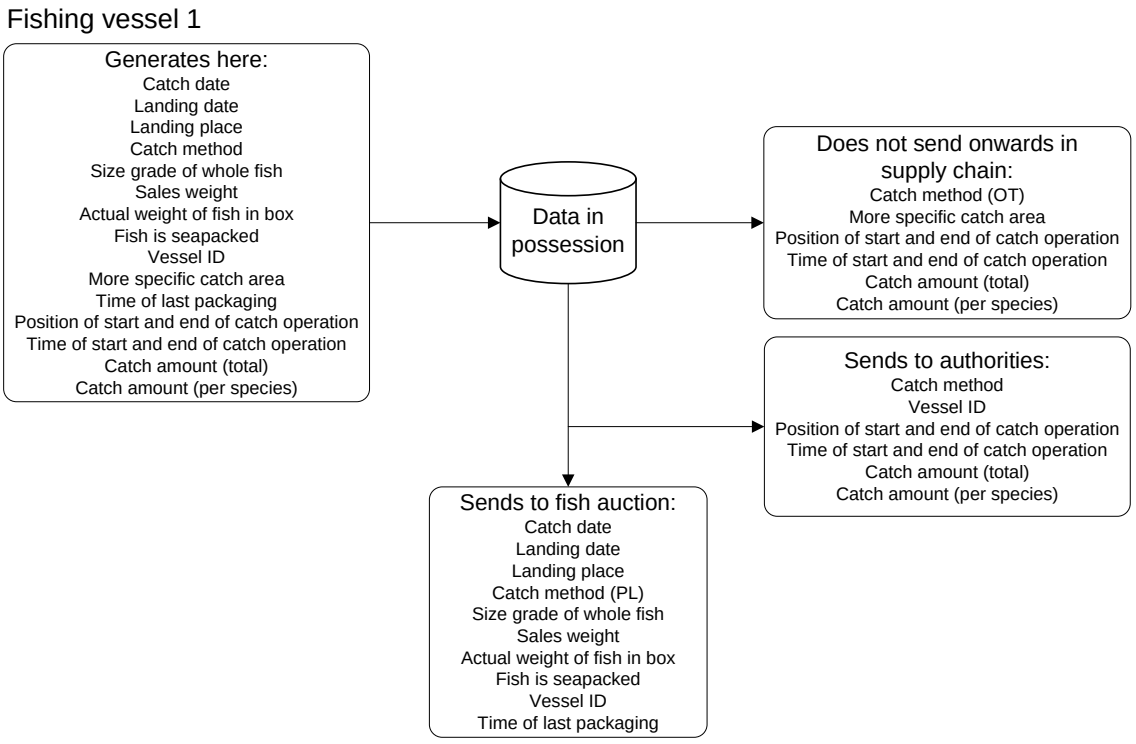

Figure 4.6. Information that is generated and transferred by Fishing vessel 1. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species.

4.3.2.3 Fishing vessel 2

Fishing vessel 2 (Figure 4.7) does not produce as much information as Fishing vessel 1. Because of the fishing vessel's small size and chosen fishery classification ("Declaration of catch area," see Section 4.3.1.3), the fisherman does not send any information directly to the authorities, or at least he did not mention them. The catch date for kystfisk is sent to the collector because kystfisk must be caught maximum 24 hours before the sale at the auction. The catch date of fish not sold as kystfisk is not necessarily sent to the collector. The catch method for plaice is sent to the collector so that the plaice can be marked with

the catch method (see Section 4.3.2.1). The landing place for Fishing vessel 2 will always be the same harbor due to the vessel's small size.

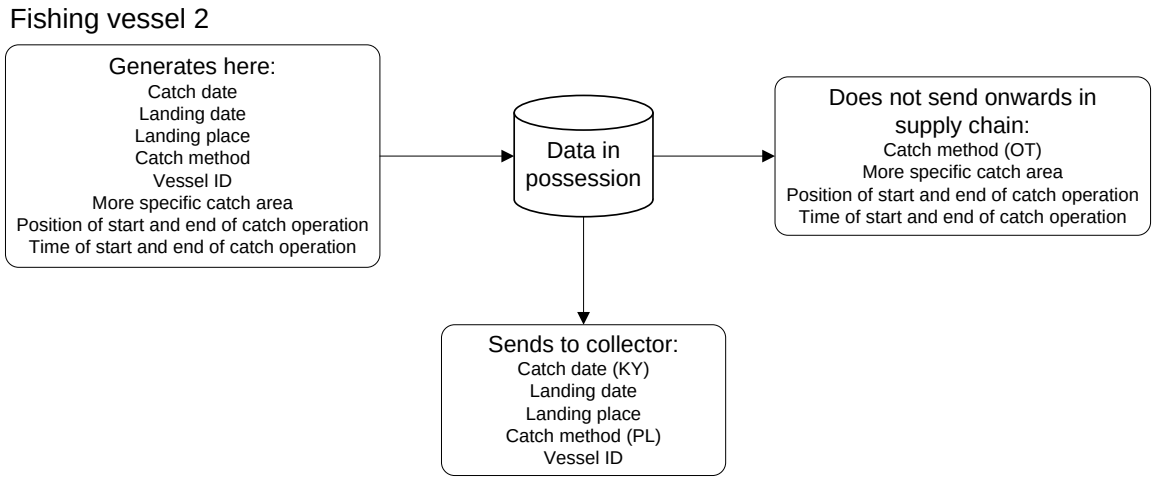

Figure 4.7. Information that is generated and transferred by Fishing vessel 2. KY = kystfisk. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species.

4.3.2.4 Collector

The flow of information for the collector is shown in Figure 4.8. The collector receives kystfisk and other non-graded fish. The collector receives the catch date for kystfisk, since they must be put up for sale no more than 24 hours after catch. The landing date and landing place are received from the vessels and sent to the auction. Plaice received at the collector is always marked with the catch method when placed in the auction hall. Catch methods for other species may also be marked or are sometimes sent on orally.

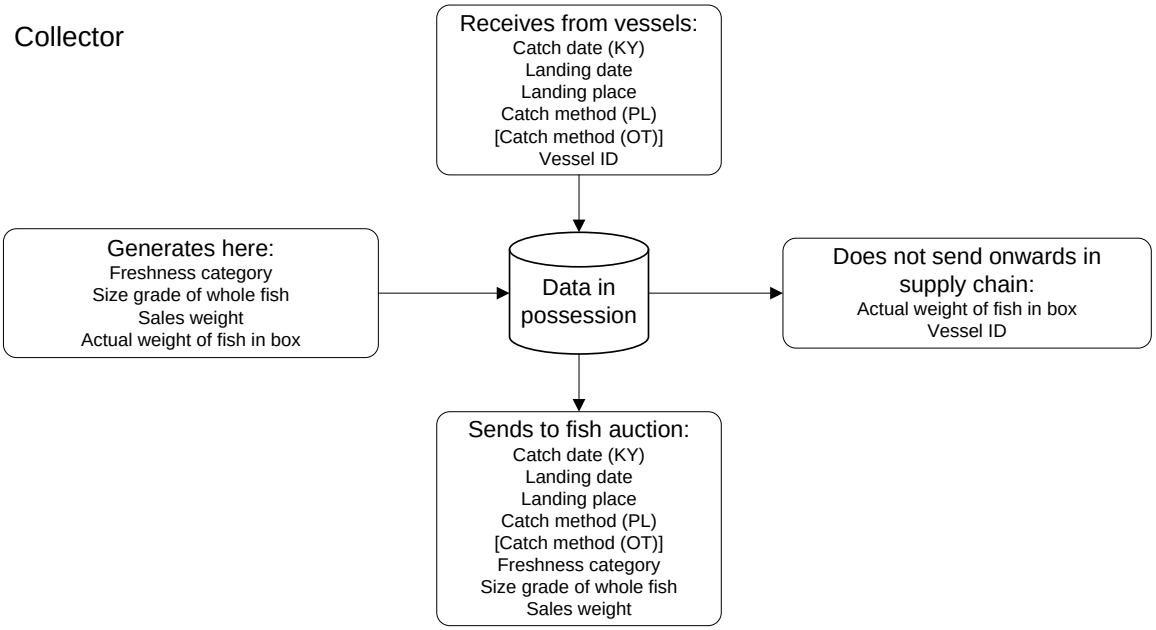

Figure 4.8. Information that is generated, received, and transferred by the collector. KY = kystfisk. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species.

The collector classifies the fish into freshness category and size, and therefore generates these types of information themselves. These information types are evident on paper slips in the boxes and are therefore passed on through the auction. Since the collector packs the fish into the auction boxes, they produce the sales weight and automatically, the actual weight of fish in the box, although the latter is not recorded. The collector presumably sends some information to the authorities, including information from, and for, the vessels, but this did not appear in the interview. Since fish from several vessels may be collected in one batch at the collector, the vessel ID is not sent further in the supply chain, although the collector knows which vessels have delivered fish to the individual batches created by the collector.

4.3.2.5 Fish auction

The fish auction receives fish either directly from seapacking vessels or from collectors (Figure 4.9). Five types of information are provided by both the vessels and the collectors: landing date, landing place, catch method, size grade of whole fish, and sales weight. The collectors provide the freshness category, while the seapacked fish is freshness graded by the auction. Some of the seapacking vessels print the catch date on the box labels, while others only write day 1, day 2, etc. so the order of the catches is indicated. Therefore, the catch date of fish from seapacking vessels is only sometimes received. The seapacking vessels of course send the name or number of the vessel to the auction to identify the origin of the fish. The vessel ID of the seapacked fish is also sent by the auction to the authorities, while for the fish coming from the collectors, the auction indicates the name of the collector to the authorities. The type of sustainability information that the auction receives is whether the fish is MSC-certified. That is, they receive information about the fish being MSC-certified, but when the fish is not MSC-certified, they do not receive that information. Rather, the lack of information is equated with the fish not being MSC-certified. So, the auction always receives the information when the fish is MSC-certified.

In general, the auction sends most of the received information onwards to the buyers. Information about the seapacked fish is most often written on a label attached to the fish box, so this information is easily passed on. Similarly, information about the freshness category and the size grade are also indicated on paper inside the boxes. Other types of information such as the catch method for plaice are also conveyed through paper slips in the boxes. During the auction, the buyers may sometimes be informed orally of the catch method of other species and the landing date.

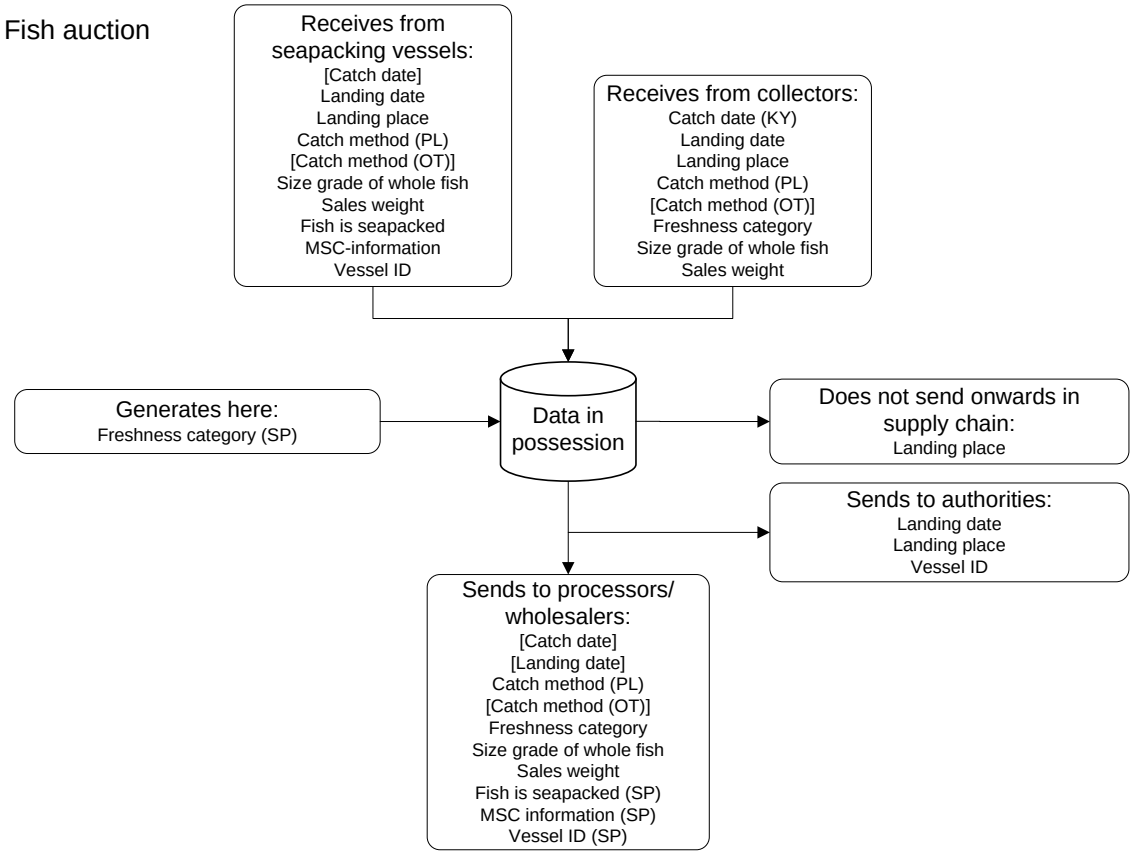

Figure 4.9. Information that is generated, received, and transferred by the fish auction. SP = seapacked fish. KY = kystfisk. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species.

4.3.2.6 Processor

The processor always receives the freshness category, the size grade, and the sales weight of the purchased fish (Figure 4.10). Aside from these, the processor sometimes receives more information, for example when the auctioneer conveys other information orally during the auction (e.g. catch method and landing date). Catch method is not divided into catch method for plaice and other species here, since the processor does not necessarily receive plaice from only the auction in this study. The catch date is sometimes evident on the seapacking labels. For non-seapacked fish, the catch date may be mentioned orally by the auctioneer. If the processor makes the fish into fillets, information about the size grade of the fillets is generated and is sent to the retailers and other processors/ wholesalers. The size grade of fillets is also listed as being received in Figure 4.10 since the processor may also buy fillets from other processors/wholesalers. If the fish is sold as whole fish, the size grade of the whole fish is also sent onwards. In cases where the whole box of fish bought at the auction is sold untouched (i.e. to one customer and where the fish are still whole), the sales weight received from the auction is sent on to the processor's customers. The landing date and catch method are sent on in some cases, e.g. if the processor's customers ask for this information or if the processor wants to indicate

the high quality of the fish due to a specific catch method. In both cases, this information is many times conveyed during telephone conversations.

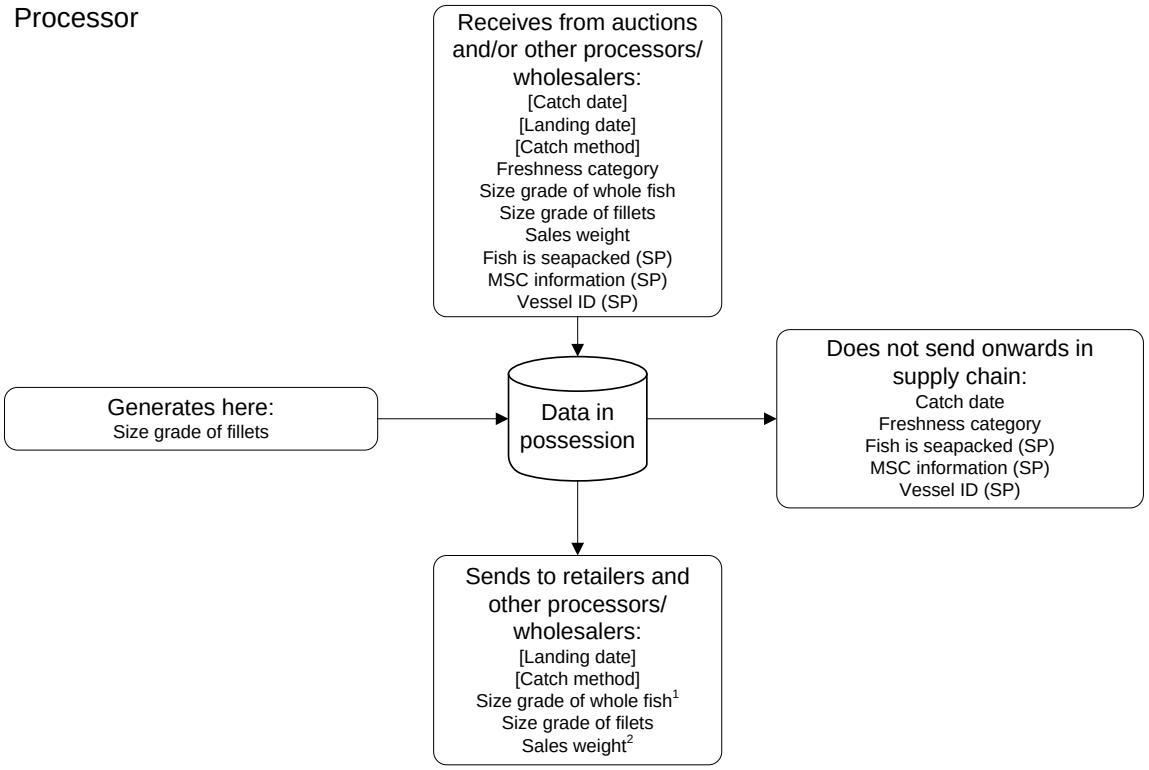

Figure 4.10. Information that is generated, received, and transferred by the processor. SP = seapacked fish. [Information type] = the information type is transferred sometimes. [1]Fish that is traded whole. [2]Sales weight of the box of fish sold at the auction when that box is traded untouched.

4.3.2.7 Retailer

The retailer always receives the size grade, whether for whole fish or for fillets (Figure 4.11). When the retailer receives a whole box untouched since the auction, then the sales weight is also sent along. In addition, the retailer sometimes receives the catch date, landing date and catch method, often over the telephone. With regards to shrimps, the retailer always receives the information when the shrimps are seapacked (and cooked at sea) and when the shrimps are MSC-certified, since these information types are written on the packaging.

When selling the fish to consumers, the retailer may tell them the size grade of the whole fish and four types of information which the retailer denotes “bonus information” (Table 4.8). The bonus information makes it possible for the retailer to tell a good story to the consumers. The retailer presumes that the consumer will tell the story at home and come back to the retailer again to hear another good story. The size grade of fillets (i.e. weight interval) is not communicated to the consumers, but the actual weight of the fillet that the consumer buys is of course passed on.

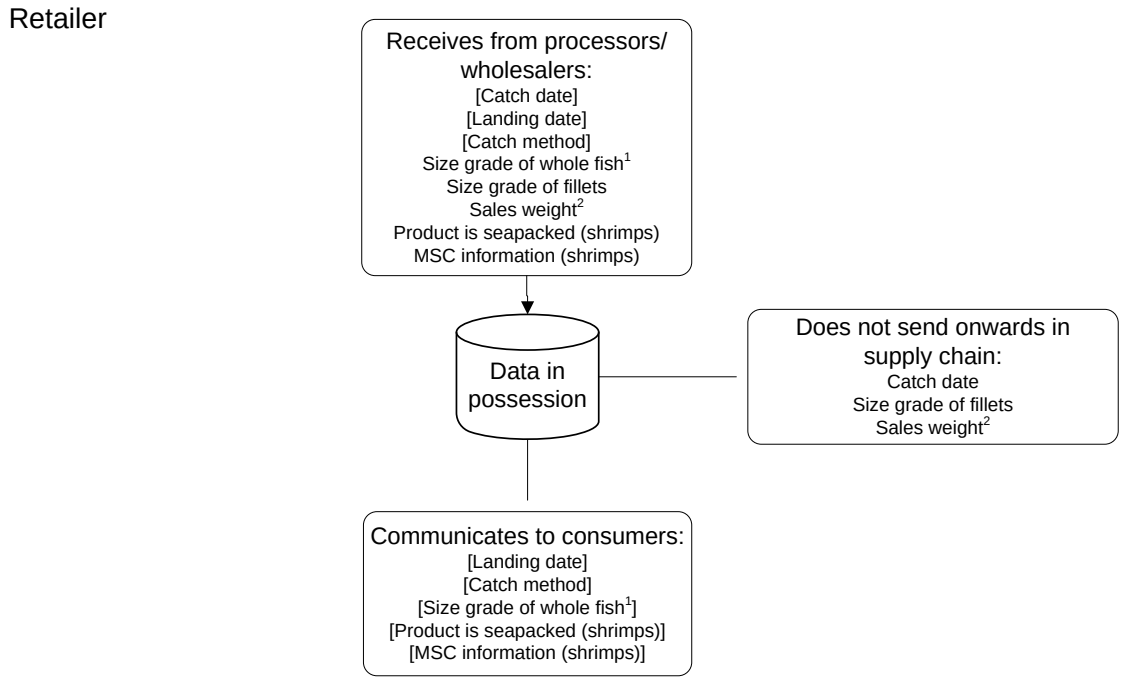

Figure 4.11. Information that is received and transferred by the retailer. [Information type] = the information type is transferred sometimes. [1]Fish that is traded whole. [2]Sales weight of the box of fish sold at the auction when that box is traded untouched.

Table 4.8. The information types that the retailer considers bonus information, i.e. information that he can use in marketing fish and shrimp products to the consumers.

Bonus information for the retailer
Landing date
Catch method
Sustainability information
Product is seapacked (shrimps)

4.3.2.8 Chains 1-1 and 1-2

Figure 4.12 shows the flow of information throughout Chain 1-1, i.e. the supply chain consisting of Fishing vessel 1, the auction, the processor and the retailer. Thus, the information flow regards only seapacked fish. It is known that each of the steps supply fish to the next step in the chain, but it is not known if fish caught by Fishing vessel 1 has been bought by the processor, and even if so, whether those fish have been sold by the processor to the retailer. Thus, the resulting chain (Figure 4.12) shows how the information flow presumably would be if each step supplied fish to the next step. The information that is sent by each step to the authorities is not included in Figure 4.12, since the main focus is the information flow in the supply chain. In a similar manner, Figure 4.13 shows the presumed flow of information in a supply chain where the last three steps are identical to those in Figure 4.12, but where Fishing vessel 1 is exchanged with Fishing vessel 2 and the collector.

In order for an information type to be shown as sent onwards in the chain, the information type:

(a) has to be produced by the starting point in the chain or generated by a later step,
(b) has to be sent at least sometimes by each sending step, and
(c) has to be received at least sometimes by each receiving step.

When the last two conditions are fulfilled *throughout* the chain, the information type is shown as being communicated to the consumers.

In the case of catch date of seapacked fish, it is known that the catch date is printed on labels on each box of fish. Thus, even if the fish auction sometimes sends on and the processor sometimes receives the catch date, then the catch date is shown in Figure 4.12 as being *always* received by the processor, since the catch date will always be shown on boxes of fish stemming from Fishing vessel 1. The same situation is the case for catch date of kystfisk in Figure 4.13.

With regards to the actual weight of fish in the box and the time of last packaging, these information types are produced and forwarded by Fishing vessel 1 (Figure 4.6). However, the auction claims they do not receive these information types. Therefore, because of condition (c) above, these information types are not shown as being received by the auction when the steps are linked together in Figure 4.12. However, the information types are not shown in the box "Does not send onwards in supply chain," either, because Fishing vessel 1 has said that they forward this information.

Fishing vessel 1 generates at least 14 types of information about their catches. Of these, 10 are directly relevant to the individual fish (catch date, landing date, landing place, catch method, size grade of whole fish, fish is seapacked, vessel ID, more specific catch area, position and time of start and end of catch operation). Fishing vessel 2 generates at least 8 types of information which are relevant to the individual fish. Of these 10 and 8 types of information, respectively, only the same three types are conveyed to the consumers in both chains – and only sometimes. These three are landing date, catch method of plaice and size grade of the whole fish.

In all, the retailer receives 3-5 types of information. Thus, it is the previous steps in the chain that omit forwarding certain types of information. The two other types of information that the retailer receives (size grade of fillets and sales weight) are understandably not of interest to the consumer. It is questionable if a consumer is interested in the size grade of the whole fish, whether it is sold whole or filleted, but perhaps the retailer mentions the size grade as part of his marketing.

Only the landing date and the catch method are part of what the retailer considers bonus information, which he uses when trying to sell the fish. The retailer also considers information about shrimps being seapacked as bonus information. In contrast, the retailer does not find it significant if fish have been seapacked because, in his opinion, fish can tolerate repacking at a collector. Though, if the retailer had the same positive association

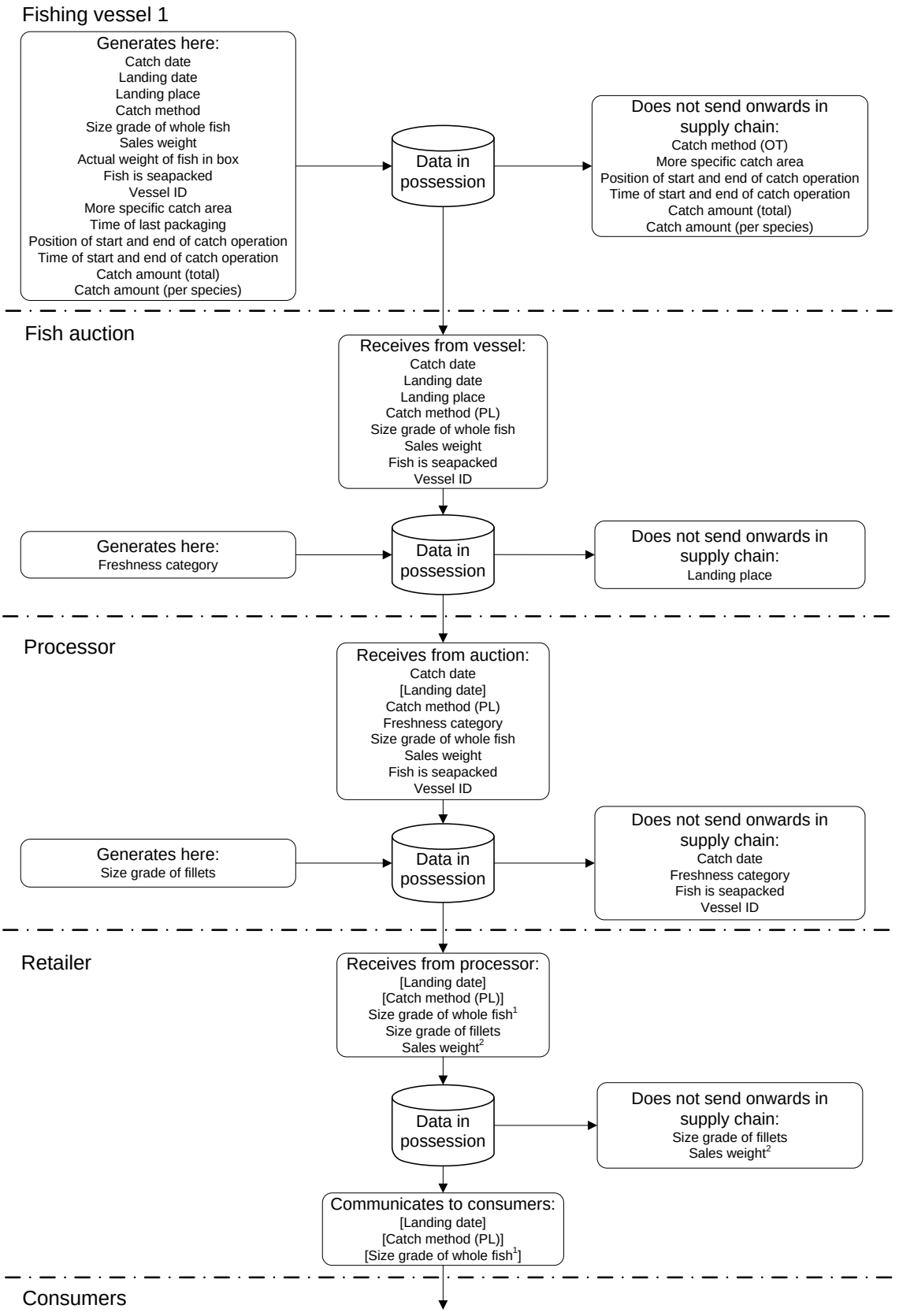

Figure 4.12. The information flow in Chain 1-1, which starts with Fishing vessel 1. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species.[1]Fish that is traded whole. [2]Sales weight of the box of fish sold at the auction when that box is traded untouched.

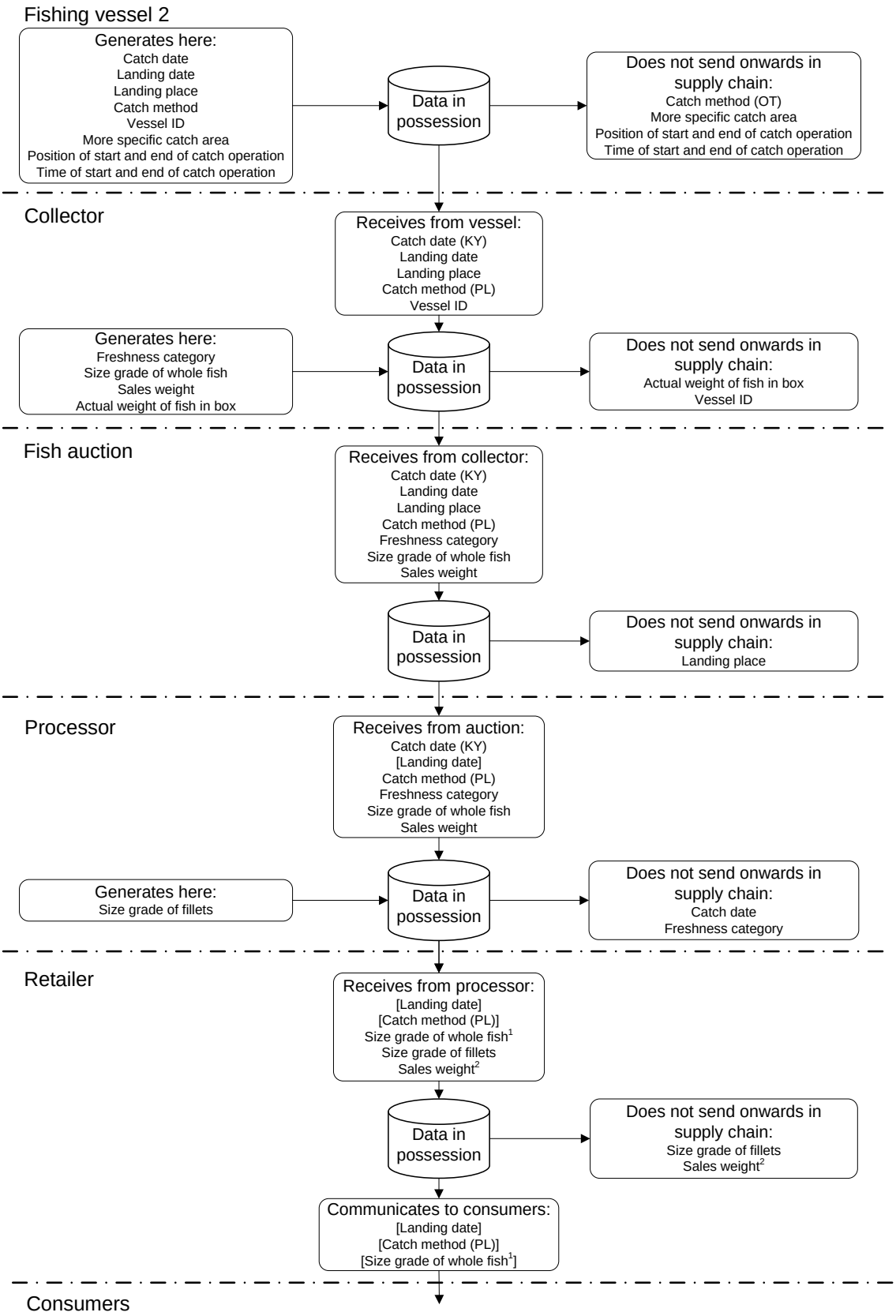

Figure 4.13. The information flow in Chain 1-2, which starts with Fishing vessel 2. KY = kystfisk. [Information type] = the information type is transferred sometimes. Catch method (PL) = Catch method for plaice. Catch method (OT) = Catch method for other species. Catch method without PL or OT = catch method for all species. [1]Fish that is traded whole. [2]Sales weight of the box of fish sold at the auction when that box is traded untouched.

to seapacked fish as to seapacked shrimps, then such information about the fish is available just one step earlier. If the processor tried to sell the advantages of seapacked fish to the retailer, then provided that the processor also passed on information about the fish being seapacked, the retailer could use the information on the fish being seapacked as part of his bonus information.

If the landing date can sometimes be sent on from the processor to the retailer, then it seems possible also to send the catch date onwards. However, the processor would preferably not send the catch date on and the retailer does not seem to be so critical about whether he receives the catch date or the landing date. If the fish is kept on ice since catch and of course if the catch date is not too long time ago, then the processor ought not to be uneasy about sending the catch date on. The processor could also make it a point to explain the use of the catch date to the retailer, inform the retailer of the catch date and thereby use the catch date actively in marketing the fish to the retailer. For kystfisk, the landing date can also provide information on the catch date, since kystfisk supposedly is caught maximum 24 hours before sale at the auction and, at the auction, the landing date is registered as being the same as the auction date. However, this requires that information about the fish being kystfisk is sent on along with information on the characteristics of kystfisk.

Since the auction in Chains 1-1 and 1-2 must be notified of the catch method for plaice, this is the catch method which is shown in Figures 4.12 and 4.13 as being sent on all the way through the chain. The catch method for species other than plaice is not actively sent through the supply chains. However, this information type may come through the chain anyway: (1) the vessel number of Fishing vessel 1 is shown on the boxes of seapacked fish, so the auction can deduce the catch method and mention it during the auction or (2) the processor may also deduce the catch method from the vessel ID on the boxes of fish from Fishing vessel 1. Either way, the processor may convey the catch method of seapacked fish species other than plaice to the retailer, and this gives the retailer the chance to communicate this information to the consumers. Also, if it is possible to send the catch method of one species throughout the chain, then it is also possible to send the catch method of other species through the chain. It requires some interest from the consumers/retailer and some effort from the processor to send it on. Fishing vessel 2 claims that it is possible to derive the catch method of his fish when it is known that it is kystfisk. This seems to be difficult, however, since kystfisk may comprise fish caught with gill net or by small trawlers. The latter information stems from the owner of Fishing vessel 2 himself.

It must be remembered that aside from the types of information that are mentioned here, the retailer must also inform the consumer about the fish species, the production method and the FAO catch area. In all, the retailer has 3-6 types of information available about the fish.

4.3.3 Importance and use of other information at each step and in the chains

4.3.3.1 Catch date and landing date

Catch date

Both fishing vessels consider the catch date very important, since the date indicates the freshness of the fish. For this reason, they believe that the buyers at the auction are very interested in the catch date. Fishing vessel 1 sends the catch date on because it is printed on the seapacking labels, while Fishing vessel 2 sends the catch date on indirectly because this is implied by the definition of kystfisk. Fishing vessel 2 is aware that one cannot equate the catch date with the freshness of the fish since the freshness also depends on how the fish has been handled and stored. However, he reasons that the more recent the catch date is of a fish the buyer buys at the auction, the longer shelf life the fish will have further in the supply chain.

On a similar note, the collector also remarks that the usefulness of a catch date and landing date depends on the handling of the fish: “A person can ruin a fish on the same day that it is caught if that is what he wants to.” The collector regards the catch date (and landing date) as important, but less important as soon as the fish has been classified into a freshness category.

The auction does not consider the catch date important since he does not use the information.

In Chains 1-1 and 1-2, the catch dates for seapacked fish and kystfisk are transferred through the auction to the processor. This is not always the case for seapacked fish and is generally not the case for non-seapacked fish. This is unfortunate, since the processor would like to receive the information, at least on a nice-to-know basis, since he thinks there is too much variation in the way the fish is handled, and thereby in the resulting quality. He says that a catch date is problematic as long as there is so much difference in the way the fish is handled. “Information about the catch date can be good enough, but they just need to be consistent all the time. Until they are consistent, then we feel most at ease by looking at the fish.” That is, if the processor knows or can trust that the fish are handled alike and well, for example by being gutted and chilled immediately, then he could probably use the catch date.

Although the processor would like to receive the catch date, he is not sure he would send the catch date onwards, since “the consumers do not always need to know everything.” However, if the processor sends the catch date to the retailer, it is the retailer’s choice whether to inform the consumers of the catch date. This must be taken into consideration because the retailer finds the information very important as an indicator of freshness. The retailer does not receive the catch date at present and he is not willing to pay more for the fish in order to receive the catch date. He believes that the consumers have no interest in the catch date. Instead, they trust the retailer’s judgment of the freshness of the fish that he puts up for sale and they trust that the quality of the fish sold by the retailer is always

good. The retailer thrives on the confidence of the customers and that is why he has many regular customers.

Although the retailer has categorized the catch date as very important, he does not have a preference for whether he receives the catch date or the landing date. He explains that this is so because he assesses the fish when he receives it and he can discern what catch method is used. If the fish has been squashed in a big trawl cod-end, then the fish does not look good and then he sends a complaint to his supplier. In other words, if the fish has been squashed, then it is meaningless that the fish was caught only 2 days ago.

Landing date

Fishing vessel 1 and the processor regard the landing date as less important than the catch date. Fishing vessel 1 is of this opinion because the catch date of his fish is visible on the seapacking labels. For the processor, the landing date can be important, but if he has the catch date, then he is indifferent about the landing date. He prefers to receive the catch date. Actually, he would like to know the following information about the fish that he contemplates on buying: catch date, storage data (presumably temperature data), catch method, and finally, towing time. He explains the latter by saying that fish towed in a trawl for 12 hours are more damaged than fish towed for only 3 hours.

The landing date is very important for Fishing vessel 2 because a very recent landing date is a sign of freshness. If a buyer buys some fish that has been landed almost the same day as it was caught, then there is a high chance that the buyer will have 5-6 days in which to sell the fish. For the collector, the landing date is important for the reasons mentioned under catch date above.

Contrary to the catch date, the landing date is very important for the auction (Table 4.9) since they must report this date to the Danish AgriFish Agency. If the fish is landed the day before the auction, it is permitted to report the landing date as the auction date.

The landing date is important for the retailer since he uses it as part of his repertoire of bonus information to the consumers in an attempt to sell the fish to the consumers.

Table 4.9. Overview of the information types which the auction considers as essential information in order to carry out an auction process.

Essential information for the auction
Landing date
Landing place
Freshness category
Size grade of whole fish
Sales weight
The fish is seapacked
MSC information (Sustainability information)
Vessel ID

4.3.3.2 Landing place

The landing place is important for Fishing vessel 2 and the collector. Since Fishing vessel 2 is less than 10 meters in length, it cannot venture far away, and thereby, the landing place gives an indication of the location of the catch grounds. For the auction the landing place is essential information in order to carry out the auction since the landing place specifies to which harbor the tax on the goods must be paid. The auction receives information about the landing place of both fishing vessels 1 and 2 from those who unload the fish from the vessels; thereafter, the landing place is registered by the auction. For both the processor and the retailer, the landing place is not important since there is no demand for this information. The processor thinks that the information might become important in 5 years' time because maybe the consumers would like to know which harbor the fish comes from. At present, there are only a few retailers that would like plaice from a specific place. Though, as the processor says, fish landed in a harbor on the west coast of Jutland can be caught in the whole North Sea (near the Faroe Islands, near Norway, etc.), indicating that the landing place does not provide that much information to the consumers.

4.3.3.3 Catch method

Fishing vessel 1 and the collector both consider the catch method unimportant, although Fishing vessel 1 has to record it in the logbook which is sent to the Danish AgriFish Agency and the collector must know the catch method of plaice. Fishing vessel 2 thinks the catch method is very important because the consumers want to know how the fish is caught.

As mentioned in Section 4.3.2.1, the collector and the auction label the boxes of plaice according to catch method, e.g. trawl, Danish seine or gill net. The catch methods are written on a slip of paper placed in each fish box. In these cases, the information about the catch method is passed on to the auction and to the buyers. The auction also records the information for plaice and when available for other species on their invoices. The collector must know the catch method of plaice, but regards information on the catch method as unimportant. The auction, though, considers the catch method to be important. The auction believes that the catch method is becoming interesting and that it will be closely related to information about sustainability and MSC. He imagines that information about the catch method and MSC will be used further in the chain.

Fishing vessel 2, the collector, the auction, and the retailer regard the catch method as an indicator of sustainability. The processor uses the catch method in marketing their products because their customers know that for example fish caught by Danish seine and longline are of a better quality than fish caught by other unspecified catch methods. According to the processor, "fish caught by longline fishing is the best one can get."

The processor receives this information sometimes and sometimes sends it onwards. He is willing to marginally pay extra for information about the catch method, but he thinks he already does so: not because there is a slip of paper indicating the catch method, but

because he pays extra for fish of a high quality. The processor can tell by looking at the fish whether it is caught by Danish seine or not. Gill net fish and trawl fish which have not been towed for more than 3 hours is also of a good quality. If the processor can physically assess the quality of the fish, then he does not need any information about catch method or catch date. If he cannot physically look at the fish, then the processor wants information about the catch method, the length of time the trawl has been towed, the catch date, etc.

For the retailer, the catch method is bonus information which he can use for marketing the fish towards the consumers.

4.3.3.4 Freshness category, size grade of whole fish, and size grade of fillets

Freshness category

The collector and the auction attach great importance to the freshness category because this information is essential to carry out an auction and because the freshness category informs the buyers about the quality of the fish. The buyers are very interested in the information according to the auctioneer, but he doubts that the information is used in the steps after the auction. The information is sent onwards through slips of paper in the fish boxes and on the invoice.

The processor receives this information but he inspects the quality of the fish anyway, since there can be some variation in the quality of the fish within each freshness category (see Section 4.1.3). The processor does not send the freshness category onwards. The retailer is unaware of the freshness category and does not receive it.

Size grade of whole fish

The steps in the chain agree that the size category of whole fish is very important. All the steps want to know what size fish they either are selling or are buying.

Fishing vessel 1 believes that the buyers are very interested in this information and that the buyers use this information when selling the fish onwards. This information is on the seapacking labels. The collector size grades the non-seapacked fish and sends the information onwards through slips of paper in the fish boxes.

The auction cannot carry out the auction without the size classification. The fish is marked with the information through slips of paper in the fish boxes, but the information is also noted on the invoices. Like Fishing vessel 1, the auction believes that the buyers are very interested in this information, although many times, the buyers divide the fish further into smaller sizes intervals. At that stage, the auction's size classification becomes irrelevant for the buyer.

For the processor, the size classification is part of the minimum requirements to be able to work with the fish (Table 4.10). The processor receives this information in the fish box

and/or on a delivery note or invoice. When the processor sells the fish onwards as a whole fish, the information about the size classification is sent along.

Table 4.10. Overview of the information types which the processor considers as essential information in order to work with the fish.

Essential information for the processor
Size grade of whole fish
Size grade of fillets
Sales weight

The retailer uses the size grade of the fish as an indication of the structure of the fish meat. His customers prefer a size 3 cod (2-4 kg/fish) because of the fine-textured meat. He says the consumers are not interested in the size grade of the whole fish, but he may inform the consumers of the size grade anyway.

Size grade of fillets

The processor and the retailer are the only steps in the chains that handle fish fillets. The processor produces fish fillets, but also receives fish fillets from other processors and wholesalers. Like for whole fish, fish fillets are also grouped into different size intervals. For both the processor and the retailer, the size grade is essential information to receive. The retailer places his orders of fillets based on the size grade. His customers are not interested in such information.

4.3.3.5 Sales weight and actual weight of fish in box

Sales weight

Each auction specifies the sales weight of the boxes of fish for each fish species and size interval. According to EEC Regulation 3703/85 (EEC, 1985), which is still effective in the current EU, a deviation of ± 5% of the sales weight is accepted. If these boundaries are exceeded, the auction, collector, and/or fishing vessel may be fined by the Danish AgriFish Agency. In practice, the boxes are never short in weight, since the buyers will not accept this. Thus, the boundary is + 5%. The sales weight is the minimum weight specified for that fish species and size interval. For example, the sales weight of a certain fish species of a certain size may be 25 kg, while the actual weight of the fish in the box may be 25.4 kg.

The steps agree that the sales weight is very important. Fishing vessel 1 and the auction say that the buyers are very interested in this information because as the collector says, this tells you how many kilograms of fish you are about to buy. If the collector cannot fill a box up to the sales weight prescribed by the auction for that species and size, then the collector will put a slip of paper in the box indicating the weight of the fish in the box, e.g. 17/25, meaning that the top box contains 17 kg and the boxes underneath in the stack contain 25 kg each.

The auction cannot carry out the auction process without the sales weight. The auction receives this information from the collector through slips of paper in the fish boxes and the information is sent onwards to the buyers both through the papers in the box and on the invoice. The sales weight also forms part of the minimum requirements for the processor. When the processor sells the fish untouched in the fish box from the auction, this information is also sent along to the customer. Whether the retailer receives a box of fish untouched since the auction or a box of different species of fish, the retailer uses the sales weight to carry out random checks if his suppliers have packed the correct amount of fish in the box.

Actual weight of fish in box

The actual weight of fish in the box is very important for Fishing vessel 1, the collector and the auction because they may receive fines if the weight of the box exceeds the permitted ± 5% weight deviation. It is important for Fishing vessel 1, but not Fishing vessel 2, because Fishing vessel 1 seapacks the fish. Thus, Fishing vessel 1 is responsible for the weight of the fish in their boxes if the Danish AgriFish Agency inspects the vessel upon landing. The auction takes random samples from each batch in the auction hall and checks that the weight of the fish in the box does not exceed the ± 5% boundaries. The Danish AgriFish Agency may check the weight of the fish and if they happen to find an infringement of the ± 5% rule, then the auction receives a fine, even if the auction found that the random sample they took from the same batch was within the ± 5% boundaries. This rule is made to prevent over-exploitation of the quota for each fishing vessel. According to the auction, the fishing vessel does not receive any income for the overweight, whether the overweight is within or exceeds the + 5% boundary.

However, one could imagine that if a fishing vessel had built up a reputation for packing e.g. 27 kg fish in boxes with a sales weight of 25 kg, then there may be a high probability that that fishing vessel's fish will be sold at a higher price compared to other fish of the same species, catch date, quality, size, etc. That way the fishing vessel would indirectly receive some income for the extra overweight in the boxes.

The actual weight of the fish in the box is not important for the processor and he does not wish to receive this information. He knows that the actual weight is always higher than the sales weight.

4.3.3.6 Fish is seapacked, sustainability information, and vessel ID

Fish is seapacked

Information that the fish is seapacked is very important for Fishing vessel 1 and the auction. Fishing vessel 1 believes that the buyers are very interested in this information and that they use this information when they sell the fish onwards. Fishing vessel 1 sends this information on by way of the seapacking label that is on each box.

Information that the fish is seapacked is very important for the auction because this means that the fish boxes must be labeled with the vessel number and that the auction must

check the weight of the batch by random sampling. The latter entails both checking the weight of the individual fish to see if the size grading is correct and checking the weight of all the fish in the box to make sure that the weight does not exceed +5% of the sales weight. The auction cannot carry out the auction without information on whether the fish is seapacked or not. The information is sent on to the buyers via the boxes, but not on the invoice, since this has not been a demand. According to the auction, the buyers are very interested in this information. Some buyers choose seapacked fish because the fish retains its quality better, but other buyers, who want large, homogeneous batches, would rather buy fish graded by the collector since they have very big batches.

When the processor buys fish from an internet auction, it is important for him to know that the fish is seapacked. When he buys fish from the auction in this case study, then it is not so important to know that the fish is seapacked because in such situations, he can assess the fish physically before he buys it.

The retailer considers seapacking important when it regards shrimps, but not important when it regards fish. The retailer uses this information as bonus information when marketing shrimps to the consumer. When shrimps have been packed and cooked at sea, the retailer always receives information about this. The retailer believes that fish can tolerate the extra handling at a collector and thus, he has no preference for seapacked fish.

Sustainability information

The expression “sustainability information” was used during the interviews and is also used in Tables 4.11 and 4.12 regarding importance. When the steps were asked whether they received/forwarded sustainability information, they only considered MSC-certification. Therefore, the expression “MSC information” is used in the flow diagrams in Figures 4.9-4.11.

The collector and the processor regard sustainability information as not important because there is not so much demand for this type of information. However, the processor says that MSC can be important in the future. He sometimes receives information that the fish is MSC-certified, but he does not use the information yet.

It is very important for the auction to receive information on whether the fish is MSC-certified because the buyers are very interested in this. Other sustainability information is not interesting. The information is sent onwards in the box and on the invoice. According to the auction, the information is certainly a piece of information which will be used throughout the chain since it is meant to end as consumer information in the supermarket.

Sustainability information is bonus information for the retailer, i.e. information that he uses for story-telling to his customers. Therefore, he considers sustainability information important. He always receives the information, at least for shrimps, because it is written on the package.

Vessel ID

The name or number of the fishing vessel is very important for the two fishing vessels and the auction. The fishing vessels mention that when the buyers know which vessel has caught the fish, then they also know which catch method has been used. Furthermore, according to Fishing vessel 1, if buyers were satisfied with the fish they bought, then they can buy fish from the same fishing vessel next time. Fishing vessel 2 says that the buyers can even call the auction and inquire when a certain vessel will land its fish. Similarly, if they are dissatisfied with the fish purchased, then the buyers can make a complaint about the fish directly to the fishing vessel (and perhaps also avoid buying fish from that vessel in the future). Fishing vessel 2 believes that the buyers are very interested in this information because it provides a higher level of traceability and because the vessel ID provides information on the sustainability of the catch method. The information is sent on through the seapacking labels and through the label "kystfisk." In the latter case, the buyer can ask the collector which vessels landed kystfisk of a certain species and size on a certain day.

The collector regards the vessel ID as unimportant, but mentions that sometimes the buyers enquire about which vessel has caught certain fish because they would like information on the catch method and thereby, sustainability information.

The name or number of the fishing vessel is very important for the auction because they must record this information and report it to the Danish AgriFish Agency. For fish received from the collector, the collector's name is reported and the collector can be contacted for a list of the fishing vessels that contributed to a certain batch. For seapacked fish, the information is sent on in the supply chain through labels on the boxes and on the invoice. Like the fishing vessels, the auction says that the buyers use the ID of the vessel to provide them with information on the catch method, which in turn supplies some sustainability information.

The processor and the retailer say that identification of the fishing vessel is unimportant. Though, the processor, who receives this information for seapacked fish, says that the information can be used to keep track of which vessels usually have good-quality fish. He mentions that the vessel ID can become important in the future. The retailer does not find the vessel identification relevant for other than high-value products like genuine caviar in which case the caviar is traceable back to the individual fish.

4.3.3.7 More specific catch area, fish box number, time of last packaging, former step is quality certified, and temperature records

More specific catch area

More specific information about the catch grounds than the FAO areas required by EU Regulation 104/2000 and EU Regulation 2065/2001 is important for the auction but unimportant for the other steps.

The auction believes that more detailed information on the catch area is gaining ground and is beginning to be important. This information is not needed now to sell the fish at the auction, but the information is "nice to have." The auction thinks that future regulations on traceability will require a more specific catch area than what is currently required. Presently, the auction does not think that the buyers would pay extra to know specifically where the fish is caught. However, he thinks that in the future, the consumers will require more information about the catch area. Though, one should have in mind that the consumer most likely cannot relate to areas that are more specific than the Skagerrak, the Kattegat, and the North Sea. Thus, the auction predicts that the more detailed catch area descriptions will be at that level, and not for example at the level of the ICES squares (Appendix 1).

A more specific catch area is not important for the processor now, but maybe in five years' time, the consumers would like to know where the fish is caught. The processor says that no one has any relation to where in the North Sea the fish is caught, indicating that the description of a more specific catch area must not be too specific. This may be the reason why the retailer says that the information might be interesting for freshwater fish like pike-perch. In other words, the consumers might have more of a relation to freshwater bodies of water and moreover, these bodies of water are most often much smaller than bodies of sea water. The retailer would consider this bonus information, but not a very interesting one.

Fish box number

An identification number on the fish boxes is not important for the steps except for the processor. Although the processor fails to explain why he finds a fish box number important, perhaps he would like to use a fish box number to link the contents of the box with his intended use of the fish once the fish arrives at the processor's site. This is explained further in Section 4.3.4.1. The processor does not receive this information, but since he considers the information important, this indicates that perhaps he would like to receive the information.

The auction says that the fish box number may become important in the future when they begin to use the fish boxes with embedded RFID tags. Each fish box will have its own unique identification number. The number will then be the link to the electronic database where all the information about the fish in that specific box is stored.

Time of last packaging

The time that the last packaging has taken place is not important to the majority of the steps. This information type is not interesting for them and the steps do not receive this information. The exception is Fishing vessel 1, who regards this information as very important because, in his opinion, the buyers at the auction are very interested in this information. He claims that the buyers use this information when they sell the fish onwards. Fishing vessel 1 says he sends this information onwards as it is printed on the seapacking label.

The processor says that perhaps the printing of the time of last packaging can make the workers in the steps before the processor more aware of keeping the fish at a low temperature and packing the fish quickly. However, the processor does not want to pay for information about the time of last packaging.

Former step is quality certified

All the steps that have a former step agree that information about the former step being certified against a quality standard is not important. This is probably a natural reaction since none of the steps' suppliers are quality certified. In addition, the processor does not have high thoughts on the quality of fish at a retailer that is certified against ISO 22000.

Temperature records

Both fishing vessels regard temperature records as irrelevant. Both fishing vessels are aware of the temperature requirements but do not record the temperature. However, the temperature in the hold of Fishing vessel 1 is shown in the wheelhouse.

For the collector, auction, processor, and retailer, temperature records are not important. The temperature of the fish and of the rooms where the fish is stored is important, but there is no demand for records. The temperature records could become important if one of the steps must show documentation that the fish has been under a certain temperature. The collector and the auction check the temperature in their storage rooms, but only make records of the temperature if it is too high. They have not had any demands for temperature records from the buyers.

Temperature records of the fish are unimportant for the retailer because he can see if there is ice on the fish upon reception, indicating to him that the fish is cold enough. Also by looking at the fish, the retailer can tell whether the fish has been stored at too high a temperature earlier in the chain. He says that as long as his quality inspection is good enough, then he does not care what his suppliers do. He will send a complaint if the fish is not fresh, and have some new, fresh fish sent. If the supplier makes too many mistakes like that, then the retailer will find a new supplier. The retailer regards the following aspects of fish handling as more important than the temperature records: that the fish is placed nicely with its belly on ice, that the fish is not thrown into the box, that the fish does not have a broken neck, and that the fish is packed neatly.

4.3.3.8 Position of start and end of catch operation, time of start and end of catch operation, catch amount (total), and catch amount (per species)

During the interviews, these types of information were only offered for commenting to the fishing vessels since they were deemed irrelevant for the other steps in the chain.

Fishing vessel 1 regarded them all as most important, while they were not important for Fishing vessel 2. These four information types are important for Fishing vessel 1 because they must be sent to the Danish AgriFish Agency via the vessel's fishing logbook. If they give erroneous information to the Agency, then they will be fined. The information is not

sent to the auction or to the buyers. According to Fishing vessel 1, the buyers are not interested in these information types. The Danish AgriFish Agency uses the information to check whether the fishing vessel conducts their catch operations in the permitted areas and within their quota.

Fishing vessel 2 does not record these types of information due to the type of his fishing license ("Declaration of catch area," see Section 4.3.1.3).

4.3.3.9 Discussion

The importance of the information types for each step is summarized in Tables 4.11 and 4.12. The reception of information is also shown according to the information flow in Chains 1-1 and Chains 1-2 (i.e. Figures 4.12 and 4.13). Hence, the data in Tables 4.11 and 4.12 give an indication on whether the steps receive the information types that they consider important.

Fishing vessel 1, Fishing vessel 2, and the collector

Fishing vessel 1 generates all the information that they consider most important (Table 4.11). Likewise, Fishing vessel 2 and the collector either produce or receive all the information that they consider most important and important (Table 4.12).

Fish auction

In Chains 1-1 and 1-2, the fish auction produces or receives all information that they consider most important except the actual weight of fish in the box and sustainability information in addition to the vessel ID in Chain 1-2.

It has been mentioned before (Section 4.3.2.8) that Fishing vessel 1 claims that they forward the actual weight of fish in the box to the auction, but that the auction does not receive it. The actual weight is printed on the label of every box of seapacked fish from Fishing vessel 1, so perhaps the auction should be notified that they actually do receive the actual weight from some vessels. However, the reason why the actual weight is most important for the auction is that the auction randomly checks if the weight of the fish in the boxes is within the ± 5% weight deviation permitted (Section 4.3.3.5). Thus, the auction does not produce this information for all the boxes. Further, even if the auction did receive the actual weight for all the boxes from Fishing vessel 1, they may still feel that they need to make a random check of the actual weight since they, along with the vessel, are also accountable for the weight of the fish in the boxes. The auction does not receive the actual weight of each box of fish in Chain 1-2, either.

Sustainability information was only received by the auction if the fish were MSC-certified. Since neither Fishing vessel 1 nor Fishing vessel 2 provides MSC-certified fish, the auction cannot receive this information in Chains 1-1 and 1-2.

The vessel ID is considered most important by the auction, but they do not receive this information in Chain 1-2 (Table 4.12) because fish from the different vessels may be

Table 4.11. Importance of the different types of information for the steps in chain 1-1. (Two filled symbols = most important, one filled symbol = important, one unfilled symbol = not important, n.a. = not applicable[1]. ▲ = information that the step generates itself, ■ = the information is always received, ◆ = the information is received only sometimes, ● = information that the step does not receive. Reception/generation of the information is shown according to Figure 4.12.)

Information types	Steps			
	Fishing vessel 1	Auction	Processor	Retailer
Catch date[2]	▲▲	□	■	●●
Landing date	▲	■■	◇	◆
Landing place	△	■■	○	○
Catch method[3]	△	■	■	◆
Freshness category	n.a.	▲▲	□	○
Size grade of whole fish	▲▲	■■	■■	■■
Size grade of fillets	n.a.	n.a.	▲▲	■■
Sales weight[4]	▲▲	■■	■■	■■
Actual weight of fish in box	▲▲	●●	○	○
Fish is seapacked	▲▲	■■	■	○
Sustainability information	n.a.	●●	○	●
Vessel ID	▲▲	■■	□	○
More specific catch area	△	●	○	○
Fish box no.	○	○	●	○
Time of last packaging	▲▲	○	○	○
Temperature records	n.a.	○	○	○
Former step is quality certified	n.a.	○	○	○
Position of start and end of catch operation	▲▲	n.a.	n.a.	n.a.
Time of start and end of catch operation	▲▲	n.a.	n.a.	n.a.
Catch amount (total)	▲▲	n.a.	n.a.	n.a.
Catch amount (per species)	▲▲	n.a.	n.a.	n.a.

[1]n.a. covers situations in which the information type is not available for the step because the information is produced later in the chain and situations in which the interviewed step has deemed the information type irrelevant.

[2]Importance is shown in general. Reception/generation of the information is shown according to Figure 4.12 (seapacked fish).

[3]Importance is shown in general for all species. Reception/generation of the information is shown according to Figure 4.12 (catch method in general for Fishing vessel 1; catch method for plaice for the rest of the chain).

[4]Importance is shown for the sales weight of the boxes of fish for sale at the auction for all steps except the retailer. Importance for the retailer regards the sales weight of the boxes of fish that he receives from his suppliers which may be comprised of different species of fish. Reception/ generation of the information is shown according to Figure 4.12 (i.e. sales weight of the auction box for all steps).

Table 4.12. Importance of the different types of information for the steps in chain 1-2. (Two filled symbols = most important, one filled symbol = important, one unfilled symbol = not important, n.a. = not applicable[1]. ▲ = information that the step generates itself, ■ = the information is always received, ◆ = the information is received only sometimes, ● = information that the step does not receive. Reception/generation of the information is shown according to Figure 4.13.)

Information types	Steps				
	Fishing vessel 2	Collector	Auction	Processor	Retailer
Catch date[2]	▲▲	■	□	■	●●
Landing date	▲▲	■	■■	◇	◆
Landing place	▲	■	■■	○	○
Catch method[3]	▲▲	□	■	■	◆
Freshness category	n.a.	▲▲	■■	□	○
Size grade of whole fish	n.a.	▲▲	■■	■■	■■
Size grade of fillets	n.a.	n.a.	n.a.	▲▲	■■
Sales weight[4]	n.a.	▲▲	■■	■■	■■
Actual weight of fish in box	n.a.	▲▲	●●	○	○
Sustainability information	n.a.	○	●●	○	●
Vessel ID	▲▲	□	●●	○	○
More specific catch area	△	○	●	○	○
Fish box number	n.a.	○	○	●	○
Time of last packaging	○	○	○	○	○
Temperature records	n.a.	○	○	○	○
Former step is quality certified	n.a.	○	○	○	○
Position of start and end of catch operation	△	n.a.	n.a.	n.a.	n.a.
Time of start and end of catch operation	△	n.a.	n.a.	n.a.	n.a.
Catch amount (total)	n.a.	n.a.	n.a.	n.a.	n.a.
Catch amount (per species)	n.a.	n.a.	n.a.	n.a.	n.a.

[1]n.a. covers situations in which the information type is not available for the step because the information is produced later in the chain and situations in which the interviewed step has deemed the information type irrelevant.

[2]Importance is shown in general. Reception/generation of the information is shown according to Figure 4.13 (catch date in general for Fishing vessel 2; catch date for kystfisk for the rest of the chain).

[3]Importance is shown in general for all species. Reception/generation of the information is shown according to Figure 4.13 (catch method in general for Fishing vessel 2; catch method for plaice for the rest of the chain).

[4]Importance is shown for the sales weight of the boxes of fish for sale at the auction for all steps except the retailer. Importance for the retailer regards the sales weight of the boxes of fish that he receives from his suppliers which may be comprised of different species of fish. Reception/ generation of the information is shown according to Figure 4.13 (i.e. sales weight of the auction box for all steps).

mixed at the collector. As explained in Section 4.3.3.6, the auction does not need the vessel IDs in such cases. Therefore, it is not a problem that the auction does not receive the vessel ID even if they consider this important information in general.

The auction considers the catch method (in general) and the more specific catch area important, but only receives the catch method for plaice from the fishing vessels. If Fishing vessel 1 only uses a trawl, then one could say that given the vessel ID, then the auction could deduce the catch method for the vessel's other fish species. In both chains, however, if it is possible to send the catch method of plaice on to the auction, then it must also be possible to forward the catch method of other species.

The more specific catch area is naturally produced by the fishing vessels but the information is not sent on because, according to Fishing vessel 1, no one has requested this. The auction believes that more detailed information on the catch area is gaining ground and predicts that such information will be demanded in the future. For this reason, it would be a wise step for the vessels, the collector, and the auction to examine at which level of detail the more specific catch area can be passed on. It must be possible to make the more specific catch area large enough (but of course smaller than FAO fishing area 27) for the collector to be able to include fish that are pooled into one batch from different vessels. However, a requirement of EU Regulation 1224/2009 (effective as of Jan. 1, 2012) is that at the auction, a batch of fish must be labeled with the vessel ID and the so-called relevant geographical area (which is smaller than a FAO fishing area). In other words, aside from one exception pending further explication from the EU, fish from different vessels cannot be pooled any longer and then one of the obstacles blocking the transfer of the more specific catch area (and the vessel ID) along with the fish is removed.

Processor

In both chains, the processor receives and/or produces the three information types that he considers most important: the size grade of whole fish, the size grade of fillets, and the sales weight. The processor produces the size grade of fillets in Chains 1-1 and 1-2, and when he receives fillets from other processors, he receives this information. Only the former situation is depicted in Tables 4.11 and 4.12.

With regards to the important information types, the processor receives the catch date for seapacked fish and kystfisk fish and, only for Chain 1-1, information that the fish is seapacked. The processor also considers the catch method and the fish box number important. He always receives the catch method for plaice in these two chains so, as explained above, it should be possible to forward the catch methods for other species as well. Numbers on the fish boxes did not exist at least at the time of this investigation. Therefore, the processor could not receive them.

Retailer

Just like the processor, the retailer also receives, in both chains, the size grade of whole fish, the size grade of fillets, and the sales weight, all of which are most important to him.

The catch date is also rated as most important by the retailer, but he does not receive this. Instead, he uses the landing date as part of his bonus information. The landing date and catch method are important for the retailer and he receives them sometimes in these chains. Sustainability information is also important for him, but since fish from the two fishing vessels are not MSC-certified, the retailer does not receive any sustainability information in these chains.

Summary

To summarize, there are 6 types of information which the steps regard as important but which they do not always obtain (Table 4.13). Catch method and catch date would also be appreciated by other steps than shown in Table 4.13. Tables 4.11 and 4.12 show that the auction and processor receive the catch method, but it is only the catch method of plaice that they can be sure of receiving in these chains. Similarly, the processor would like to receive the catch date for not just kystfisk or seapacked fish, but for all fish. As mentioned earlier, the auction and retailer would like to receive sustainability information, but since the two fishing vessels in this study do not provide MSC-certified fish, the auction and retailer cannot receive this information in these chains.

Table 4.13. Overview of the information types which the steps consider important and most important but do not receive or do not always receive (the latter in square brackets). Based on data in Figures 4.12 and 4.13 and Tables 4.11 and 4.12.

Importance of information	Steps		
	Auction	Processor	Retailer
Most important	Actual weight of fish in box		Catch date
Important	More specific catch area	Fish box no.	[Landing date] [Catch method]

4.3.4 Wishes and suggestions

4.3.4.1 Wishes from the steps

Based on the results presented in Section 4.3.3, it is possible to make a list of the information types that the steps would like to receive (Table 4.14). These wishes will be addressed below.

Table 4.14. Types of information which the steps wish to receive.

Information type	**Steps involved**
Catch date	Processor, (retailer)[1]
Landing date	Retailer
Catch method	Auction, processor, retailer
Sustainability/MSC information	Retailer, (processor)[1]
More specific catch area	Auction, processor
Batch number	Processor
Temperature records	Processor
Length of towing time	Processor

[1] The steps in parentheses have not said that they wish to receive the information type concerned, but it could be beneficial for them to receive it or to forward it.

Catch date

The processor would like to receive the catch date on a nice-to-know basis. In his opinion, he cannot use solely the catch date as a measure of the quality status since the fish are handled in various ways and stored under varying conditions on their way from catch until they are put up for sale at the auction. Because of this, the processor has stated that he would like to receive the catch date, storage data (presumably temperature records), the catch method and in the case of trawled fish, the length of the towing time. He would especially like to receive these types of information if he cannot see the fish himself (e.g. if he is to buy fish through an internet auction or from another processor/wholesaler).

The retailer regards the catch date as important as an indicator of freshness, but it is regretful that he does not use the information and actually seems indifferent about whether he receives the catch date or the landing date. Given information on how the catch date can be used and other information types to supplement the catch date as well as confidence that the catch date can be trusted, perhaps the retailer could begin to appreciate the catch date as a trustworthy information type that could prevent him from having faulty fish delivered. If the retailer receives fish that he finds unsuitable to be sold, then it could leave him with a short supply of fish, he could lose some income, and the processor could incur an extra expense as a result of sending a new delivery of fish to the retailer.

Since the processor can forward the landing date, it should be possible for him to forward the catch date, provided that he has access to it. For the processor, this probably requires that he has nothing to hide with regards to the catch date and/or that he is relatively sure that the fish has been stored on ice since catch. Then the processor can also use the catch date actively when marketing the fish.

Landing date

The retailer would like to receive the landing date because this information type is part of what the retailer calls bonus information. Since he uses the bonus information to market the fish, he would preferably like to receive the information types that comprise the bonus information for all the fish he orders and not just occasionally.

Catch method

The catch method is mainly requested by the processor because the catch method provides an indication of the quality of the fish and because the processor uses the catch method when marketing the fish. In addition, as mentioned under catch date, the catch method is one of the information types that the processor would like to have in order to assess the fish when he is not able to physically see the fish.

The catch method is not demanded as such by the auction, but the auctioneer says this information type is becoming interesting and he imagines that this information will be used later in the chain. For the retailer, the catch method is desirable due to it belonging to the group of bonus information.

Sustainability/MSC information

Sustainability information in the form of MSC-certification is bonus information for the retailer and therefore, he would like to receive it. For the processor, it would be a good idea to ensure that he receives and records the sustainability information if the fish he buys is MSC-certified, since he acknowledges that MSC information can be important in the future and that he sometimes receives this information, but that he does not use the information yet. He may be able to take advantage of this information when selling fish to customers that seek MSC-certified fish and who might be willing to pay extra for MSC-certified fish. However, the processor will have to be MSC-certified first.

More specific catch area

A more specific catch area is mentioned by both the auction and the processor as information that is gaining ground and that may be demanded later in the chain in the near future.

Batch number

The processor would like the auction to place some labels on the fish boxes, so that the processor can identify the boxes when they arrive at his production site. The processor has problems keeping track of which boxes of fish were intended for which customers. With these labels, it will be easier for the workers in the packaging section to know which fish were intended for which customers. The processor's idea is to have a batch number on these labels. This means that each time the collector makes a batch containing fish of a defined species, freshness, and size, then the collector should give the batch a number, which all of the boxes belonging to that batch should be labeled with. Similarly, the auction should give batch numbers to the seapacked fish. The idea is that when the processor buys the fish at the auction, the processor can make a note to himself that, for example, the 8 boxes he bought from batch number 645 is intended for customer X or is good for product Y. However, according to the processor, neither the collector nor the auction is willing to label the fish boxes in this way. As a consequence, the processor will start to label the fish himself upon buying the fish at the auction.

EU Regulation 1224/2009 includes a clause (Article 58(5) point (a)) requiring lots of fish at the first point of sale to be labeled with a lot identification number. This regulation is in effect from Jan. 1, 2012 and could seem to solve the processor's wish for batch numbers. A lot before the first sale constitutes fish from the same vessel, but may include fish of differing catch dates, since it is permitted to state the catch date as one period of time including several catch dates (EU Reg. 404/2011, Article 67(9)). The lot will still have to be divided into freshness categories, so whether the lot identification number is changed or the freshness category is somehow added to the original lot identification number, one has the opportunity to identify a lot of fish from the same vessel, with the same freshness category and of either one catch date or a group of catch dates. This would accommodate the processor's wish of batch numbers. A challenge could be posed if the boxes of fish have electronic batch numbers because then the processor cannot write them down and correlate them to his intentional use of the fish in the boxes.

Temperature records

The processor mentions that he would like to receive temperature records together with the catch date, the catch method, and the towing time in order for him to attain the best impression of the quality of the fish. The temperature records will assure the processor that the fish has been stored at the optimal temperature since catch.

Length of towing time

The producer is interested in the time that a trawl has been towed because this may influence the appearance and the stress level of the fish. These factors may have an effect on the overall quality of the fish and may determine the use of the fish.

4.3.4.2 Other suggestions

Although the steps may not have mentioned them, there are also other possibilities regarding which information types it would be advantageous for some steps in the chain to receive. These are listed in Table 4.15 and discussed below.

Table 4.15. Types of information which, if received, may possibly give the steps mentioned an advantage.

Information type	Steps that may use the information
Actual weight of fish in the box	Auction
Fish is seapacked	Retailer, processor
Vessel ID	Retailer
Landing place	Retailer

Actual weight of fish in the box

Since Fishing vessel 1 prints the actual weight of fish in each box of seapacked fish, the auction could perhaps put these actual weights to some use. Maybe the auction could have the weights sent electronically and then check the actual weight of the fish in those boxes where the actual weight is close to the upper limit (+ 5% overweight). It would be most cost-saving if the auction trusted the stated weights and therefore would not need to use time to check the weight of the fish in random samples of fish boxes. If this was the case, then it would be desirable for all seapacking vessels to write the actual weight of fish in the box on the seapacking labels.

Fish is seapacked

The retailer would like to receive the information if the shrimps that he buys are seapacked, since he considers this bonus information. He is indifferent when it regards fish that are seapacked. Since the processor has mentioned that he finds seapacked fish of a better quality and since the processor always receives the information if the fish is seapacked, it would be a possibility for the processor to explain to the retailer that seapacked fish has been handled one time less than other collector-packed fish and to try to sell seapacked fish to the retailer. Perhaps the processor may be able to demand a higher price for seapacked fish.

Vessel ID and landing place

The vessel ID and the landing place are information types that could be used by the retailer as information for storytelling, i.e. to market his fish by making them more interesting for the consumer.

4.3.5 Traceability in the steps and in the chain

In the previous sections of Chapter 4, the exchange of information between the steps has been elucidated. In order to exchange information about a certain batch of fish, it is necessary to be able to identify the batches of fish so that the information associated with the fish can be linked to the right batch. This section will describe the traceability systems of the six steps in brief. In addition, the steps' experience with a practical use of traceability systems, namely recalls, will be covered. Lastly, the steps' satisfaction with their levels of traceability will be reported.

4.3.5.1 Levels of traceability

Fishing vessel 1

Each box of fish packed by Fishing vessel 1 can be traced back to the specific trawl haul that it originated from based on the information available on the seapacking label, which is the data carrier. Much information can be read on the seapacking label, including the species, the size, the sales weight, the actual weight of fish in the box, the catch date, the vessel ID, and the time of packaging. The more specific catch area is not printed on the label, but Fishing vessel 1 would be able to inform a customer of that if they made a request. The view of Fishing vessel 1 is that the more information they can provide and the more beautiful and fresh the fish is, the more money the fish is able to bring in.

The fishing vessel is readily able to provide a customer with more information because the information is stored in the electronic fishing logbook and/or the computer program that creates the seapacking label. For example, the more specific catch area for each haul is recorded in these databases.

The fish can be traced back to Fishing vessel 1 and the haul of origin as long as the fish is still in the original box with Fishing vessel 1's label attached. Alternatively, the fish can also be traced if the information from the label is recorded e.g. on paper or in a database and there is assurance as to which fish the information describes.

Fishing vessel 2

When Fishing vessel 2 lands his fish at the collector, his fish can be traced back to a batch consisting of all the fish caught by the vessel in one day. The batch is made up of different species of different sizes, but caught with the same catch method.

There is a lack of information about whether Fishing vessel 2 places any type of data carrier in his boxes of fish. If he does, the most likely carrier would be a slip of paper indicating the vessel ID. However, it is not necessary since the fisherman only goes on

fishing trips of one day, so fish from different catch dates cannot be mixed while he is in possession of the fish. A problem could arise when he delivers the fish to the collector. Either he may give oral information to the collector or the collector places paper notes in the boxes identifying the vessel that caught the fish. In any case, the collector must be informed of the vessel ID, the catch date if it is to be labeled kystfisk, the catch method, and the catch area. These information types combined serve to identify the batch delivered by Fishing vessel 2.

If the fish from Fishing vessel 2 is mixed with fish from other vessels at the collector, the fish cannot be identified as coming from Fishing vessel 2 by a potential customer, since there is no visible communication of which fishing vessels caught the fish. The collector claims that he is able to identify the fishing vessels that have contributed fish to that new batch. Even if the fish from Fishing vessel 2 was not mixed with fish from other vessels at the collector, it is still doubtful whether they would be marked with the identification of the fishing vessel when the boxes leave the collector.

Collector

When a vessel lands fish at the collector, information about the fish is written on a so-called weighing-in form. The data recorded about the fish include the species, the catch method, vessel ID, catch area, landing date, landing place, the freshness category, sometimes catch date and if relevant, kystfisk. These records are kept for only one week after the settlement of accounts. The accounts are settled within a day of the landing.

Fish from one vessel is sometimes placed apart from other fish of the same characteristics, for example if the batch is large or if the grader has observed something different about the batch. At other times, fish of the same characteristics but from different vessels are packed together. In these cases, the collector knows which vessels' fish are included in the mixed batches. The characteristics that the fish are graded according to are the species, the size, and the freshness category. Furthermore, the fish may also be graded according to the catch method and according to whether they fall into the kystfisk category. Thus, fish that has been packed by the collector may be traceable back to either the fishing vessel that caught the fish or a group of fishing vessels.

The data carriers consists of paper notes placed in the boxes denoting the size, the freshness category and when relevant, a piece of paper identifying the fish as kystfisk. Sometimes the catch method may also be written on a piece of paper in the boxes.

Fish from the collector can be identified as such only as long as there are slips of paper in the boxes indicating the collector's name, the size of the fish, and the freshness quality. Other information such as kystfisk and the catch method may also be in some boxes. The collector will be able to state which fishing vessels have delivered fish of those characteristics on a certain day, but if there are two batches with the same characteristics, it is unknown whether the collector can identify the vessels that have contributed to precisely that batch based on the information in the boxes. However, as of January 1,

2012, the collector will have to provide fish of the same species, from the same "relevant geographical area," and from the same fishing vessel a lot number, so then they will be able to distinguish the batches from each other (see Section 2.1.2.2).

Auction

There is no handling of fish at the auction and therefore, the auction does not mix batches of fish. Any joining of fish batches from different vessels occurs at the collectors. In the words of the auction, a collector is "poison" and is a "dreadful" step to be mindful of with regards to traceability. Though, the auction acknowledges that collectors will have to mix the fish as long as there are many small fishing vessels.

At the auction, fish labeled as kystfisk are traceable back to a batch consisting of kystfisk from a certain collector on a certain date. Then the collector that has graded and packed the fish has a list of which vessels landed kystfisk on that date. Fish from a collector, whether kystfisk or not, will almost always be from a group of vessels, but the collector knows which vessels comprise that group. The batches are smaller when the collectors split (and label) the batches on the basis of the catch methods.

Seapacked fish is identified through the label and they can be traced back to the vessel. Not all seapacked fish is labeled with the catch date.

The seller of a batch of fish that a buyer has purchased at the auction is written on the invoice along with other information to identify the batch of fish. If the fish is seapacked, the seller is written as the fishing vessel ID and if the fish is packed by a collector, the seller is denoted as the name of the collector.

The slips of paper and/or sticker labels placed in the fish boxes by the collector and the seapacking vessels remain in the boxes during the auction. Aside from classifying seapacked fish into freshness categories, the auction does not place any more information in the boxes that could identify the batch of fish. A batch of fish at the auction is often divided because different parts of the batch are sold to different buyers.

Processor

The processor keeps the batches purchased at the auction separated as far as possible, but sometimes a customer of his may receive a delivery consisting of some boxes from one batch and some boxes from another batch. Thus, in general, the processor can trace his outgoing products back to a batch consisting of all the fish of the same species that was packed by them on a certain date. With the new system of batch numbers that the processor will place in each box of fish that he buys at the auction, he hopes to be able to distinguish more precisely which batch at the auction the fish comes from and further, who has received fish from precisely that batch. If he buys 10 boxes each of good quality and poor quality category A fish, then his wish is to be able to isolate the 10 boxes of poor quality category A fish, such that if a recall of the poor quality category A fish is necessary, he will only have to recall those 10 boxes of fish and not all 20 boxes.

If the processor receives complaints, then it is difficult for him to know which batch at the auction the fish comes from due to lacking unique identification. The outgoing fish is only labeled with the packaging date, the weight of the fish in the box, the species, and the size of the fish. This is not enough to trace the fish back to the original batch that it came from. The processor plans to label the outgoing products with the batch number corresponding to the batch bought at the auction and from which the products are made. Then the fish will be identifiable back to the original batch.

Information about the fish received by the processor from the auction and other processors are transferred through paper slips in the boxes, labels on the boxes, invoices, and consignment notes.

The processor relates that at the national border, the traders put new labels with new packaging dates on the packages. Such a practice can make it difficult to trace the fish if the packaging date is used as an identifying piece of information, since there must be a link between the old and the new packaging date. With the new legislation enforcing the establishment of batch numbers from the start of a supply chain (i.e. the fishing vessel for wild-caught fish), there is hope that either the practice of renewing the packaging date will fade away or that the batch numbers will simplify the traceability of such exported products.

Retailer

When the retailer receives fish, he receives the following information along with the fish: catch area, amount of fish, species, the date that the retailer received the fish, and the price. The information is printed on labels on the package and on consignment notes.

The retailer makes sure that the oldest fish is sold first by filleting the oldest fish first. If there is some unsold fish from the day before, those fish are arranged at the front of the refrigerated display counter. The newer fish are placed at the sides and at the back, such that it is the older fish that are in focus. The older fish are most often filleted while the newer fish are still whole. This indicates that the physical location of the fish designates the date of receipt of the fish. It is thus assumed that the fish can be traced back to a batch consisting of one day's delivery, although there is some uncertainty associated with this method.

4.3.5.2 Handling of recalls, withdrawals, and complaints

Fishing vessel 1

Fishing vessel 1 has not had to withdraw or recall any products and has only once received a complaint from the auction that their fish was not rinsed so well.

Fishing vessel 2

Fishing vessel 2 mentions that he once had to discard some crab claws because a burst hydraulic hose on the vessel had contaminated the claws. Other than that, Fishing vessel 2 did not mention any recall incident in which his catch was involved.

Collector

The collector says that they never have any withdrawals or recalls. The collector cannot imagine how that could happen because if there is something wrong with the fish, then they will never put it up for sale in the auction hall. Thus, it is not possible to get an impression of whether they are able to trace the fish back to the batch that it stemmed from or to track the fish forward to other buyers that have purchased fish from the same batch.

The collector mentions that they have made mistakes, for example a box of freshness category A fish has been placed among category E fish or a box of size grade 2 fish has been placed among size grade 3 fish. Such mistakes may happen if the grader has been off guard, for example if someone has called him. As the collector says, “Mistakes can happen, but if you make them intentionally, then you are not in this field for very long.”

Auction

The auction has had some complaints. An example was a box, in which the fish in the top layer was fine, but the fish underneath was not good. It was sold as freshness category A, but he says it should probably have been classified as freshness category B.

The auction has also had recalls, but not very often. They have never had a problem where they could not track the fish forward in the supply chain. He gives an example about a buyer who had observed that the Norway lobster he had purchased at the auction had a gasoline smell. The Norway lobster was seapacked and the batch was so small that the auction could quickly find out who else had bought Norway lobster from the same batch. The auction contacted the other buyer and recalled the batch.

Processor

When the processor receives a complaint, he will usually make a deal with the customer instead of having the goods returned.

The processor’s biggest problem regarding complaints arises when they buy the fish from an auction or another processor and have it sent directly to the customer without having seen the fish first. He gives an example of some fish that they bought from a company in the Faroe Islands and had sent to a customer in France and 3-4 other customers. The customer in France was dissatisfied with the fish, and in this case, the processor asked to have the goods returned. Oftentimes the processor will ask the buyer to send a photograph of the fish. In the processor’s opinion, the fish was still fine, so this incident taught the processor the quality of fish that the French customer expected. The processor realizes that, in that example, it would have been nice to have some of the information types discussed in Section 4.3.3. The 3-4 other customers that received fish from the same company in the Faroe Islands found the fish to be fine, so the fish was not recalled from them.

In the above example, the processor was able to trace the fish back to the supplier in the Faroe Islands and to find the other 3-4 customers that had received fish from the same batch. Thus, the processor did not have a traceability problem in this regard. He would like to have had more information about the fish. Such information has to be produced by the supplier or some step earlier in the chain, but subsequently, the information can be forwarded via the existing traceability system.

Retailer

If the retailer receives some fish that is not edible, then he withdraws the fish and sends the fish back to the supplier. If a consumer comes back to the retailer with a fish of poor eating quality, then the retailer will not recall all the other fish sold from the same batch. Usually, it is just a single fish that has gone bad.

4.3.5.3 Satisfaction with their level of traceability

Fishing vessel 1

Fishing vessel 1 is satisfied with their level of traceability and do not think that a more detailed level of traceability is in demand. If their customers would like more information, then the fishing vessel would be willing and able to provide the information as long as they have the wanted information recorded in their logbook.

Fishing vessel 2

Fishing vessel 2 did not say whether he is satisfied with the level of traceability of his fish onboard the vessel, but if he was not satisfied, then he could group (and label) the fish according to the information that he finds relevant. However, the size of the vessel may create a limit as to how many fish boxes and how much ice he can bring on the fishing trip.

Collector

The collector is satisfied with their level of traceability. The collector is sure that even if they had 10 times as much fish, then they would still be able to manage the fish.

The buyers have not demanded a higher level of traceability. Sometimes the buyers ask about the vessel ID and the catch area of a certain batch of fish, but they have not requested more information available in or on the boxes.

It seems as if the collector regards the vessel ID as more information, but not as an information that could lead to a higher level of traceability. This is probably because the buyers use the vessel ID as an indication of the expected quality of the fish and not necessarily as a means of tracing the fish back to the origin. However, the vessel ID or IDs, if there are fish from several vessels in one batch, actually leads to a higher level of traceability, at least for that batch. It could be interesting to know if it is the same buyers that ask for the vessel IDs because then they are actually repeatedly requesting a higher level of traceability.

Since the collector has had some queries about the vessel IDs and catch areas, perhaps it would be a good idea to make these information types readily available for the buyers by placing them in the boxes or at the start of the row of boxes belonging to the same batch. This way the information is visible in the auction hall if the information is needed during the bidding situation. With the RFID tags in use now, it would also be possible to register these data in a central database, so that the buyers can retrieve the information when needed after the auction.

Auction

The auction is satisfied with their traceability level "for the sake of traceability." By this, the auction presumably means that he is satisfied with their traceability level because it satisfies the legislative requirements. However, he foresees that there probably will be some buyers that will request a higher level of traceability and that this may lead to the auction being able to demand a higher price for the fish.

The auction believes that a higher level of traceability can be encouraged by emphasizing the benefits of using traceability in marketing one's products and in safeguarding one's market shares, since this gives a possibility to earn money. He does not think that companies in the fish industry will implement a higher level of traceability because of food safety except if new legislation requires this. Instead, he believes that the possibility of marketing the sustainability of one's fish will be a main driver for companies to implement a higher level of traceability. Once the companies have implemented this higher level of traceability, however, then they can use the traceability system to ensure food safety, too, for example if they have to recall a batch of products.

Processor

The processor will be satisfied with their traceability level after he begins to use batch numbers when buying fish at the auction. His sales team will be more in command of what batches they have and the characteristics of the batches that they can sell (e.g. the catch date, the catch method, etc.). The packers will better be able to manage which fish is intended for which customers and to pack the deliveries correctly. The processor might also begin to process and trade MSC-certified fish.

Retailer

The retailer is satisfied with his level of traceability and says that he has not received any demand for a higher level of traceability.

4.3.5.4 Summary and suggested changes

Summary

The level of detail of the batch size to which outgoing products at each step can be traced back varies from for example one trawl haul, one day's catch, and one day's production of the same species to one day's delivery. Once the processor has purchased some fish at the auction and used it in their production, it appears that the fish cannot always be traced back to either the vessel or the group of vessels that caught the fish. However, the batch

numbers to be implemented by the processor will make it possible to trace the fish back to one or more vessels as long as the processor links the batch number to the various information types provided by the collector and/or auction that together can identify the origin of the fish. Throughout both chains, a paper trail is used as the means of identifying the fish, with slips of paper either in or on the box of fish or accompanying the box. Combinations of different types of information are used to identify the fish depending on which step the fish is located at.

Judging by the responses of the steps, they have seldom had to recall products that have already reached the following step. In fact, only the auction mentions that they have had to perform recall operations, but that they were always successful in locating the fish (or shellfish) in question.

All the steps are satisfied with their level of traceability except the processor who will first be satisfied when he has implemented the batch numbers on fish he buys at the auction. The auction predicts that a higher level of traceability may be demanded by the buyers later.

Suggested changes

The processor's idea about giving each batch at the auction a batch number is a good step towards a higher level of traceability, at least from the auction to the processor and onwards with regards to the products that the processor dispatches. Even better would be that the batch numbers were given back at the fishing vessel stage, so that the fish products were traceable back to the vessel that caught them. This is namely one of the requirements of EU Regulations 1224/2009 and 404/2011 to be in effect by January 1, 2012.

These lot numbers, as they are denoted in the above regulations, can be used, among other things,

- for food safety purposes, i.e. for more success at recalls should they be required,
- as a link to information about the fish that can be used to assess the quality of the fish without having to visually appraise the fish, and
- as a link to information about the fish that can be used to market the special attributes of a batch of fish.

It is advisable for the collector to provide more information about the batches they produce that have the same characteristics based on the information on the slips of paper in the boxes. However, with the new EU legislations mentioned above, the collector will have to distinguish between such batches since each batch must be given a lot number and must only contain fish from one fishing vessel and one so-called relevant geographical area (a more specific catch area).

4.3.6 Summary of Section 4.3

The three types of product information required by EU Reg. 104/2000 and Reg. 2065/2001, namely the fish species, the catch area, and the production method, are for the most part passed through to each step in Chains 1-1 and 1-2. Once in a while, the processor does not receive the production method and the catch area. The retailer also sometimes does not receive the production method.

Aside from those three information types, Fishing vessels 1 and 2 generate ten and eight types of information, respectively, that are relevant to the individual fish. The retailer, which is the same in both chains, receives 3-5 of these types of information in both chains. Of these, he sometimes communicates the following three types of information to the consumers: landing date, catch method of plaice, and size grade of the whole fish.

The landing date and the catch method are categorized as important information by the retailer, while the size grade of whole fish as well as the two types of information that the retailer otherwise receives (the size grade of fillets and the sales weight) are categorized as most important by the retailer. In fact, the size grade of whole fish and the sales weight are classified as most important information types by five of the six steps studied. (They are irrelevant for Fishing vessel 2.) For the five steps, these information types are essential to know to be able to trade the fish. Moreover, each step has a number of other information types that they also consider essential. The rest of the information types may be regarded as extra information which can be used to further assess the freshness and quality of the fish, for logistical purposes or for storytelling.

The information types that the steps have indicated they wish to receive naturally belong to the extra information category. However, some of these will be mandatory to forward throughout the chain effective Jan. 1, 2012 due to requirements specified in EU Reg. 1224/2009 and EU Reg. 404/2011. Thus, the auction and processor can look forward to receiving the catch date, the more specific catch area, and the batch number. Though, the catch date might not prove to be so useful for the processor because it is permitted to state the catch date as the period of time that the fishing trip lasted (i.e. departure date until landing date). In addition, the vessel ID, which was listed as a type of information that the retailer could be interested in receiving, will also be mandatory information. Though, the retailer may end up receiving not one but several vessel IDs since after the first point of sale (i.e. at the auction), it is permitted to mix fish from different vessels as long as all the contributing vessels are listed.

The new legislative requirements may entail that some of the steps will have to improve their traceability systems in order to keep track of the batch numbers and the corresponding information. Ultimately, the steps will be required to implement more advanced data carriers such as barcodes or electronic chips.

4.4 FEEDBACK AND TRUST

4.4.1 Feedback and relationship of trust between a step and its suppliers

Fishing vessels 1 and 2

The fishing vessels have no suppliers, since they are the starting point of Chains 1-1 and 1-2.

Collector

The collector provides both positive and negative feedback to the fishermen concerned, for example that the hake a certain fisherman had landed was not rinsed properly and there was mud in the gills or that the fish a certain vessel landed the day before was outstanding. In the former case, the collector feels that it is his duty to report back to the skipper so that he can tell his crew to improve their catch handling. Poor catch handling can have a negative effect on the price that the fish may attain.

The collector's relationship with the fishing vessels is good. The fishermen are always welcome to come in and see their fish be graded at the collector. Further, the collector relies 100% on the information provided by the fishermen. The collector says they can easily do this because the fishermen cannot cheat: they must keep a logbook of their fish catches and/or they are monitored by satellite. Other (smaller) vessels that have a "Declaration of catch area" have fishing trips of maximum one day, so they cannot sail so far away.

Auction

The auction provides feedback to the fishing vessels, mostly about irregularities that the auction has spotted or if the auction has some information which would be useful for the fishing vessels to know. Irregularities could be that the quality of the fish landed by a certain vessel that day was unusually poor or that a certain vessel is just about to exceed the + 5% overweight permitted in their fish boxes. The auction is mainly in contact with the seapacking vessels. He says that gradually quite a few vessels have begun to call him up to ask if the fish they landed that day was alright. Many of the vessels have let the auction know that they would like to have feedback both when the fish is good and when it is poor. The auction thinks this is an excellent attitude.

The auction also has contact with the collectors. Though, if he receives a complaint from a buyer about fish from a collector, the auction would prefer that the buyer complains directly to the collector since that is most effective and the collector receives more precise information about the complaint.

The auction has a fair amount of confidence in information from the suppliers. He has not noticed anything that gave rise to a suspicion of untruthful information.

Processor

The processor gives both positive and negative feedback to his suppliers. The positive feedback, which does not occur too often, may be "It is much better than you said." The negative feedback may deal with for example poor quality or incomplete labeling. Regarding the former, the processor is often asked if he can use the product anyway and if so, how much he would offer for the product. If not, then he must return the product. Problems concerning incomplete information about the product have to be resolved before the processor dares to use the product.

The processor gives an example of erroneous information from a supplier. He ordered cod fillets of a certain weight interval from a supplier in Norway. He was told that the fish were caught, filleted, and packed on a certain Friday. Upon reception, he found out that it was packed on Thursday, the day before. The catch date is rarely printed on, but it was hard for him to believe they were caught on the Friday. Thus, instead of relying on the information given, he had to open the boxes to assess the fish himself.

The relationship of trust between the processor and other processors and wholesalers is neither good nor bad. As he says, "Trust is good. Inspection is better." There are some suppliers they trust more than others. The processor does not check their supplier of farmed trout and farmed salmon very often, since their experience is that the information on the labels is correct. For products from other processors and wholesalers, the processor opens the boxes of fish no matter what. However, some items they never see, since they are transported directly from e.g. the Faroe Islands to Padborg near the German border, where they are reloaded to be transported to customers south of the border.

With regards to the relationship of trust between the processor and the auction/fishermen, the processor is able to see the fish before buying, so the situation is different than the one above. The processor trusts some fishermen more than others, but there are none that they trust 100% to the point that they do not assess the fish in the boxes before buying. The processor says, "We trust the fish we look at." That is, he trusts assessing the fish himself more than relying on a few pieces of information.

Retailer

The retailer phones his suppliers to give both negative and "extra positive" feedback. Otherwise, the retailer talks to his suppliers on a daily basis, so he does not need more feedback from them.

The retailer is of the opinion that the longer you have a supplier, the better the relationship of trust. The processor in this study is a new supplier to the retailer. The retailer trusts his other supplier more and more. However, there are also some things that they may disagree on and then he must just change his habits, for example by buying the product from another supplier. The retailer says that there is no information from his suppliers that he does not trust.

4.4.2 Feedback and relationship of trust between a step and its customers

Fishing vessel 1

Fishing vessel 1 rarely receives feedback from the auction. As an example, the fisherman mentions that once they were told that their fish was not rinsed properly.

Fishing vessel 1 would prefer to build up a good relationship of trust with his customers. He prefers to land fish of the best quality because then the buyers know that he lands good quality fish and they will be willing to pay for the good quality. He says that if one lands good quality fish, then it is good if one does not hear from the buyers. Of course he would also like to receive praise, but in his opinion people in general are not so good at giving compliments. Fishing vessel 1 believes that his customers trust the information he provides, but he says they can double check by assessing the fish themselves. He says the buyers can virtually state what time the fish is caught without reading the information on the label.

Fishing vessel 2

By and large, Fishing vessel 2 receives feedback from the buyers only if a buyer bought some fish that is unusable.

Over a period of years, the fishermen have held meetings with the buyers up to 4 times a year. Here the buyers and the fishermen discussed what the buyers expected and how they all could do things better. At these meetings, the fishermen were praised if there was something extraordinary that the buyers liked and similarly, the fishermen were also told if they delivered some fish which was not good. Fishing vessel 2 thought that these meetings were good to improve the trust between the fishermen and the buyers.

Fishing vessel 2 remarks that it is essential that the relationships of trust with the customers are alright. If one punctures the relationship, then it can be difficult to put matters right again. He has knowledge of a vessel that acquired a bad reputation and consequently repeatedly got lower prices for their fish. The vessel then decided to sell their fish at another auction in another city.

The fisherman describes the confidence of the customers by relating that when he sometimes watches the auction, some customers have asked him where his fish is placed. In other words, they would like to know where his fish is so they can bid on it.

With regards to the kystfisk label, he says that the customers can trust that the kystfisk from the collector that he delivers to is max. 24 hours old. However, the kystfisk from another collector is up to 2-3 days old. Thus, the fisherman implies that the customers cannot trust that fish labeled kystfisk from another collector is max. 24 hours old.

Collector

According to the collector, the buyers give both praise and negative feedback to the collector. For example, the buyers may comment that the fish were beautiful or that the

fish were not so nice the day before. The latter comment puzzles the collector because the buyers are able to assess the fish themselves before buying. However, the collector knows that because of supply and demand, sometimes the buyers need to buy the fish even if they are not of as high a quality as expected. The collector describes such a situation: There have been heavy winds for 2 weeks, so the day vessels cannot sail out. The auction has not been supplied with fish for 4 days. A fishing vessel that has been at sea for 5 days lands its fish. The oldest fish from that vessel achieve a high price at the auction because the demand is high and the supply is low. Therefore, the buyers are sometimes "forced" to buy "old" fish for a high price. The collector points out that there is nothing wrong with the quality of the 5-day old fish, but that obviously it is not as fresh as the fish caught within a day of the auction.

The collector says that he has a superb relationship with the buyers. He assumes that the buyers trust the information from the collector which they can do perfectly well because the collector refrains from commenting on a topic if they are not sure that they have the correct information.

Auction

The auction generally does not deliver more information to the buyers after having sent them the invoice. However, the auction may receive some comments on the fish from the buyers. Sometimes the auction forwards the comments to the vessels. In some cases, the buyers even ask the auction to deliver the message to the vessels. For example, a buyer may call the auction and say that the fish they just bought from fishing vessel X was not as good as last time and could the auction please let the vessel know that. Another example could be a buyer that asks the auction to inform the vessel that the machine-gutted fish they bought from the vessel was cut askew so possibly there is a problem with the machine's knife. If the buyer complains that the fish he bought was rotten, the auction might ask him to come with the fish and prove that it was rotten.

Generally, the auction encourages the buyers to give feedback. Some do and some do not. There is an ongoing dialog between the auction and the buyers about requests, good ideas, etc. The auction may ask the buyers if they would be interested if the auction did such and such and the buyers may tell the auction that they have a customer who would like such and such.

The auction is of the opinion that the buyers trust information given by the auction. Though, he has experienced a situation of mistrust, which with dialog, understanding, and modification of the standard procedure was overcome. The case was as follows: the auction placed boxes of Danish and Norwegian fish of the same species, freshness category, and size together. The buyers remarked that the structure of the fish meat was different in the Danish and the Norwegian fish, and insinuated that they could not trust the auction because they mixed fish of different qualities together. The auction believed that they placed the fish correctly because the fish were of the same freshness category and size. Upon closer examination, the auction realized that there was a difference in the

structure of the meat. They began placing the Danish and Norwegian fish apart from each other, but without labeling the batches with the catch waters, since the buyers must still make their own assessment. The auction gained back the trust of the buyers.

Processor

The processor evaluates that the relationship of trust with their customers is rather good. The processor says he never cheats their customers. The customers have to trust what the processor tells them because they cannot see the fish. In the processor's opinion, the information that originates from the auction is not adequate to use as a basis for a purchasing decision. He believes that a person must assess the fish by looking at it, and this is what he does for his customers. He believes that the customers largely rely on the information that he gives them. However, he does not believe that their relationship of trust will be so good that the customers will not inspect the products upon reception.

As mentioned in Section 4.4.1, some of the fish that the processor sells to his customers is never assessed visually by the processor, but is sent directly from for example the supplier in the Faroe Islands to the customer in France. The processor sometimes receives complaints about this fish, but he must just accept that and send the complaint further back to his supplier in the Faroe Islands. He may ask the buyer to send a photograph of the fish. The fish is not rotten, but the buyer is dissatisfied at any rate.

Retailer

The retailer relates that his store is very well-liked, but that it has a reputation for being expensive. The retailer's reputation among the consumers is that they can trust him, that they can always have a talk, and that he will sort it out if they are dissatisfied with the fish they bought. The retailer concludes that the relationship of trust with his customers is quite good.

4.4.3 The steps' suggestions on how to improve their confidence in each other

Fishing vessel 1 has no suggestions since in his belief, the buyers can see what they buy and they decide how much they think is a reasonable price for the fish. If the quality is poor, then they will just offer a lower price. Fishing vessel 2 suggests that the buyers may obtain more confidence in the fish/fishing vessels if there were pictures of the vessels and vessel IDs along with the fish. The confidence lies in the fact that if the vessel owners publicize their identification, then the product cannot be all that bad. In addition, the buyers can address their complaints directly to the vessel if they were dissatisfied with the fish. Conversely, if the fish was fantastic, then the buyers have a chance to buy fish from the same vessel next time.

It may seem as if Fishing vessel 1 does not look ahead in the chain like Fishing vessel 2, but actually his vessel ID is already sent onwards since it is printed on the fish box labels. It seems strange that Fishing vessel 2 comes up with this suggestion when he has his fish

graded by the collector, where the fish most probably is mixed with fish from other vessels.

The auction's relationship of trust with his suppliers is fine and cannot be improved. With regards to the relationship with the buyers, there is always room for improvement, but the auction does not think they will get any further. There will always be some suspicion between two parties that do business with each other.

It is interesting that the auction mentions that the relationship between the auction and the buyers cannot improve because the processor proposes that if most of the information mentioned in Section 4.3.3, including the catch date, towing time, and temperature records, was put forth, then he would trust the information. He imagines that this could be valuable for him because then he could probably avoid having an employee go to the auction to assess the fish and he could also slacken the product inspection upon reception. In addition, if there were RFID tags on the boxes, then he could also save time on checking if the boxes of fish he received corresponded to the boxes that he bought at the auction. Furthermore, the processor suggests that if there was a lot of information available about the fish, then perhaps the processor's customers would not need him and his staff to physically assess the fish. This presumably would result in less telephone conversations in which the processor describes the quality of the fish he has to offer. Instead, the processor's customers could order via a web shop because they trust the information available about the fish.

The retailer will never trust his suppliers 100% because that means that he would never inspect the fish upon reception. The retailer will always inspect the fish no matter how much he trusted his suppliers. He supposes that such inspection is also about keeping each other on one's toes. A little error by a supplier might not matter, but it causes him to be a little bit more critical when receiving goods.

The retailer says that the relationship of trust between the retailer and his suppliers can be improved if the suppliers never make any mistakes, and between the retailer and the consumers if the he never makes any mistakes himself. Concerning the latter, the retailer remarks that he cannot imagine "how much more perfect it can be," but he acknowledges subsequently that it can always improve.

The suggestions from the steps on how their confidence in each other can be improved are summarized in Table 4.16.

Table 4.16. Suggestions from the steps with regard to how to improve trust in the chain.

Suggestions from the steps	**Proposed by**
Pictures of the vessel and vessel ID on the package	Fishing vessel 2
Availability of the following information: catch date, towing time, temperature records	Processor
RFID tags on boxes	Processor

4.4.4 Summary

Overall, the steps' relationships of trust with their suppliers and their customers are on the good side. Fish chains 1-1 and 1-2 are of such a nature that the next step in the chain to a certain extent can check if the information given about the fish is correct. The possibility to inspect if the fish received matches the quality that one has been promised by the supplier may serve to increase the relationship of trust provided that there have been no mistakes, whether intentional or not. If the steps have been disappointed by their suppliers repeatedly, the relationship of trust suffers and the steps would probably as far as possible avoid buying fish from their suppliers. In general, there seems to be a good dialog between the different parties, with both positive and negative feedback being exchanged as well as new ideas and wishes. Only the collector has declared that he trusts his suppliers' information 100%.

The processor suggests that availability of more information about the fish could increase the steps' trust in each other. In fact, it seems like the processor would like to know as much as he can about the fish. This would be beneficial for all parties, but perhaps just a few pieces of information could be sufficient, such as the catch date, temperature records, the catch method, the towing time as well as the fish species and the size of the fish, which are already required by EU legislation. The catch date and the temperature records together indicate the freshness of the fish while the catch method and the towing time indicate if the fish may have any bruises in addition to the stress level of the fish during the catch. With these information types at hand (and a very good relationship of trust), the steps might be able to purchase the fish without having to make a sensory assessment of the fish and thereby cut down on the degree of the product inspection.

4.5 SUMMARY OF SUGGESTED CHANGES TO IMPROVE OPERATIONS

This chapter has covered the results of the interviews, ranging from the steps' views and practices regarding maintenance of quality, the process steps onboard the fishing vessels, at the collector, and auction, the information flow in the chain, the levels of traceability, to the extent of feedback and trust in the chain.

Throughout the previous sections of Chapter 4, a number of suggestions to improve operations have been listed. They have been proposed by the steps in the chains as well as the author. In Tables 4.17 and 4.18, these suggestions have been collected and grouped according to the presumed difficulty of implementation.

The division of the suggestions into the two tables was based on an assessment of:

- The degree of investment required, e.g. any building reconstruction or new machinery,
- The amount of time needed to implement the suggestion, e.g. time for training of staff or installation of equipment,
- The complexity of the coordination and agreements necessary, e.g. if a bigger investment is involved, it may be more difficult to encourage other steps to implement the suggestion.

These assessments were presumptive, i.e. based on what is likely to be true and not based on actual calculations of time or expenses.

Moreover, an attempt to describe the supposed effects of each of the suggestions has been made. One suggestion from the auction about a logo representing both sustainability and freshness was considered not to be advisable to implement (see Section 4.1) and is not included in the overview.

The suggestions that help maintain freshness can contribute to providing all steps in the chain with fish of a longer shelf life measured as number of days on ice left when the fish is received. Fish classified in the best freshness category at the auction will be sold for a higher price, thereby benefiting the fishing vessels and the auction. Supplementary suggestions to maintain the freshness of fish in the raw material steps of the chain are found in the list of quality assurance procedures in Section 4.2.

Suggestions that match the buyers' needs better refer to improvements that can be made at the collector, but which affects the buyers at the auction. Subcategories within the size and freshness classifications and care during grading will satisfy some buyers and might lead to larger revenue for the fishing vessels, collector, and the auction. These suggestions may also lead to less variation in the quality of the fish within the categories.

The suggestions that contribute to the assessment of freshness/quality consist among others of information that may be forwarded in the chain and of carefulness in the assessment routines. The information about the fish provides a better foundation for the

buyers and subsequent wholesalers and processors on which to base a quality assessment. This consequently influences the potential use of the fish and the decision to buy the fish. The various information types can also be used by the retailer and even the final consumer if given the information.

The suggestions that lead to fewer complaints have their effects at the same step that the suggestions are meant for. The suggestions that save time do so primarily for the buyers, but the suggestions are to be carried out by steps in the chain prior to the buyers.

The effect of storytelling/marketing refers to the use of information about the fish to enhance the value of the fish towards the consumer. This purpose must be regarded in conjunction with the suggestions that improve traceability, since traceability is a tool to identify and keep track of the product through the chain. In other words, it is through traceability that the information to be used for storytelling/marketing will reach the consumers.

These suggestions are possible ways to improve the operations in the chain and in the individual steps. There are many suggestions involving the forwarding of specific information about the fish downstream in the chain. Instead of placing paper slips in the boxes of fish, the transfer of information could be made easier, for example by saving time in rewriting or retyping the same information, through electronic data carriers and/or electronic traceability systems such as SIF (Sporbarhed i Fiskeriet = Traceability in Fisheries) in Denmark (Westergaard, 2012) and DNTS (Digital National Traceability System) in the Faroe Islands (Nielsen, 2010).

The suggestions may require careful consideration before implementation. A useful approach to some of the suggestions could be to perform simulations using mathematical modeling. In such a simulation model, it is possible to obtain an idea of the effects of implementing the suggested change in a step or in the chain under the conditions that are present in the step/chain. This requires identification of the variables that are significant for the modeled situation and the parameters that may affect the outcome of the change.

Table 4.17. Collection of suggestions for improvement of operations in the chains which presumably may be relatively easy to implement and their supposed effects.

From section	Suggested by	Suggestions	Supposed effects						
			Maintain freshness	Match buyers' needs better	Contributes to the assessment of freshness/quality	Fewer complaints	Saves time	Story-telling/ marketing	Improved trace-ability
4.1	Processor	Excess ice in all boxes at auction	*						
4.1	Processor	Sufficient labeling[1] by suppliers					* for buyers		
4.1	Processor	Low temperature in auction hall[2]	*						
4.1	Processor	No mixing of fish of different freshness categories at collector/auction		*	*		* for buyers		
4.1	Author	More careful quality assessment by the collectors		*	*	* for collector	* for buyers		
4.1	Author	More careful labeling of fish at the collector		*	*				
4.1	Author	Shorter fishing trips	*						
4.1	Author	Better reviews of criteria for quality assessment among the packers at the processor			*	* for processor			
4.3	Processor Author	Reception of catch date by processor (and retailer)			*			*	
4.3	Retailer	Reception of landing date by retailer						*	

Table 4.17 (continued)

From section	Suggested by	Suggestions	Supposed effects						
			Maintain freshness	Match buyers' needs better	Contributes to the assessment of freshness/quality	Fewer complaints	Saves time	Story-telling/ marketing	Improved trace-ability
4.3 4.4	Auction, processor, retailer	Reception of catch method by auction, processor, retailer			*			*	
4.3	Retailer Author	Reception of sustainability/MSC information by retailer (and processor)						*	
4.3 4.4	Processor	Reception of towing time by processor			*				
4.3	Author	Reception of actual weight of fish in the box by auction					* for auction		
4.3	Author	Reception of fish is seapacked by retailer and processor			*			*	
4.3 4.4	Author Fishing vessel 2	Reception of vessel ID by retailer (and picture on package)						*	*
4.3	Author	Reception of landing place by retailer						*	
4.4	Author	Promotion and explanation of freshness and freshness categories by auction			*				

[1] including compliance to legislative requirements regarding labeling of supplied fish
[2] fish 0°C, room 2°C

Table 4.18. Collection of suggestions for improvement of operations in the chains which presumably may be relatively difficult to implement and their supposed effects.

From section	Suggested by	Suggestions	Supposed effects						
			Maintain freshness	Match buyers' needs better	Contributes to the assessment of freshness/quality	Fewer complaints	Saves time	Story-telling/ marketing	Improved trace-ability
4.1	Buyers in general	Smaller size intervals at the auction		*					
4.1	Processor	Low temperature at processor's packing room	*						
4.1	Processor	Improvement of catch handling (at sea)	*						
4.1	Processor	QIM at auction			*				
4.1	Author	Division of freshness category A into subcategories		*	*		* for buyers		
4.1	Author	Written rules for kystfisk			*			*	
4.1	Author	Seapacking by more vessels	*						
4.1 4.3 4.4	Author Processor	Access to temperature records from catch to processor			*		*		
4.2	Author	Use of slush ice for chilling onboard; more chilling	*						
4.3	Auction, processor	Reception of more specific catch area by auction and processor						*	
4.3	Processor	Reception of batch number by processor							*
4.4	Processor	RFID tags on boxes							*

Chapter 5 Conclusion

The steps' views on quality as well as current practices in the raw material steps to maintain quality have been described. Thereafter, quality assurance procedures for the raw material steps have been prepared. Following these guidelines will contribute to significant delay in the spoilage of the fish and to a reduction in the quality variation of the fish, which is consequently expected to improve the buyers' confidence in the quality of the fish.

The information flow in the chains along with the importance of the different types of information has been presented. The six investigated steps always either generate or receive (at least when the fish is either seapacked or kystfisk) almost all the information types that they consider most important and important. Of those not received, the auction would like to receive the actual weight of fish in the boxes and the more specific catch area, the processor would like to receive the fish box number, and the retailer would like to receive the catch date, the landing date, and the catch method. Moreover, the steps have a number of other information types that they would like to receive. The traceability systems in use were paper-based and all steps but the processor were satisfied with their traceability levels.

The steps in the chains exchange both positive and negative ideas and comments with each other. Their relationships of trust are fairly good; the processor suggests that access to more information about the fish could enhance the steps' trust in each other.

A number of wishes and suggestions for changes in the practices of the steps have been proposed by the steps and the author. The suggestions are expected to have effects on the operations of the whole chain and also just on one step. Ultimately, due to the buyers' confidence in the consistent high quality, the most appropriate handling and storage of the fish, and the access to the desired information about the fish, it is hoped that these initiatives will contribute to making fish landed in Denmark more attractive on the European market.

The next step would be to implement the quality assurance procedures and the aforementioned suggestions in each step in order to improve the operations. In order to gain knowledge about the consequences of applying a suggestion and thereby to acquire a more sound decision-making foundation on whether to implement the suggestion or not, it would be useful to first create a simulation model to get an indication of whether a suggestion leads to the desired effect, both in the short run and in the long run.

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Appendices

APPENDIX 1 MAPS OF FISHING AREAS

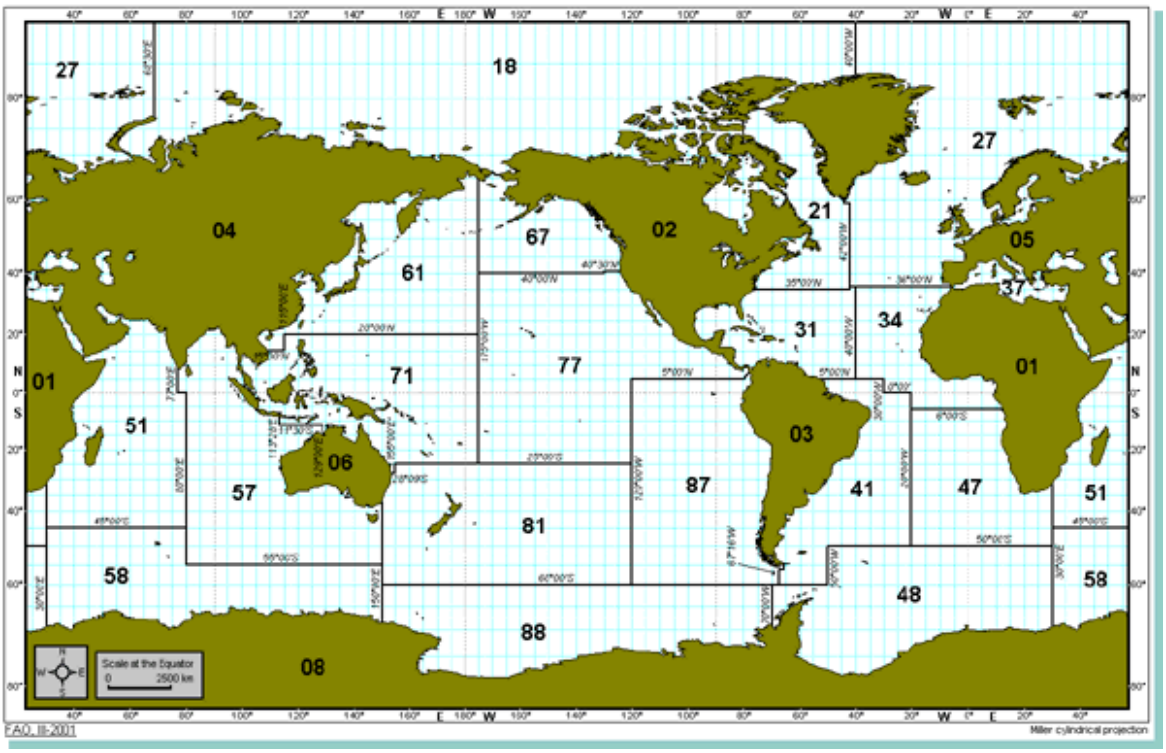


Figure 1. The FAO fishing areas worldwide. (Source: ftp://ftp.fao.org/fi/maps/Default.htm, Oct. 11, 2011)

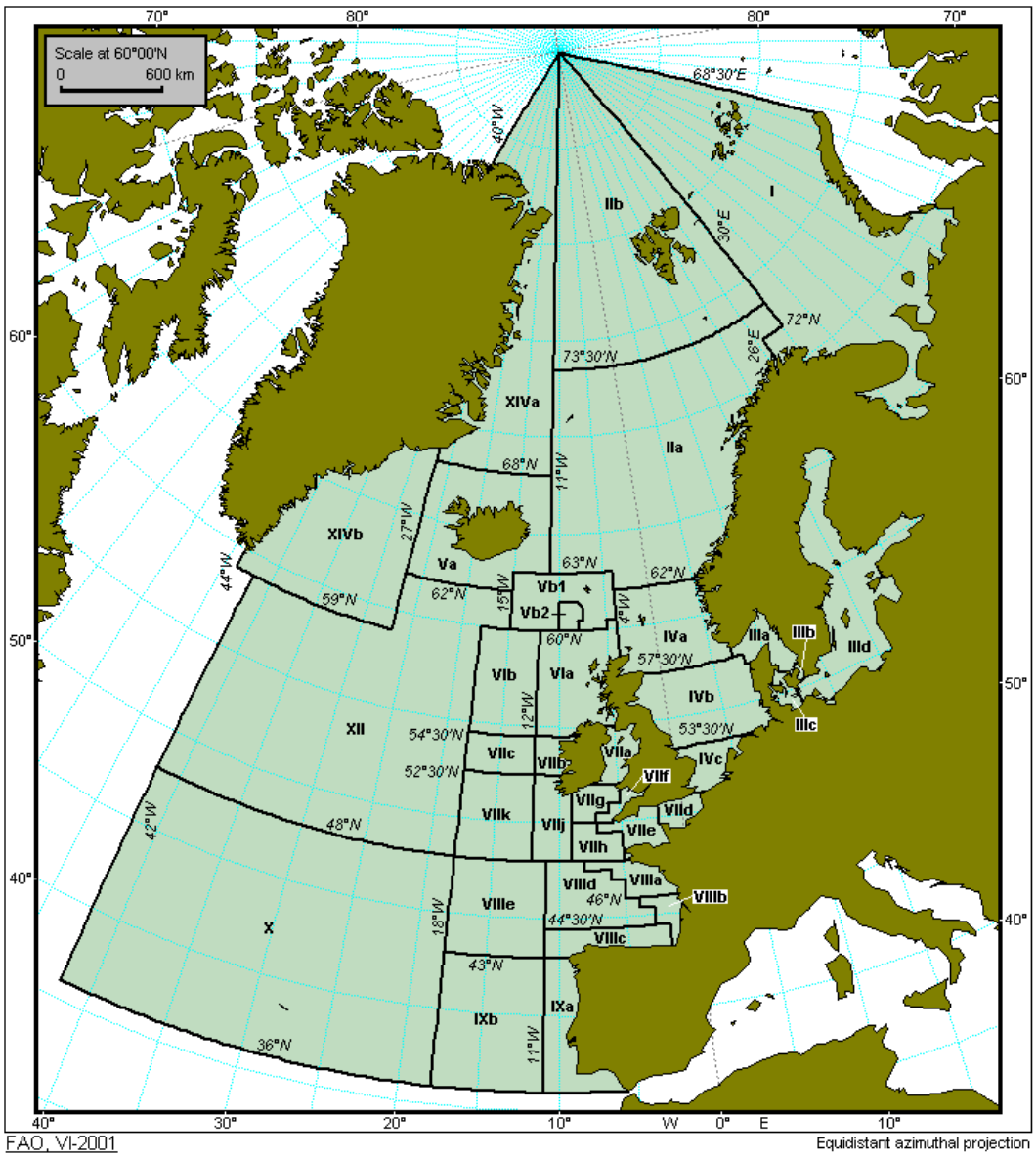


Figure 2. The subareas (I-XIV) in FAO fishing area 27 (Northeast Atlantic Ocean). Division IIIa = Skagerrak and Kattegat. Division IIIb = the Sound. Division IIIc = the Belt Sea. Division IIId = the Baltic Sea. (Source: ftp://ftp.fao.org/fi/maps/Default.htm, Oct. 11, 2011)

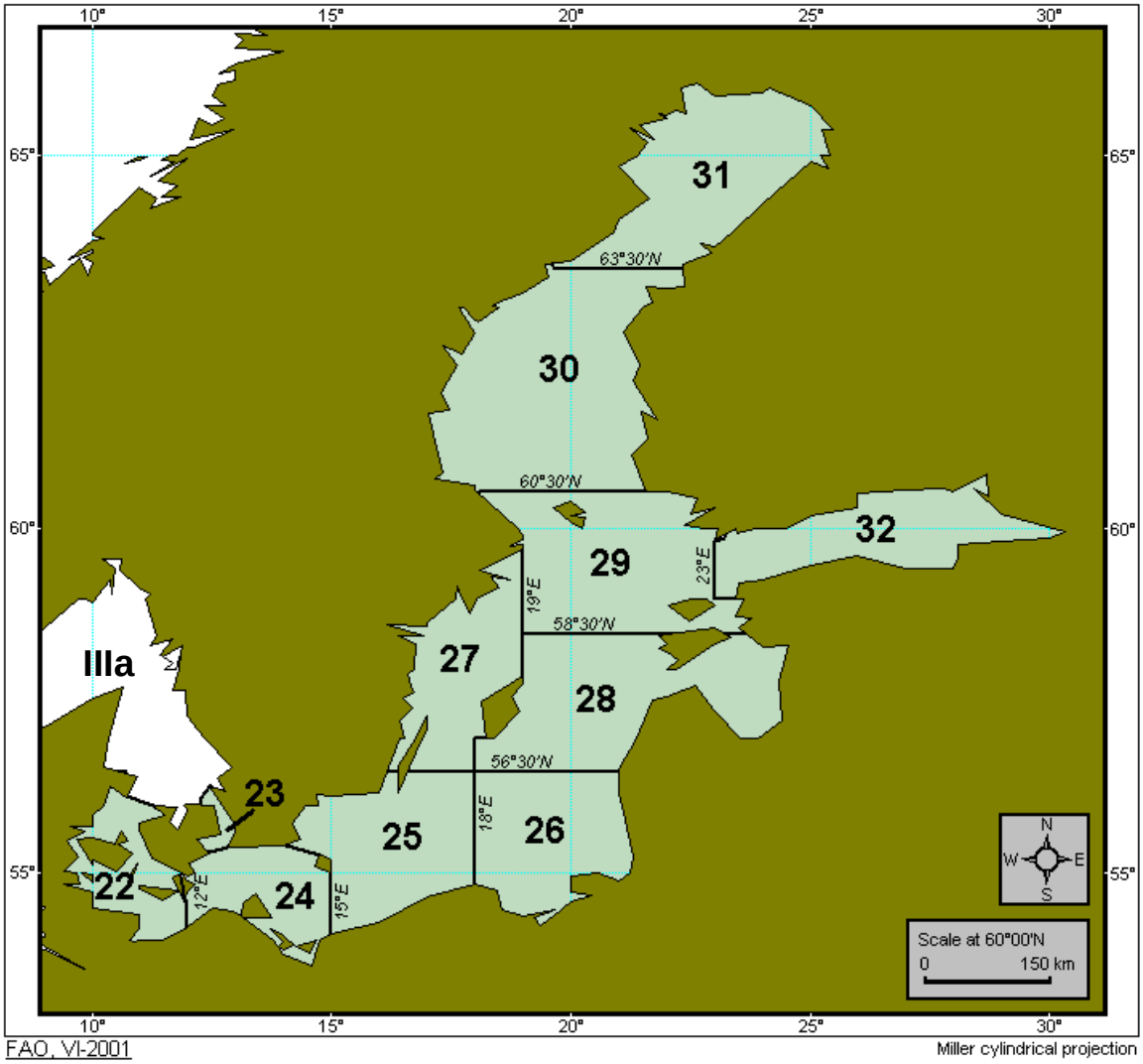


Figure 3. Divisions IIIa-IIId in area 27. The northern part of Division IIIa is subdivision IIIaN (Skagerrak) while the southern part is subdivision IIIaS (Kattegat). Quota-wise, subdivisions 22-24 make up the western Baltic Sea while subdivisions 25-32 make up the eastern Baltic Sea. (Source: ftp://ftp.fao.org/fi/maps/Default.htm, Oct. 11, 2011)

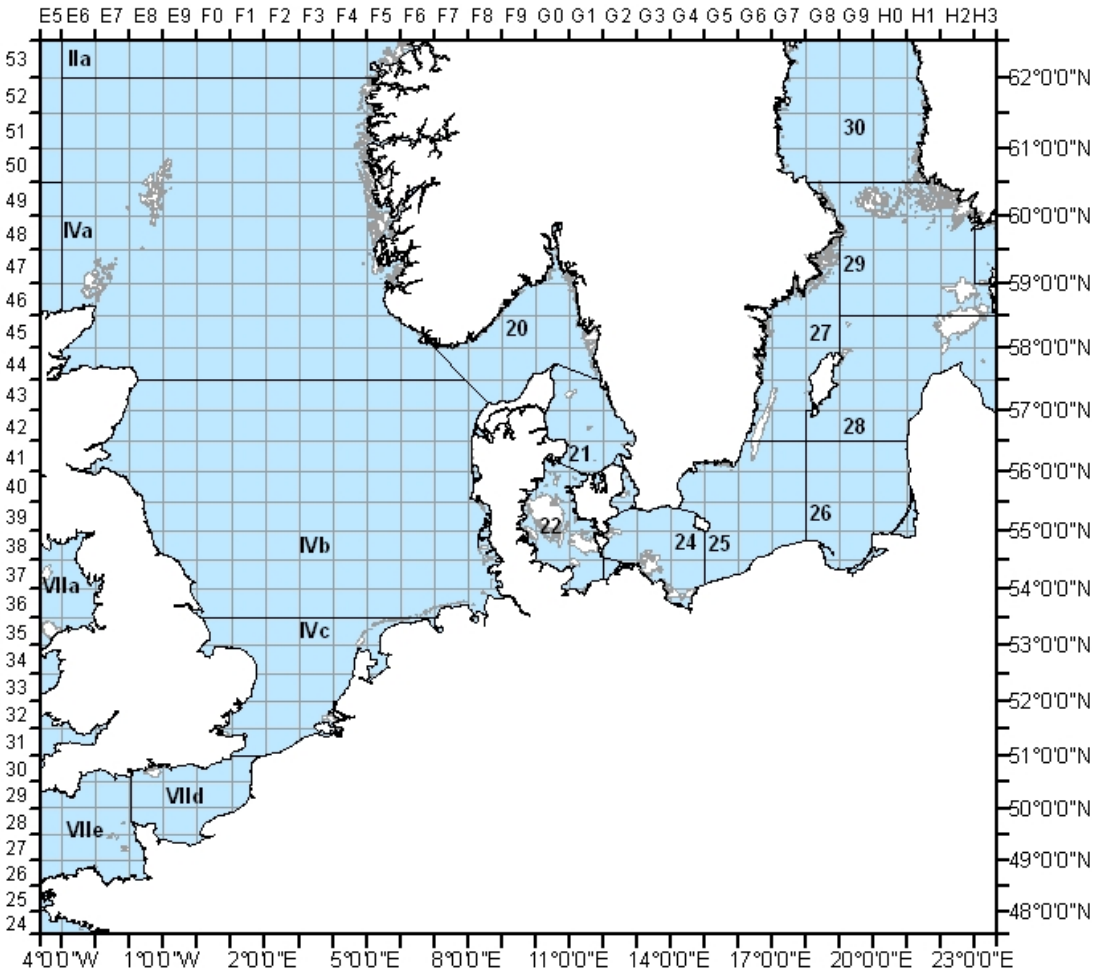


Figure 4. Divisions IIa, IIIa-d, IVa-c, VIIa and VIId-e overlayed with ICES squares. (Subdivision 20 = subdivision IIIaN, subdivision 21 = subdivision IIIaS.) (Source: Egekvist, J., Technical University of Denmark, National Institute of Aquatic Resources, Charlottenlund, Denmark, Nov. 10, 2011)

APPENDIX 2 EXAMPLE OF AN INTERVIEW GUIDE

Interview guide for collectors

Introduction to the interview
The purpose of the project is to enhance the fish supply chains' competitiveness and increase the fish industry's profits by increasing the value of the entire fish chain. The value of the fish chain can be increased by improving quality assurance, including traceability, and optimizing the operations of the chain.

I have come here today to learn about your workflow and traceability system and hear about how you assess the quality of the fish that you grade and how your cooperation and relationship is to other companies in your chain. The information collected will be used to create a mathematical model. The model can then be used to look at options for how various pieces of information about the fish can be used to optimize operations.

I would like to point out that I do not come from any authority, so I am not trying to inspect you and I will not report my findings to any of the authorities. If you wish to remain anonymous in the project, then I will respect that.

To start with, I would like to hear a little about this company and what you do.
Could you briefly tell me how the company has evolved over the last few years?
What developments do you think the company will undergo in the next few years?
How many employees do you have? – that work with grading the fish?
How many tons of fish do you receive a day?

I show the respondent a diagram of a network of companies (Appendix 1).
Here is an example of a network of companies that shows who supplies fish to whom.
How is your situation? I would be pleased, if you would draw your network of suppliers and customers.
How many suppliers do you have? What is the size of those companies? What types of suppliers do you have? Which are the most important?
How many customers do you have? What is the size of those companies? What types of customers do you have? Which are the most important?
What is your role in the chain? What roles are played by the companies prior to you in the chain? – by the companies after you?
What are your most important fish species?
Do you receive fish of all freshness categories from the various suppliers? *(In other words, is there a difference in which freshness categories you receive from the various suppliers? Why is there a difference?)*
Do you receive/sell fish of all freshness categories within each species?

Main section 1: Quality of the fish, quality variation, quality assurance

Introductory questions

The interview is based on the respondent's drawing of the network.
What criteria do you use to determine the freshness category of the fish?
Why do you use those criteria?
Which criteria are the most important?

Is there variation in the quality of the fish in freshness category E? A? B?
How much variation is there?
How important is the variation? Why?
Do you perform additional grading of the fish?
How do you grade the fish? *(Which categories do you grade them into and according to what criteria?)*
How often do you grade the fish?
Why do you grade the fish?
The questions in the block above are to be repeated for freshness categories A and B.
Do you perform other quality measurements, such as QIM, fat percentage, water content?

Additional questions

Do you have specific requirements for your suppliers (fishing vessels), for example with respect to hygiene regulations, temperature logging, that there must always be ice on the fish? *(in addition to statutory hygiene rules, legal requirements for temperature)* In other words, do you sell anything?
How well do you think the fish have been handled when you receive them?
If good, what is it that the fishermen do that you think is good? *(e.g. storage temperature, presence of ice, no sunshine, quickly below deck)*
If not good, what is it that you think is not good? Do you experience that some of your suppliers handle the fish incorrectly? If so, are they specific types of suppliers?
What would you think would be the optimal way to handle the fish? Why?
Do you have any preferences or requirements regarding the optimal handling that are not presently met?
In what ways can your customers be confident that the fish have been handled optimally? I.e. that its quality corresponds to the catch date. *(e.g. temperature records, specific quality assurance procedures)*

What criteria does customer type A (e.g. auction 1) use to assess the quality of the fish? *E.g. EAB, QIM, catch date*
Why does customer type A use these criteria?
What criteria are most important for customer type A?
The question is repeated for different customer types (noted on the network diagram).
Is there any difference in the freshness category (EAB) that the different types of customers (i.e. auctions) purchase? What is the difference? Why is there this difference?
Do you have quality specifications from your customers (the auctions)? *(e.g. what EAB fish must live up to, what customers expect from EAB fish)* Which, if any?
Are there any customer requirements which you cannot satisfy? If so, which?

I would now like to talk about your own check program. Do you use the Guidelines on Good Hygiene Practice for Collectors as part of your own check program? Is it adapted for this particular collector?
Is your own check program more extensive that the Guidelines on Good Hygiene Practice for Collectors?
Is it a requirement that collectors have a written own check program? Are collectors authorized by the Danish Veterinary and Food Administration?
Are you certified to a quality assurance standard? Which?

Do you have a procedure for storing and grading the fish? *(e.g. temperature requirements, temperature logging, adding of ice) (mentioned in the Guidelines on Good Hygiene Practice for Collectors)*
Do you have a procedure for how to train new employees to grade fish?
What training or skills do you require of those employees who assess the quality of the fish? How do you ensure that employees have the necessary quality assurance awareness?
Who fills out the forms?

I have brought along a flow chart from the Guidelines on Good Hygiene Practice for Collectors (Appendix 2). How does that compare to what you do at this collector?

Who ensures that the fish is transported from the fishing vessel to the collector?
What do you do in order to maintain the quality of the fish in the best possible manner while it is being transported to the collector?
Do you have a cold room for temporary storage until the fish is graded?
How do you ensure that the quality of the fish is best maintained during storage?
What do you do to best maintain the quality of the fish during grading?

Who ensures that the fish is transported to the auction hall?
What do you do in order to maintain the quality of the fish in the best possible manner while it is being transported to the auction hall?
Who decides on the location of the fish in the auction hall?
Who ensures that the fish is transported to that location?
Are there any guidelines on how the fish should be handled while it is transported there?
Are there any guidelines on how the fish should be handled while it is in the auction hall? *(I.e. how are the fish handled in order to best maintain their quality?) (For example, will ice be added?)*

Is there something we have not touched on that you do to maintain the quality of the fish?

Checklist
Do you know of QIM? Do you use QIM? In what way?

Main section 2: Information

Introduction

Now I would like to talk about a variety of information on the fish. I have some cards containing the information which I imagine exists.

Statutory information

We will start with these three, which must by law be forwarded to the next step in the supply chain. Three cards with "fish species," "wild or farmed fish" and "catch area, e.g. the Northeast Atlantic Ocean."
Do you receive this information?
Please rank the information in order of importance.
Is there any of the information which is not important?
How do you use the most important information?

Additional questions

Now we will look at the rest of the cards. I would like to ask you to divide them into two categories: "Important information" and "Unimportant information." Thank you. Is there any other information about the fish that you receive or generate yourself?
I will put "Unimportant information" aside.
If up to 5 cards in the category "Important information," then they can be ranked by importance.
If 6 or more cards in the category "Important information," then they can be further categorized: Now I would like to ask you to divide the cards with the important information into two categories: "The most important information" and "The second most important information." Thank you.

The most important information *In principle, each piece of information in this category will be inquired about.*
Why is this information most important/second most important?
How is this information used? *(How significant is this information?)*

I would like to ask you to divide the cards into two categories: one for information you receive and the other for information which you do not receive. *(If the collector generates the information, put the card in "Own production".)*
Regarding the information received: How often do you receive it?
When do you receive the information from the suppliers?
Would it be beneficial for you to receive this information earlier?
What do you think about the quality of the information? Could it, for example, be more precise? Do you ever consider checking some of the information?
In what form is the information that you receive? *(e.g. paper, barcodes, RFID, mail)*

How interested are your customers in this information?
Which of the information do you forward to your customers?
Regarding the information which is forwarded: Do you know what your customers use the information for?
How often do you forward this information to your customers?
When do you forward this information to your customers?
Would your customers like to have this information earlier? Why?
In what form is the information that you forward? *(e.g. paper, barcodes, RFID, mail)*
Regarding the information which is not forwarded: Why is it not forwarded?

Do you think that your customers (auction or buyers) are interested in this information?
If yes: If your customers (the buyers) could get this information, how do you think it would affect the price they would pay for the fish? *(How willing do you think your customers are to pay extra to get this information?)*

Regarding the information which is not received: Do you wish to receive it? If not, why not?
Do you think your customers (auction or buyers) are interested in it?
If yes: If your customers (the buyers) could get this information, how do you think it would affect the price they would pay for the fish?

The second most important information *Questions for "The most important information" are repeated.*

Unimportant information *In principle, each piece of information in this category will be inquired about.* Why is this information not important?

I would like to ask you to divide the cards into two categories: one for information that you receive and the other for information which you do not receive.
Regarding the information received: How often do you receive it?
When do you receive information from suppliers?
In what form is the information that you receive? *(e.g. paper, barcodes, RFID, mail)*

What information do you forward to your customers?
Regarding the information which is forwarded: Why is this forwarded?
Are your customers interested in this information? If so, how interested are they?
Do you know what your customers use the information for?
How often do you forward this information to your customers?
When do you forward this information to your customers?
Would your customers like to have this information earlier? Why?
In what form is the information that you forward? *(e.g. paper, barcodes, RFID, mail)*
Regarding the information which is not forwarded: Why is it not forwarded?
Do you think your customers (auction or buyers) are interested in this information?
If yes: If your customers (the buyers) could get this information, how do you think it would affect the price they would pay for the fish?

Regarding the information which is not received: Would you like to receive it? If so, why?
What would you use the information for?
If you could get this information, how would this affect the price you would pay for the fish?
Do you think your customers (auction or buyers) are interested in the information?
If yes: If your customers (the buyers) could get this information, how do you think it would affect the price they would pay for the fish?

Information generated by the collector
Presumably you generate some information yourselves. I have some extra cards and I would like to ask you to write down the information about the fish that you yourselves generate. *If they do not mention any of these, the following can be inquired about: date you received the fish, temperature recordings, freshness category, quality measurements.*

Is all this information important*? If not, subdivide into "Important" and "Unimportant."*
Is there any information which is more important than the rest? *If yes, this information is placed in one of two categories: "Most important" or "Second most important." Inquiries are made in respect to each pile one at a time starting with "Most important" and then "Second most important."*

Why is this information most important/second most important?
How significant is this information? *(How is the information utilized?)*

I would like to ask you to divide the cards into two categories: one containing the information that you forward to your customers and one containing the information that you do not forward.
Regarding the information that you forward: Why is this forwarded?
How interested are your customers in this information?
Do you know what your customers use the information for?
How often do you forward this information to your customers?
When do you forward this information to your customers?
Would your customers like to have this information earlier? Why?
In what form is the information that you forward? *(e.g. paper, barcodes, RFID, mail)*

Regarding the information which is not forwarded: Why is this not forwarded?
Do you think your customers (auction or buyers) are interested in this information?
If yes: If your customers (the buyers) could get this information, how do you think it would affect the price they would pay for the fish?

Checklist
If the person has not touched on the following, inquiries are made into this topic:
Do you have any exchange of information with the steps further along than the auction?

For the interview, I have made some small cards beforehand with the following information:
Catch date
Landing date
Other dates *(e.g. if the landing date is different from the date the fish is put on sale at the auction)*
Time of the last packaging of the fish
Size grade (weight category, e.g. 0, 1, 2, 3)
Freshness category (e.g. E, A, B)
Actual weight of fish in the box
Sales weight
Catch method (e.g. trawl, Danish seine)
More specific catch area *(map of ICES-squares/example from Seafood Plus MapService on the back)*
Name or number of vessel
Landing place (e.g. Thorup Strand, Hirtshals)
Sustainability information, e.g. MSC-certification
Fish box number
Temperature records (e.g. in the vessel's hold)
Other information. Which?
One or more of the previous steps in the chain are quality certified, e.g. ISO 9001, ISO 22000

Generated by this step:
Temperature records during storage at the collector
Temperature records in the auction hall
Freshness category (e.g. E, A, B)
Size category (weight category, e.g. 0, 1, 2, 3)

Main section 3: Traceability, ID, batches

Introductory questions

When you receive fish from your suppliers, how do you identify the individual batches?
What constitutes a batch? Can the batch be divided into smaller traceable units?
How do you keep these batches separate? How do you mark each batch?
Do you mix fish from different vessels? – of varying quality or freshness categories?
Do you keep track of what is mixed? How?
Have you considered other methods? *(e.g. RFID tags)*

Two situations regarding the extent of internal traceability are shown (Appendix 3).
Which best describes the way you handle your batches within the company?
(Is there a connection between the identifications of your raw materials and your finished products?) *(Internal traceability)*

Additional questions

If you get a call from a customer who says that something is wrong with some fish which were graded by you, what information do you need to identify which batch or which batches may be affected by this problem?
Will you be able to find the other fish in the batch purchased by other buyers?
Will you be able to trace the fish back to the fishing vessel?
If so, what information enables you to do that?

If you receive information from a fishing vessel that something is wrong with some fish they have supplied, will you be able to locate this fish?
What information would you use to make this possible?

Have you tried to recall some products from the market before? How did you do that?
Was there anything you would like to have done differently? *(Do you have contingency plans – i.e. a procedure for what to do in case of a recall?)*

Two situations regarding the extent of internal traceability are shown (Appendix 4).
Which best describes the way you can trace the fish back and forth?
How far ahead can you track the fish? *(beyond the auction)*

In general

Are you satisfied with the level of traceability you have at present?
If not, do you plan to develop your traceability system further?
Is there a demand for more detailed traceability?

Main section 4: Feedback and trust

Regarding suppliers:

Introductory questions

What kind of feedback is exchanged between you and your suppliers (fishing vessels)? (*e.g. about whether the information is used, about whether you would like other information, about whether there were fish of inferior quality in the catch, about whether the fish were extremely good)*

Is the feedback useful for you and your suppliers?

Would you like to receive other kinds of feedback from your suppliers? *(Do you receive suggestions from your suppliers on ways to improve and better collaborate?)*

Additional questions

Please describe the relationship of trust between you and your suppliers.

To what extent do you trust that the information you get from your suppliers is correct?

Is there some information that you do not believe? Which? Why? What do you do about it?

How can the degree of trust between you and your suppliers be improved?

Regarding customers:

Introductory questions

What kind of feedback is exchanged between you and your customers (auction or buyers)? (*e.g. about whether the information is used or about whether other information is wanted)*

Is the feedback useful for you and your customers?

Would you like to receive other kinds of feedback from your customers?

Additional questions

Please describe the relationship of trust between you and your customers.

In your opinion, to what extent do your customers believe the information you provide them about the fish?

Is there any information that your customers do not believe? Which? Why? What do you do about it? What do your customers do about it?

What do you do to ensure that the information which you give your customers is correct? *(generally)*

How can the degree of trust between you and your customers be improved?

Concluding remarks

We have now spoken about the quality of fish, quality variations, information which is exchanged in the chain, traceability, and feedback and trust between the companies in the chain. We are approaching the end of the interview. Are there any additional comments you wish to make before we finish?

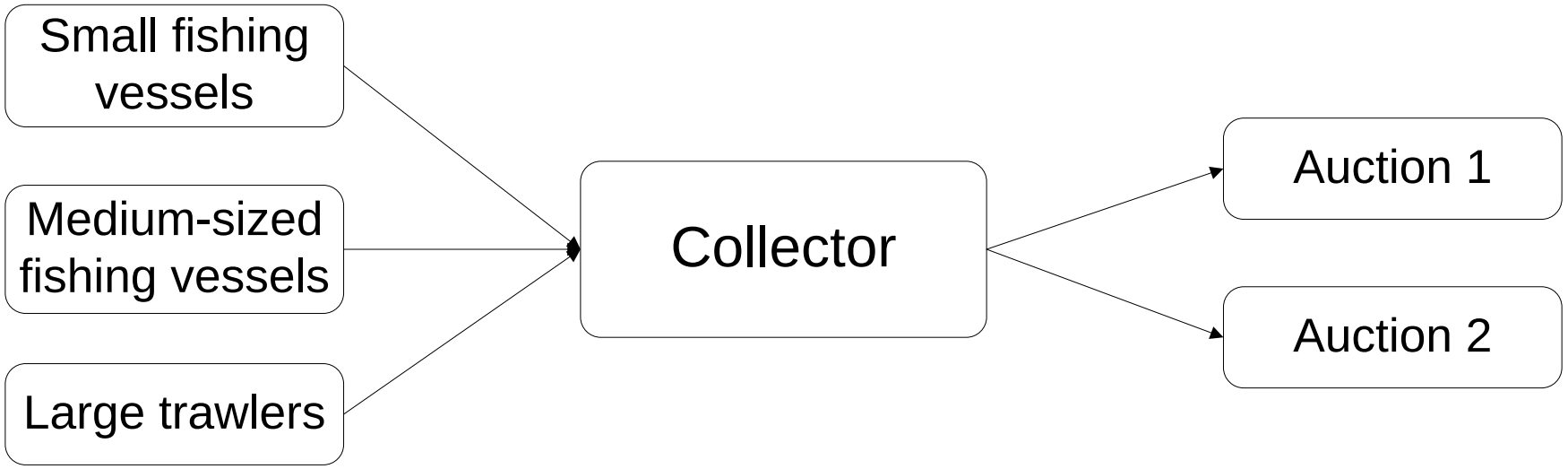
I would like to thank you for participating in this interview and for taking the time to do so.

This is the beginning of an extensive research project and I hope you won't mind if I get back to you if it turns out that new questions emerge which I need to have clarified. Needless to say, you are also very welcome to contact me.

Thank you for now.

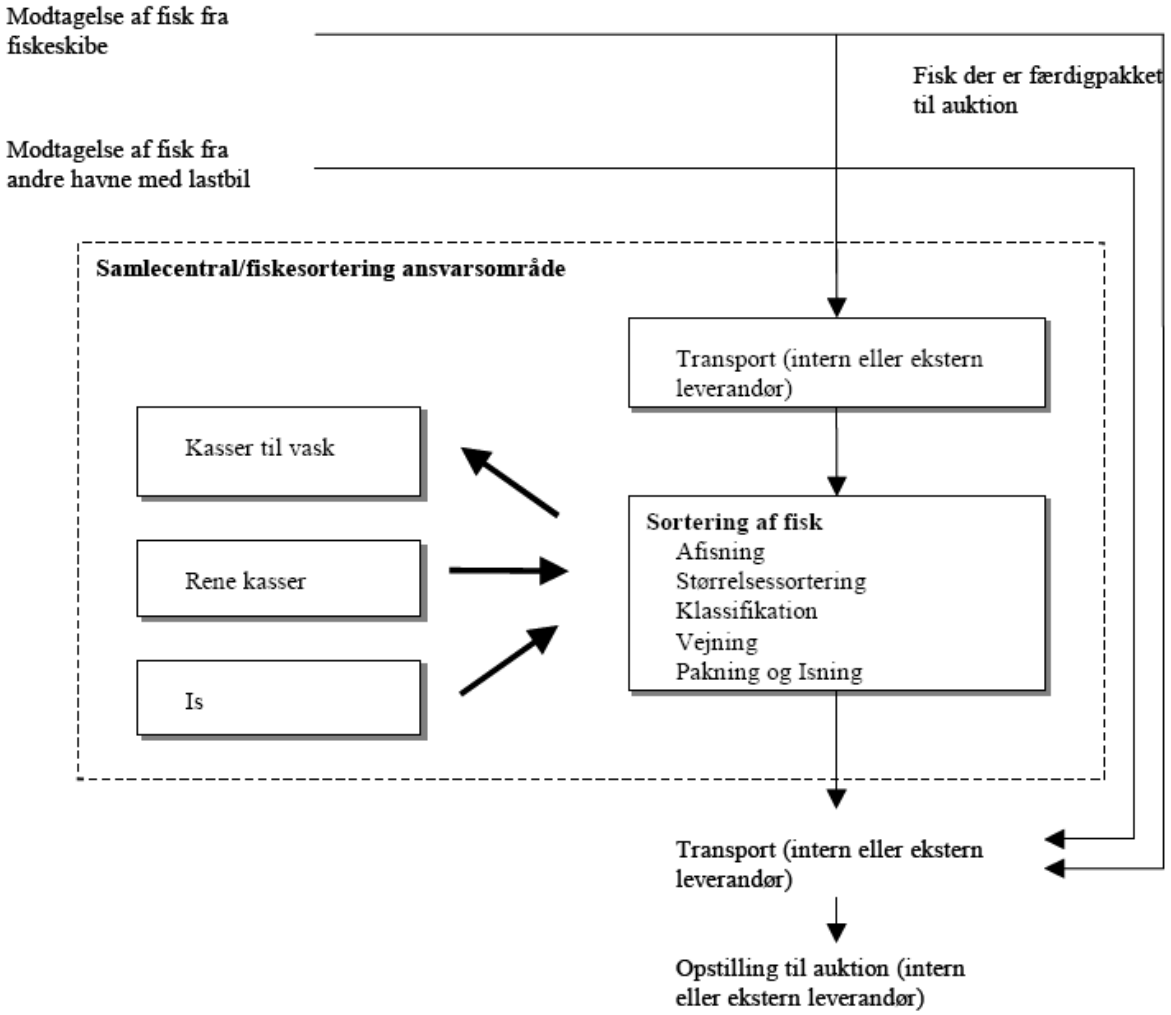
Appendix 1

Example of a network of companies



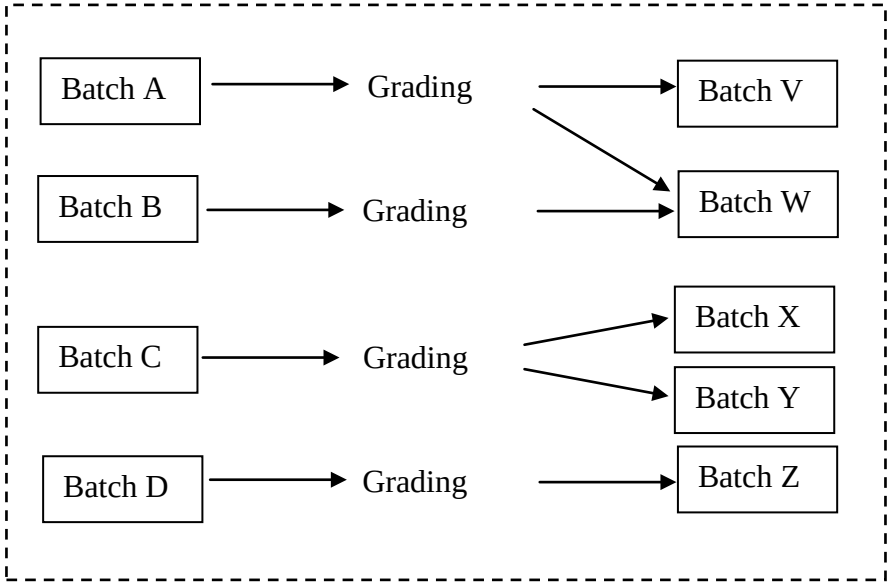
Appendix 2

Process steps at a collector
[from “Guidelines on good hygiene practice for collectors and auctions laid down by the Association of Fish Auctioneers” (“Branchekode for egenkontrol på fiskeauktioner med tilhørende samlecentraler”); in Danish]

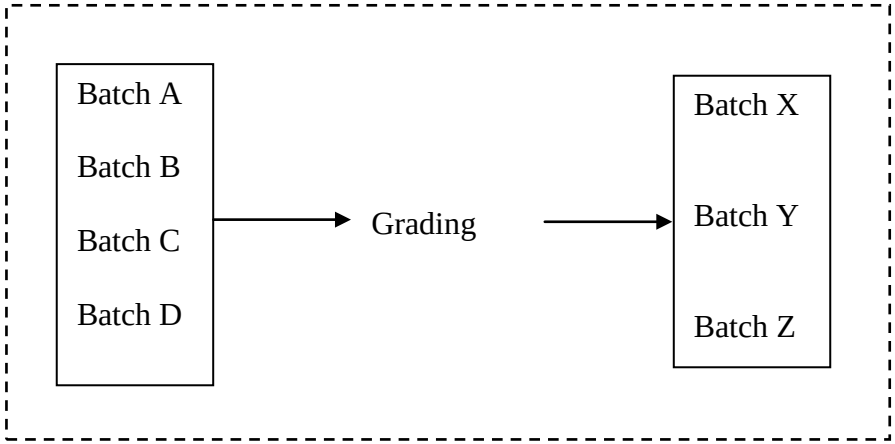


Appendix 3

Situation 1

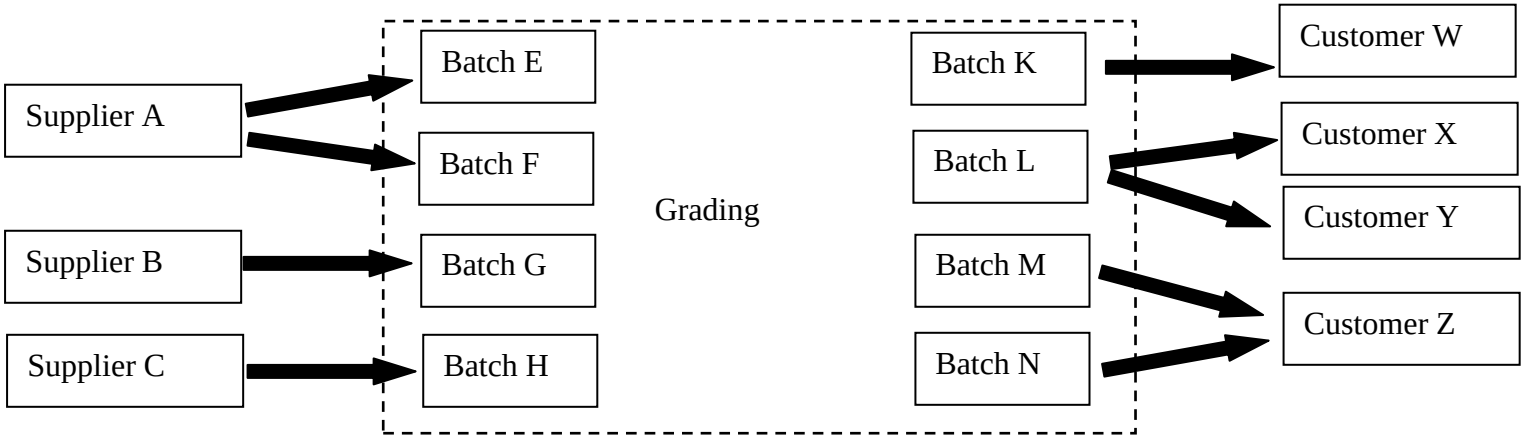


Situation 2

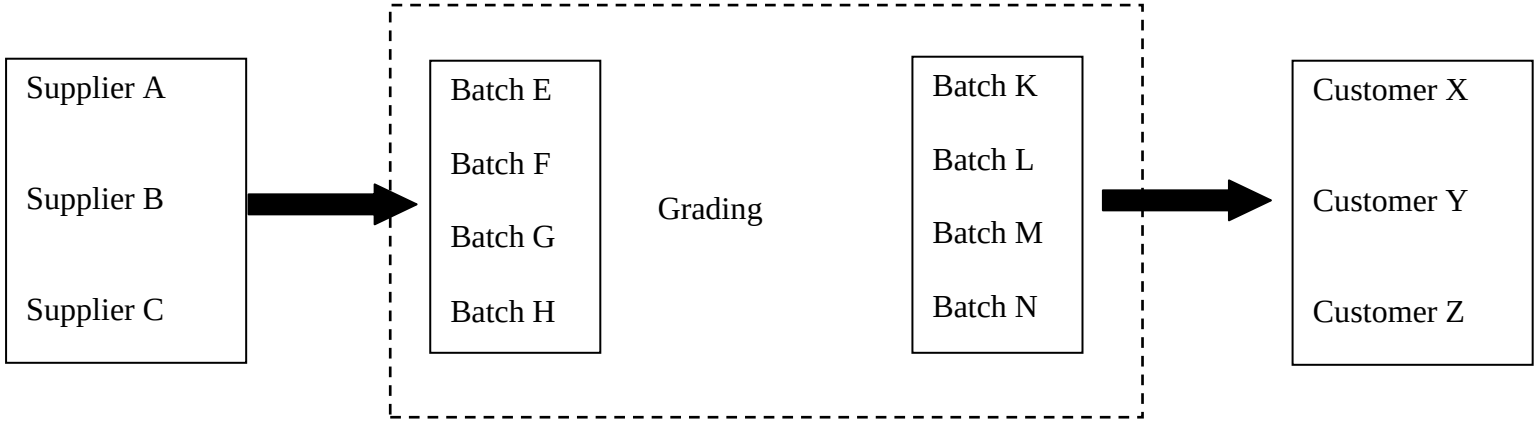


Appendix 4

Situation 1



Situation 2



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