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Integrating Food Safety and Traceability (IFSAT)

- The Nordic food industry in general is not prepared for a recall
- QIM is verified as a very important tool to settle quality-related discussions in a chain by objective means
- Including: A traceability software solution for generating data on pelagic fishing vessels



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Abstract: The aim of the project has been to integrate food safety and traceability by finding common features within food safety and traceability that can benefit each other. To integrate, in a constructive way, food safety and traceability in the management systems that are used in the food sector. To try to document the achieved synergetic effect by integrating food safety and traceability in the management systems. Networking and dissemination activities and liaison to other projects have also been important aims in the project. The main results of the project The project group has worked on a food safety oriented traceability analysis method. This work is in the progress of being published as a scientific publication. Several tests have been made on RFID-tags and international workshops on data capture technology have been arranged. A traceability software solution for generating data on pelagic fishing vessels has been made. A guideline "Recommendations for Good Traceability Practice (GTP)" has been developed. A food safety oriented preparedness test has been conducted in the Nordic countries and reported. The conclusion is that the Nordic industry in general is not prepared for a recall. The study has been submitted for publication in <i>Food Control</i>. The QIM (Quality Index Method) has been verified by three studies of salmon from Norway to Denmark. The conclusion is that QIM is verified as a very important tool to settle quality-related discussions in a chain by objective means. The SSSP (Seafood Spoilage and Safety Predictor) program has been tested by three series of temperature measurements in the whole chain from fishing vessel to retailer shop. The program is very suitable to validate the product information on freshness provided by a traceability system when a temperature record is available. More than 70 IFSAT-related conference/seminar/meetings and presentations have been held during the project period. More than 15 EU projects have been contacted, and several Nordic and EU projects have been generated as a direct result of the IFSAT collaboration.		
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Executive summary:

Background

Traditionally, traceability dealt mostly with what happened in-house: the documentation of information relating to one's own processes and products. Lately, however, the focus has been on chain traceability, where the goal is to eliminate or reduce the information loss that happens between the links in the supply chain. To achieve complete internal traceability in a processing company, all batch transformations must be recorded. In practice, this means that IDs of received batches must be linked to related production batches, and IDs of produced batches must be linked to related batches dispatched. To obtain chain traceability, internal traceability data from all companies, which a product or fraction of a product has been through, must be linked together, preferably via electronic systems.

The EU financed concerted action project TraceFish, coordinated by Norway under the 5th Framework, has created the platform for the traceability infrastructure framework (TraceFood) to be used in the near future. The technical TraceFish standards have to be further developed. This is being done under the 6th Framework in the EU projects 'SEAFOODplus' and 'Trace'.

Risk analysis has traditionally been tied to in-house data, in particular to data from food safety oriented systems. In addition to obvious deficiencies in risk assessment when data is missing, there are related problems with risk management and risk communication. Risk management relates to the social and political aspects of risk, and aims to determine an acceptable level of protection. There is a common agreement among the Nordic countries that the EU Commission will join the viewpoint that traceability and risk analysis shall be an integrated part of the HACCP system/"Own check system".

Scope

With systems and standards for chain traceability now able to be put into operation in the Nordic food industry, a lot of functionality that was previously unavailable becomes possible. In particular, chain traceability enables food safety by providing access to data elements that are relevant for risk analysis, relevant for identification of contamination source, and necessary for targeted recall.

The challenge of the near future is to integrate food safety aspects and traceability in an operational way. The project tries to solve the problem in respect of the unique position that the Nordic food sector and especially the fish sector has on the world marketplace.

Aim of the project:

To integrate food safety and traceability by finding common features in the two systems that can benefit each other.

To integrate, in a constructive way, food safety and traceability in the management systems that are used in the food sector.

To try to document the achieved synergetic effect by integrating food safety and traceability in the management systems.

The aim of the two sub projects:

ChainTrace:

The main objective of the work package ChainTrace is to develop, implement and test food safety oriented traceability systems in the food industry in order to help users to carry out product recalls in a fast and surgical manner.

Multitask:

The role of the multi-disciplinary task force has been to provide advice and guidelines on the implementation of chain traceability in the fish industry and to serve as liaisons to the many other ongoing national and international traceability efforts, projects and networks, both sectorial and general. In addition, harmonization of work and practices, as well as internal and external dissemination and co-ordination has been an important goal.

Conclusions and recommendations

ChainTrace:

The project group has worked on a food safety oriented traceability analysis method.

This work is in the progress of being published as a scientific publication

Several tests have been made on RFID-tags and international workshops on data capture technology have been arranged.

A traceability software solution for generating data on pelagic fishing vessels has been made.

A guideline “Recommendations for Good Traceability Practice (GTP)” has been developed.

A food safety oriented preparedness test has been conducted in the Nordic countries and reported. The conclusion is that the Nordic industry in general is not prepared for a recall (a situation where the products have to be removed from the market, e.g. the supermarket shelves). The traceability of the fish products can be improved. The study has been submitted for publication in *Food Control*.

Guidelines for food safety oriented traceability recordings are implemented in a software solution for the pelagic industry, and a scientific article on integration of food safety and traceability is written.

The QIM (Quality Index Method) has been verified by three studies of salmon from Norway to Denmark. The conclusion is that QIM is verified as a very important tool to settle quality-related discussions in a chain by objective means. In practice, management of the observed cool chain can be improved very much.

The SSSP (Seafood Spoilage and Safety Predictor) program has been tested by three series of temperature measurements in the whole chain from fishing vessel to retailer shop. The conclusion is that the program is very suitable to validate the product information on freshness provided by a traceability system when a temperature record is available.

Multitask:

More than 70 IFSAT-related conference/seminar/meetings and presentations have been held during the project period. An IFSAT web site has been set up, and practices and methods have been discussed and harmonized between the participants. IFSAT has had representatives from -, or liaisons to all the existing 6FP food traceability IPs. More than 15 EU projects have been contacted in particular through the PETER forum (an EU traceability coordination project), and several Nordic and EU projects have been generated as a direct result of the IFSAT collaboration, where the IFSAT partners have key roles.

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Part 1: ChainTrace

Introduction

Both food scandals, new legislation and requirements set by supermarket chains have put traceability and food safety on the agenda. Nordic researchers have been active in the new research topic of traceability since the Nordic Council of Ministers funded the first network project “Traceability and electronic transmission of qualitative data for fish products” in 1995. Since then, these researchers have led the development of new standards, methods and good practice guidelines, e.g. the TraceFish standards and the TraceFood Framework. Nordic researchers are now participating in most of the important European traceability projects in the food area (e.g. SEAFOODplus and TRACE). In the Nordic countries, it is also a trend that industrial implementation projects have been started, aiming at testing the standards and tools developed by the research environment.

In this project, food safety experts were also included in the network, and the joint research team has been discussing how traceability and food safety can be more closely interlinked in the management function of a food company.

With systems and standards for chain traceability now being able to be put into operation in the Nordic food industry, a lot of functionality that was previously unavailable becomes possible. In particular, chain traceability enables food safety by providing access to data elements that are relevant for risk analysis, for identification of contamination source, and that are necessary for targeted recall. The challenge of the near future is to integrate food safety aspects and traceability in an operational way. This project tries to solve the problem in respect of the unique position that the Nordic food sector and especially the fish sector has on the world marketplace.

In the IFSAT project, we have aimed at integrating traceability and food safety by e.g. conducting the following tasks:

1. Discuss models for and suggest how traceability and food safety can be integrated in the different software systems in a food business.
2. Test and improve radio frequency identification (RFID) tags with sensors in order to collect food safety data throughout the food chain (e.g. temperature).
3. Develop a software program for the pelagic fishing fleet to record both traceability and food safety data.

1 Food safety based fish chain process studies

1.1 Introduction

Objective: Significantly reduce the existing information loss related to traceability and food safety in the case chains.

The activity to investigate information and material flow in selected case food chains have mainly been done in co-operation with the EU project SEAFOODplus. The aim of conducting such process mappings are to identify the present practice and hence to be able to suggest improvements for the companies involved. It is of special interest to notice where critical traceability information is lost and to correct this.

1.2 The method

The objective of the process mapping is to analyze the material flow and the information flow, and in particular to identify systematic information loss.

The overall steps for process mapping are outlined in Figure 1.

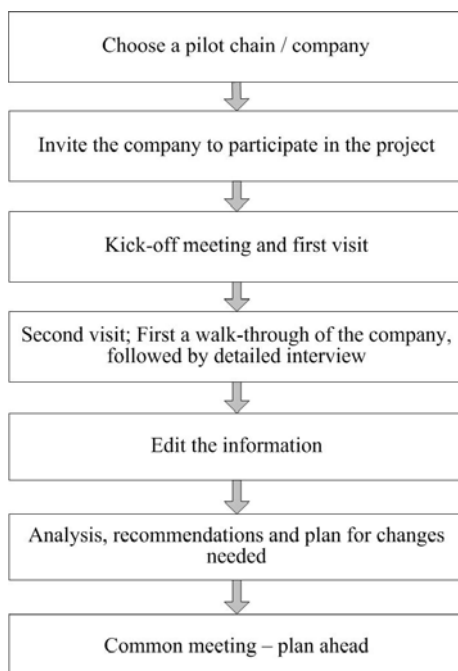


Figure 1. Overview of the steps in the process mapping.

Companies in a pelagic supply chain in Denmark, a tuna supply chain in Spain and a farmed salmon supply chain in Norway were chosen to be pilot companies in SEAFOODplus. These companies were visited in 2004 and 2005, and the process mapping study was carried out.

A walk-through of the each company was followed by detailed interviews of the staff. The first step in process mapping of this type was to identify the end product.

The method “Analysis of traceability in food supply chains - Standard method” was used (Olsen, 2007). This method was developed for exactly this type of analysis.

The principle and sequence of events can be illustrated as follows:

When performing process studies to document material and information flow of the food, each of the 9 steps in Figure 2 can be converted to a form to be used in the mapping or interview. The tables with questions (see Olsen, 2007) are quite extensive, and not all questions will apply to all steps. In addition, some products or steps may have special attributes that are relevant to record in addition. These may easily be appended to the respective forms.

Note that steps 2, 4, 6 and 8 deal with the transformation information, i.e. the documentation of what happens exactly at the point and time when the product moves from one context to the next.

Steps 1, 3, 5, 7 and 9 deal with durations, i.e. what happens or what is the state during transportation, pre-processing, production and packaging of the product.

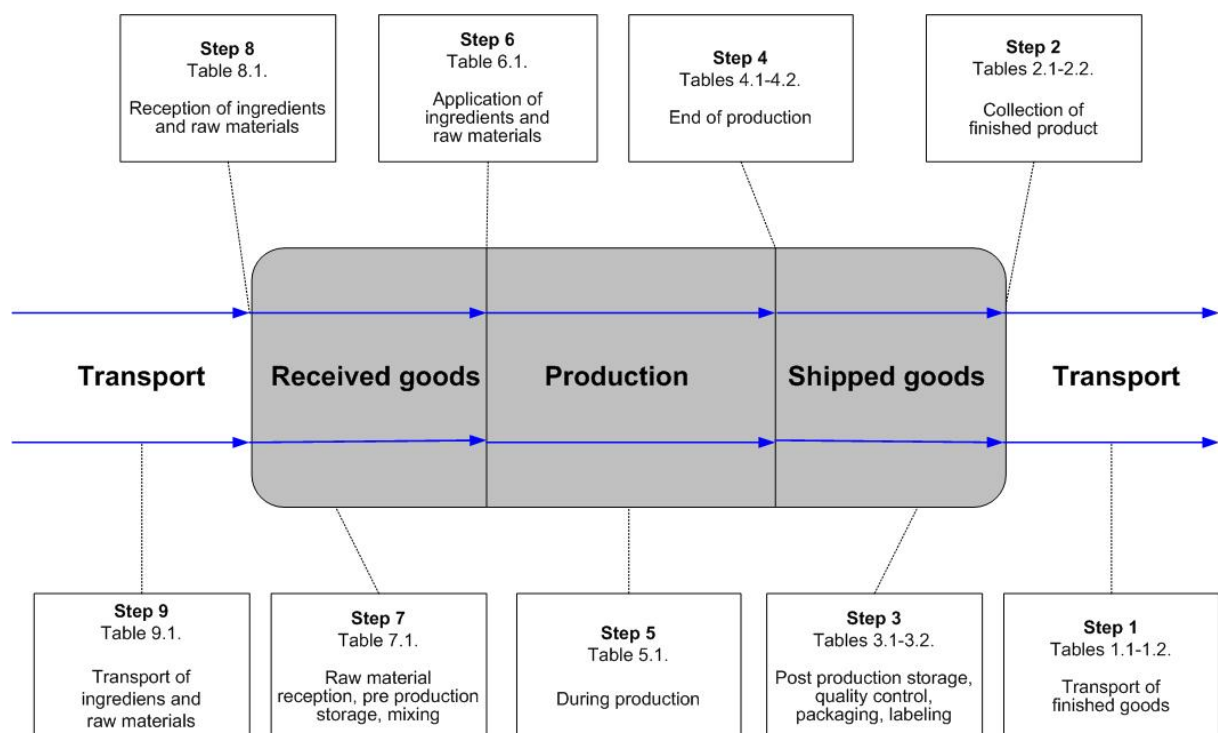


Figure 2. Overview of the method in process mapping to analyze the material flow and the information flow. The tables referred to are in Olsen (2007).

The diagram above and the tables with questions show how to map one product, starting with a form or table where the information about the transportation of it to the next step is recorded. As the process mapping moves against the material flow, it is likely that multiple tables or forms will be needed. In particular, this is true when moving from mapping the process parameters (step 5) to mapping the application of raw materials and ingredients (step 6). If only one product, process and transportation route is

documented, there will be only one set of questions to ask (one form or table) in steps 1, 2, 3, 4, and 5. If multiple raw materials or ingredients are used, then each of these will be documented on a separate form 6, and each of these form 6's will then have to be traced through steps 7, 8 and 9.

Reference

Olsen, P., 2007. Analysis of traceability in food supply chains - Standard method. Submitted to *Journal of Supply Chain Management*.

1.3 Process mapping in fish factories in Iceland

1.3.1 Introduction

Process mapping in fish factories has been the basis of a large research project which has been carried out in Iceland for the last five years. This research project has been connected to the ChainTrace work in the form of networking, but will not be discussed in detail here. For further information on this work, we refer to Margeirsson et al. (2006) and Margeirsson et al. (2007).

Within the direct mandate of the IFSAT project, some work regarding mapping of processes in fish factories was done in Iceland. This was done in order to get an overview of the processes in the factories with a special emphasis on the possible use of quality/HACCP related data in relation to traceability data.

This work has partly been reported in earlier reports and is partly being worked on in relation with planned publications from the IFSAT group. It has also partly been reported in reports published by the Icelandic Fisheries Laboratories (IFL).

The factories that were mapped were within the fields of fresh fish / fish portions for export by plane and lightly salted fish portions to be exported frozen. Both companies had many systems that data relating to quality and traceability matters were stored in. These systems were a combination of computerized on-line systems, paper based systems and paper based data periodically transferred to computerized systems. One of the factories had a closed tub-system, i.e. the company had its own fish-tubs, which are used on vessels owned by the company. The tubs contain RFIDs, which are read when the fish tubs are filled up with fish (right after catch). Before that, the fish is graded onboard automatically. The next reading point is when the fish is landed and finally, the RFID is read when the fish goes to processing.

1.3.2 Traceability data

Traceability data were kept in computerized form as a general rule. However it was in more than one system. In some cases, data were recorded on paper and transferred to computer at the end of the day. The production or outgoing batches vary in size from a few hours' production to a whole day's production. The raw material or incoming batches are usually defined as catching date or haul and boat and in some cases, size grade. Upon arrival at the processing factories, the incoming batches are split up into processing batches that usually are defined by age of raw material, catching ground and

size grade. When the raw material comes from trawlers, this is easy, but it becomes more complicated when the raw material comes from smaller boats and from the fish auction. In the latter case, processing batches are made by grouping fish from certain catching grounds (southwest coast, northwest coast. etc.) based on information from the boats or from the auction. It is the size of the production batches that determines the size of the outgoing batches. This means that the factories in question are producing from one to four outgoing batches per day depending on the homogeneity of the raw material.

It was noted that traceability is mostly connected to the main raw material. When it comes to secondary aspects like packaging, salt, cleaning agents, etc., traceability data is commonly in the form of purchase receipts in the management system.

In general, starting times of processing batches are recorded (and hence the ending time of the previous batch). This gives information about when a certain batch was passing through the factory. This is relevant in order to connect other information to the production batches.

1.3.3 Quality related data

Quality related data are often a big and quite inhomogeneous data pool. It can be online data from flow scales and graders, continuous temperature measurements, periodic checks of the raw material or of the processing environment or random samples taken and checked against quality and production specifications. Online data is usually stored for a limited time and if it is kept, it is usually only as summary data. Other data are usually kept for a longer time but in many different systems and forms.

Some data systems make it possible to directly connect some quality related data to batches in the production. Examples are Wisefish from Maritech and MPS from Marel. In other cases, a connection has to be made through date and time of the records.

1.3.4 Use of quality related and traceability data

Comparing the above findings to our knowledge of the fish industry, we found that the situation described above is the most common in the fish factories in the Nordic countries today.

In order to better use quality related and traceability data together, they need to be linked in some way. The data can be categorized in the following way:

1. Product / batch related data
2. Process / place in the production related data
3. Processing related data

In broad terms, one can say that item one is covered by traceability systems and item two by quality systems. Item three, however, relates to material flow, splitting and/or joining of material streams and is not covered in these two systems. Still, this data is in many cases the key to linking traceability and quality related data.

In order to get a common denominator for these three points, all data need to be mapped to a common time axis and methods to determine throughput and material flow need to be incorporated into these systems. In this way, it will be possible to link all relevant events in the processing chain to the batches as they flow through the chain.

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1.4 Process mapping in the Danish herring industry

1.4.1 Introduction

A pelagic chain has been analysed in Denmark using the analysis method of Olsen (2007).

1.4.2 Description of the analysed chain from vessel to supermarket

Figure 3 shows the analysed chain. The analysis scheme has been used four times in the chain (bolded frames), but all steps in the chain were visited.

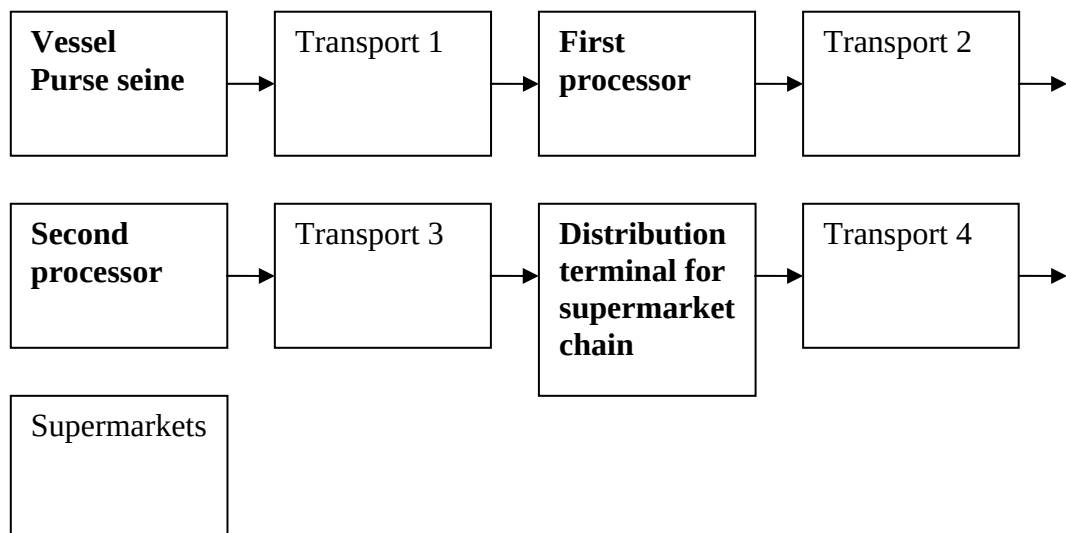


Figure 3. The analysed pelagic chain (herring product).

1.4.3 The process mapping

The fish species for the analysis was herring caught by purse seine vessel (surrounding net). The catch is kept in RSW (Refrigerated Sea Water) in tanks onboard the vessel until unloaded at the harbour.

The transport 1 on shore is done by tanker trucks for only one kilometre to processor 1. No mixing of batches is possible in this step. The first processor step size grades the herring in four sizes. Then they are filleted and pre-salted for 24 hours. The day after they are transferred to 100 liter barrels and brine is added. The barrels are kept on storage for at least four months and are then transferred to the second processor when they need more raw materials for their production. The transport 2 between processor 1 and 2 is done on whole pallets. Each pallet contains 6 barrels and each barrel is labelled uniquely.

The second processor drains the brine from the barrels and repacks the herring in the 100 liter barrels to small consumer units (jars with unique lot numbers) with pickle. Six jars are collected into one unit and collected on pallets. The whole pallet is transported (3) to the distribution terminal for the supermarket chain.

Each product is marked uniquely and is selected for each final supermarket in the distribution centre. All selected products are collected on a pallet labelled with the final supermarket. The pallet is transported (4) untouched to the end destination supermarket.

1.4.4 Short result of the traceability analysis

Vessel

One batch is one whole fishing trip from the vessel leaves the harbour until it returns again. Several catches are collected into one big batch. Each single catch is documented in the EU standard logbook. In that book, the FAO catch area, the fish species, the catch date and estimated amount is documented.

The catch is kept in 12 tanks onboard and the catch is chilled to around 0°C with RSW. The water between the fish in the tanks will be mixed among all tanks that are used in one fishing trip. Even if each tank is kept separate, a potential contamination in the water can, depending on the actual substance, be transferred to other tanks.

First processor

The catch from one vessel is shared between two factories. Data such as vessel identification and the date of unloading are kept separate inside the company. Coloured notes are used (one colour for one date) internally to keep different vessels separated. Catches from a maximum of two vessels will be in the company on the same day. The traceability is ensured manually, but it is an easy job because maximum two batches will appear at the same day. In five minutes it was measured that it was possible to find the vessel and landing date for a given batch number. The end product (herring in barrels) is uniquely labelled by a lot number. No ingredients (salt, sugar, vinegar, and species) or packaging material are registered with unique numbers to ensure traceability.

Second processor

The raw material from processor one is kept separate from other raw material. One day's production is one batch. The finished material (pickled herring in jars) is labelled with a unique lot number (date/time based). One sample is taken from each day's production and this can be tested if necessary. There is no registration of ingredients (salt, sugar, vinegar, and species) or packaging material. The used batch numbers from processor 1 are recorded. Six finished jars are collected in one unit. The units are collected in one pallet. The finished pallet is wrapped with plastic and labelled with a production code for the supermarket. Every jar has a unique lot number on the label.

Supermarket chain distribution centre

No repacking is made from the units of six jars. The pallet is placed at the "selection position" in the storage room. Jars for each supermarket are selected directly from the pallet. Whole pallets with the supermarkets name are distributed to the final supermarket. In case of a recall, all supermarkets that have received a delivery of the product are asked to go to the shop shelves to remove the lot numbers that are included in the recall.

1.4.5 Overall conclusion

The chain has a relatively good ability to trace and track the main product (the herring and the herring fillets). Because of the very big batches, it is also possible to have an effective manual paper based traceability system. But with regards to all other ingredients, no registration is made at all. Processors 1 and 2 have continuous batches of vinegar, salt and all brine and pickle.

The "mother brine" at processor 2 has existed for as long as the tank has existed.

No packaging material is registered for traceability anywhere in the chain.

There is a long way for the chain to be "TraceFish compatible". The GS1 (barcodes) system is only used at the finished product from processor 2. No SSCC (Serial Shipping Container Code) labels are used on pallets. In the whole chain, manual methods are used. However, the manual methods are very well integrated in the daily production in all steps. When asked, processor 1 has "no intention to apply GS1 barcodes as long as no one will pay them the money to do it". Processor 1 would like to have more specific information about the content in each tank of the vessel, but does not want to pay for it. One factor that will begin to change the recording of traceable data in the chain is the development of a freeware pelagic information programme for the vessels. The programme records the content of each tank and transfers the information via the Internet to the processor in a standardized way using the TraceFish standard. In that way, more exact information can be retrieved by the processors. Utilisation of the data further on in the chain will demand use of information technology. That can in the end make the change from the current practice to the TraceFish standard possible.

1.4.6 Recommendations

A plan to improve the traceability for the vessel could be as follows:

1. A catch is split up, thus each trade unit shipped needs a unique identification. Extend the use of GS1 codes so that each trade unit gets a unique GTIN (Global Trade Item Number). Add a serial number (or a guaranteed unique date/time stamp) to the GTIN to get unique identification of each trade unit (TU) shipped.
2. Develop a freeware pelagic information programme for the vessels. The programme records the content of each tank and transfers the information via the Internet to the processor using the TraceCore XML. More exact information can then be retrieved by the first processor.

A plan to improve the traceability for the first processor and the second processor could be as follows:

1. Encourage suppliers of ingredients to use globally unique numbers when identifying their shipments. Having the number in standard format would act as an enabler for electronic dissemination of information, both from supplier to the first and second processor, and from the first and second processor to the customer.
2. Reception: Record identification of ingredients (salt, sugar, vinegar, and species) and packaging materials.
3. Decide on the level of traceability wanted for vinegar, salt, brine and pickle.
4. Record the relationship between the identification of ingredients and packaging material and an internal batch number.
5. Extend the use of GS1 codes so that herring in barrels and pickled herring in jars each receive a unique GTIN.
6. Record the relationship between the uniquely identified herring in barrels / pickled herring in jars and an internal production number.
7. Extend the use of GS1 codes so that each pallet gets a unique SSCC code.

A plan to improve the traceability for the distribution terminal could be as follows:

1. Record the SSCC code of the received pallets.
2. Extend the use of GS1 codes so that each mixed pallet gets a unique SSCC code.
3. Record the relationship between the identification of pickled herring in jars and the SSCC code of the mixed pallet.

Reference

Olsen, P., 2007. Analysis of traceability in food supply chains - Standard method. Submitted to *Journal of Supply Chain Management*.

1.5 Process mapping of farmed Norwegian salmon

1.5.1 Material flow and identification

A salmon supply chain from breeding to production of salmon fillets in Norway has been studied (Figure 4), including production of vitamins and pigment colour and production of salmon feed. The grey steps in the supply chain have been analyzed by using the analysis schemes in Olsen (2007).

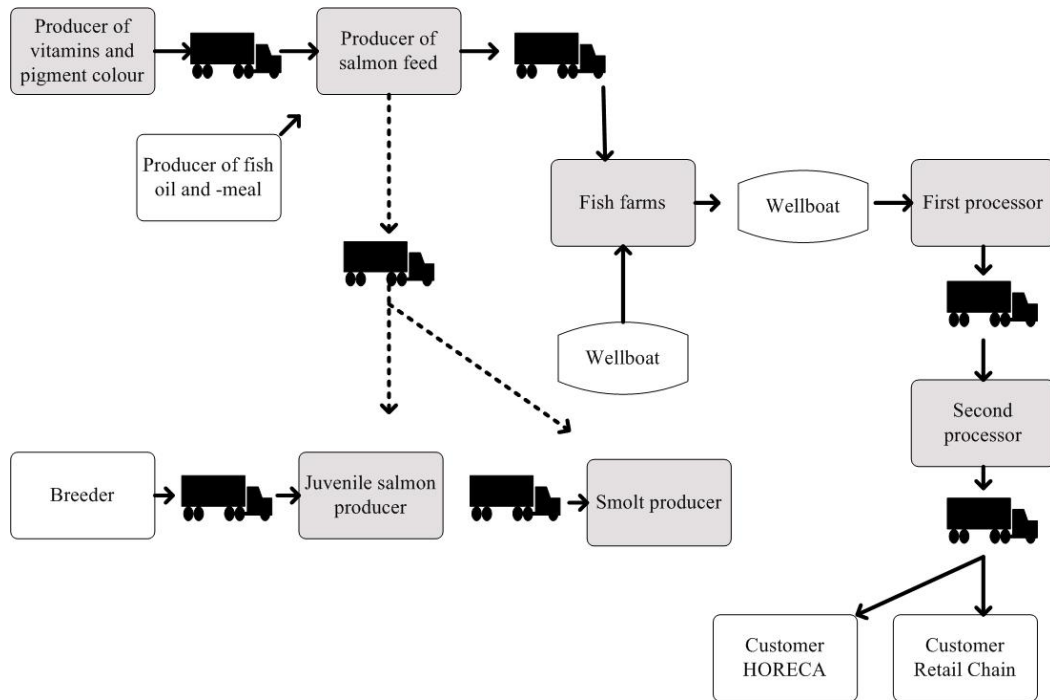


Figure 4. Overview of the salmon supply chain in Norway.

The first step in process mapping of this type is to identify the end product. The product chosen to map was salmon fillets.

Producer of vitamins and pigment colour

The producer of vitamins and pigment colour supplied vitamins to the producer of salmon feed. The vitamins were based on chemical products. All the steps, including the natural gas supply, were internal in the company. The internal traceability of the vitamin-producing company was not evaluated in this study. This evaluation will only focus on chain traceability starting from the producer of vitamins and pigment colour. The transformation information in the Enterprise Resource Planning system (ERP) between producerID, production batchID and customerID indicated that the producer of vitamins and pigment colour had the possibility to trace each batch of an article to a defined number of customers. A barcode labelling and reading system was implemented and running. The system was based on the EAN-128 code, which is the preferable system for global unique identification.

Producer of salmon feed

The producer of salmon feed received raw materials from more than 100 different suppliers. The sizes of the received batches could vary between a few kilos in a single box of vitamins to several tons in a bulk cargo of fishmeal. The study focused on the methods and systems for receiving raw materials from the producer of vitamins and pigment colour. Traceability between the producer of vitamins and pigment colour and producer of salmon feed was based on manual recordings of identifications and additional traceability information. The identifications used were only partly based on an internationally standardised system.

Breeder

The breeder produced salmon roe and delivered it to the juvenile salmon producer. This step was not analyzed in this study.

Juvenile salmon producer

The juvenile salmon producer received salmon roe. Feed, water and oxygen was added to make the salmon grow into juveniles, and temperature and light was controlled to optimize the growing conditions. During the production, only splitting of the original fish groups was done. The identification of trade units was unique both for reception and dispatch of fish groups. Input factors, such as feed, were not recorded with unique trade unit (TU)/logistic unit (LU) IDs. Traceability of feed was therefore only possible at the feed type level. For the salmon itself, developing from roe to juvenile, the information loss was not significant. Salmon of one origin/generation were kept separate from other salmon in all stages through this step, from roe to juvenile. The roe could be distributed across numerous cylinders, and the juveniles in many tanks, but the splitting, mixing and joining that happened did not cause significant information loss, as the fish was uniform. There is a concern, however, that relevant information pertaining to the feed could be lost unnecessarily; if a recall based on feed batch ID should occur, it might be problematic for the juvenile salmon producer to prove that the fault is not to be found in his company.

Smolt producer

The smolt producer received salmon juveniles. Feed and water was added to make the salmon grow from juveniles to smolt (ready for salt water), temperature and light was controlled to optimize the growing conditions, and the fish was vaccinated against disease. Salmon smolt was delivered to fish farms either in September/October of the same year as when received (0 yearlings) or in April/May the following year (1 yearlings). Traceability of the fish TUs were considered to be good. During the production, only splitting of the original fish groups were made. The IDs of the TUs were unique both for reception and dispatch of fish groups. The input factor feed was not recorded with unique TU/LU IDs at reception. At consumption, feed name and batch ID were linked to the actual fish groups. Traceability of feed was therefore possible at feed batch level per fish group. The software was, however, not capable of reporting these references. Because of this, the traceability was not electronic. The input factor vaccine was recorded with unique TU/LU IDs. Traceability of vaccine was possible at the TU/LU level per fish group.

Fish farms

The fish farms received smolt. Feed was added to make the salmon grow from smolt to 4-6 kg salmon. Temperature and light was controlled to optimize the growing conditions, and the fish was chemically treated against lice. Salmon smolt was received at fish farms either in September/October or in April/May. It took 10-18 months to grow from smolt to 4-6 kg. Traceability of the fish TUs were considered to be good. During the production, only splitting of the original fish groups were made. The IDs of TUs were unique both for reception of smolt and dispatch of salmon for harvesting. These IDs were internal and proprietary and were not used as a link by the live fish transporters. Input factors such as feed were not recorded with unique TU/LU IDs. Traceability of feed was therefore only possible for feed type per fish group.

Well boat

Well boats transported live salmon from the fish farms to the first processor. This step was not analyzed in this study.

First processor

Live salmon was received from well boats and placed in waiting cages. The salmon in each cage was assigned a production batch ID and processed one cage at a time. Salmon from the cages were pumped one cage at a time to a cooling tank. The production lines were emptied between batches to make sure that batches were not mixed. To keep the salmon calm, CO₂ was added in the cooling tank. From the cooling tank, the salmon was pumped to a station for 'throat cutting', and then on to a bleeding tank. The salmon was then sent through a grader for sorting by size, and sent to the appropriate gutting line.

Gutted fresh flow:

The packaging of fresh salmon in boxes was done automatically according to customer orders. The boxes were then filled with ice, labeled and strapped. Palletizing was done by a robot, sorting the boxes by quality and size. Pallets were transferred to the terminal area by pallet truck.

Fresh fillet flow:

Filleting was done by customer order, and the required size/quality was sent to a manual fillet line. Fillets were manually packed in boxes, labeled and strapped. The boxes were stacked on pallets and transferred by pallet truck to the terminal area.

Gutted frozen flow:

From the grader, the salmon was transported by pallet truck in 400 kg containers. After stacking in racks, the salmon was placed in freeze tunnels. Frozen salmon was packed in boxes, labeled and strapped. After palletizing, pallets were transported to freeze storage. Selecting from storage was done by customer order, using the first in, first out (FIFO) principle as much as possible. The process of loading onto trucks was common for all the product flows. The pallet labels were placed on top of the pallets. This made it possible to find errors discovered after loading by crawling on top of the cargo. The transport to customers either went directly or via terminal/other transport modes.

The salmon in each waiting cage was treated as one separate batch. When a new batch was started, the production plant information system assigned a batch ID. The operator chose a supplier (fish farm) from a list, and could also enter the fish farm cage number. The batch number assigned to the salmon from each waiting cage was kept through the production plant, and was printed on both box labels and pallet labels.

Transport

The transport company transported salmon from the first processor to the second processor. The loading of each customer order at the second processor was recorded on a freight manifest printed from the plant information technology (IT) system. This was a standardized document with basic information about the transport, and each manifest had a unique consignment number. This number was also printed on the document as a barcode. The processing plant printed the customer order number on the freight manifest as a reference between the transport and the customer order. The document was signed by sender, transporter and receiver, and each party kept their own copy. For each transport order, the transport company assigned a transport order number. This was used as the internal reference in the transport company for tracing the transport. As an external reference, the transport company normally linked the second processor's customer order number to each transport order number. The invoice number was also linked to the transport order number. One transport (transport order) consisted of one or several trips, identified by a unique trip number. The trip numbers were linked to the transport order number. The information stored for each trip was origin and destination, date/time of start and arrival, truck registration number, etc. For international transports, the transport company issued an international freight manifest. In addition to the name of the receiver, the reference to the second processor's customer order on this document was the transport company's transport order number. When the transport company stored salmon in the terminals, the transport company kept track of pallets/boxes by assigning a physical area for each client. The location of individual pallets/boxes was not managed by a Warehouse Management System (WMS). When a sale was made, the transport company received an order with a packing list with reference to individual boxes.

Second processor

Fresh salmon was received from first processor (above) in 20 kg styrofoam boxes on pallets. The transport was made by refrigerated trucks. The outgoing products could vary between a few kilos to several tons of smoked salmon in 10 kg styrofoam boxes.

The level of external traceability was poor, as they missed traceability links at both ends of their internal chain – that is, the reception of raw materials and the dispatch of outgoing products. At the reception of raw materials, there is no scanning of box or pallet labels. But some data from the box labels are entered manually into paper forms. However, nothing that can be used as unique backward links (to the slaughtering plant or to the transporter) is entered.

The situation is similar at the dispatch of products. Production lot numbers are stamped on the boxes using ink-stampers, but the numbers are not globally unique, and not even internally unique. The boxes receive printed labels from the Marel system too, but the

labels only identify the customer and transporter at a generic level (name only), and does not contain the production lot number (as this is being stamped on the box).

1.5.2 Conclusion

In general, traceability is good along the production chain. Internal traceability is acceptable in all the steps. The methods and systems of chain traceability are, however, more insecure and partly missing.

1.5.3 Recommendations

General recommendations for the salmon supply chain

1. For each unit received from the fish farms and other suppliers, the SSCC, supplier ID (GLN; Global Location Number) and transporter ID should be recorded and linked to the internal production batch ID.
2. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal production batch ID, customer ID (GLN) and transporter ID.
3. For recording SSCC numbers on pallets when loading trucks, a logistic unit ID data capture system should be in place at the plant. The data capture system must be integrated with the company's ERP system.

General comments

It is assumed that the ERP systems for each step in the chain have functionality for linking logistic units (SSCC) and trade units (GTIN+) to customer orders.

A plan to improve the traceability at the producer of vitamins and pigment colour could be as follows:

1. Redefine the barcode on the trade unit labels to include the following EAN-128 AI's:
 - a. AI (01) GTIN
 - b. AI (10) Lotnumber
 - c. AI (21) Serial number or (8008) Date and time of production
2. If trade units are assembled into a logistic unit:
 - a. Labelling and identification of the logistic units including EAN-UCC's SSCC in a barcode
 - b. Links between ID of each trade unit in the logistic unit (1a, b and c) and the SSCC
 - c. Link between SSCC and order number in software such as SAP
3. Labelling and identification by the producer of trade units and logistic units by using the EAN-UCC Global Identification Number (GLN) AI 410-415 in barcode.

A plan to improve the traceability at the producer of salmon feed could be as follows:

1. Scanning of SSCC and GLN at raw material reception. Automatic data capture may be the most efficient improvement to improve traceability in the raw material reception. This is only possible through the use of standardised company and batch IDs from suppliers according to the TraceFish standard for identification of company and batch/trade units.
2. Use the GTIN article numbers instead of proprietary raw material numbers.
3. Apply GLN in product labels using EAN-UCC 128 coding at all production sites.
4. Identification of small bags with GTIN (AI 01), batch number (AI 10) and Serial number (AI 21) or date and time of production (AI 8008).
5. Links between ID of each trade unit on the logistic unit (ref. 4. above) and the SSCC.
6. If small bags are dispatched as single bags, they should be labelled as a logistic unit with an SSCC.
7. To ensure the link between trade unit/logistic unit and customer (fish farmer), a logistic unit ID data capture system should be in place at the transporter, or alternatively at the fish farm.

A plan to improve the traceability at the juvenile salmon producer, the smolt producer, the fish farms and the first processor could be as follows:

1. For each unit received from the suppliers (previous step, feed, chemicals, etc), the SSCC, transporter ID and supplier ID (GLN) should be recorded and linked to the internal fish group I.
2. For recording SSCC numbers, a logistic unit ID data capture system should be in place at the fish farm. The data capture system must be integrated with the company's ERP system.
3. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal fish group number, customer ID (GLN) and transporter ID.

A plan to improve the traceability at the transport company could be as follows:

1. Loading: For each unit received from the first processor, the SSCC, supplier ID (GLN) and freight manifest ID should be recorded and linked to the internal transport company order number.
2. For recording SSCC numbers during loading, a logistic unit ID data capture system should be in place at the first processor /the transport company vehicle.

3. Unloading: For each unit unloaded at a distribution terminal or at the customer site, the SSCC of the logistic unit and the GLN of the destination should be recorded.

A plan to improve the traceability at the second producer could be as follows:

1. For each unit received from the suppliers, the SSCC, transporter ID and supplier ID (GLN) should be recorded and linked to the internal production batch ID. This also includes the received SSCC or other appropriate ID for packaging.
2. For recording SSCC numbers, a logistic unit ID data capture system should be in place at the fish farm. The data capture system must be integrated with the salmon fillet producer's ERP system.
3. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal production batch ID, customer ID (GLN) and transporter ID.

Reference

Olsen, P., 2007. Analysis of traceability in food supply chains - Standard method. Submitted to *Journal of Supply Chain Management*.

1.6 Changes and reengineering of production practice in the Norwegian farmed fish industry

The production practice in the Norwegian farming of Atlantic salmon was until the first few years after the millennium not influenced by traceability principles. A traceability survey conducted in 2002 (Forås et al., 2004) revealed the following shortcomings:

- Not standardised and unstructured identification of generations of fish groups.
- Insufficient labelling of batch ID on trade units.
- Absence of recording of feed ID when used.
- A high degree of mixing of different fish groups from diverse suppliers and with different genetic characteristics.
- No data is recorded at the live fish carriers between farm sites and harvesting sites.

Recommendations to the case chain were to:

- Reengineer production processes in order to reduce the size of their traceable units. Reduce the number of size grading and mixing of fish groups in the smolt, on-growing and live fish carrying steps.
- Implement global unique identification keys for the traceable units.
- Implement recording routines of IDs of raw materials and input factors at reception, production and delivery.

- Develop integration modules for traceability information exchange between software applications.
- Develop a software application for recording of traceability.

In the period of 2003-2004, many of the fish farmers experienced challenges that required improved product traceability. Examples of problems that occurred were inexplicable mortality, customers complaining on product quality caused by factors early in the supply chain, etc. Tracing back to the causal factors and tracing forward to all the batches that were influenced was described as problematical by many of the farmers.

A new traceability survey in 2004 in the same case chain as in 2002 displayed a change in practice (Forås et al., 2006). The new production practices gave smaller traceability units in the chain from smolt to harvesting due to:

- Substantial reengineering in production practices in order to avoid mixing of different fish groups in the smolt, ongrowing and live fish carrying steps
- Improved records on reception and use of input factors such as vaccines and feed
- Improved traceability records documenting transformation information between steps in the chain

The same process reengineering as mentioned above has been adapted by the majority of the fish farming industry during the period 2003-2005.

During the same period of time the actual feed producer implemented globally unique identification on their trade units. They also started keeping records of which batch numbers were delivered to which customer.

Despite these improvements, the 2004 survey revealed that the reengineering only to a certain degree reduced the traceable units. The feeding records per fish group did not include the unique ID on the feed bags or the feed batch numbers. This gave complex relations between feed and fish groups, which again gave a high traceability granularity.

Regarding globally unique IDs, none of the fish farmers had implemented such on the fish groups.

The live fish carriers still had minimal recording of traceability information and none of this were available electronically.

Conclusion

There has been substantial reengineering of production processing in the salmon farming industry in Norway between 2002 and 2004. This reengineering has led to an improved granularity of traceability. At the same time, there are still multiple

challenges towards optimal chain traceability. Further focus should be made on implementing globally unique IDs and an improved solution for the live fish carrier.

References

Forås, E., Fremme, K., & Senneset, G. (2006). Internal project report TELOP Trace (Project report March 2006): TraceTracker.

Forås, E., Storøy, J., & Olsen, P. (2004). Kjedesporbarhet innen fiskeri og havbruksnæringen (STF80 A044068): SINTEF Fisheries and Aquaculture.

1.7 Critical Traceability Points

There are at least two main reasons why there should be a traceability system in place in a food company:

1. The ability to trace the origin of a product
2. The possibility to find and reduce the risk and consequences in time when something has gone wrong.

A food production plant is like a black box where the raw materials, ingredients, packaging materials and water are put into.

One of the most important steps in the traceability analysis is to ensure that each material coming into a food plant has a unique identity and that this identity is linked to the facts/documents from this delivery. The identity should then be reiterated every time the product or material is used in the process. During production, groups of materials are put together during different process steps as temporary batches and in the end, they receive their final batch or lot identity. It is thus also important to control that the product identities do not get lost during production.

This means that the traceability itself is based on the sum of identities in a specific lot and this is also enough to trace or track a product through the production. However, during the different production steps, these batches are also influenced by the process equipment, environment and the personnel. Information reflecting these influences are often collected within the frame of a process control system, a quality control system or a HACCP system. This is in fact the information that could be used to analyse the cause of a recall or withdrawal. The more precise process information that is linked to the identities, the better and faster analysis could be done to reduce a recall.

Identification of critical traceability point

In order to identify critical traceability points, the actual traceability level has to be identified, taking into account batch sizes or “length” of the batch of raw material as well as ingredients. The frequency of quality control measurements verifying that everything is as it should be has to be looked over. The risk that something goes wrong will vary; this has to be considered as well.

Traceability level

There is no specific level of traceability, but for each used material's identity, there is one. This means that the material identity with the longest time in production has to be in very good control, since it influences many lot identities. The end product lot identity has in fact a mix of traceability levels.

What is an optimal traceability level? For the main product there are seldom any problems, but for ingredients, the situation is often different and one may often find that the same lot number is used for several months or mixed (e.g. flour in silos). If something happens, this may lead to very large withdrawals/recalls.

By connecting data with a time line (Figure 5), as described below, a simultaneous overview of the quality control system, the HACCP system and the traceability system can be obtained and critical traceability points can be identified.

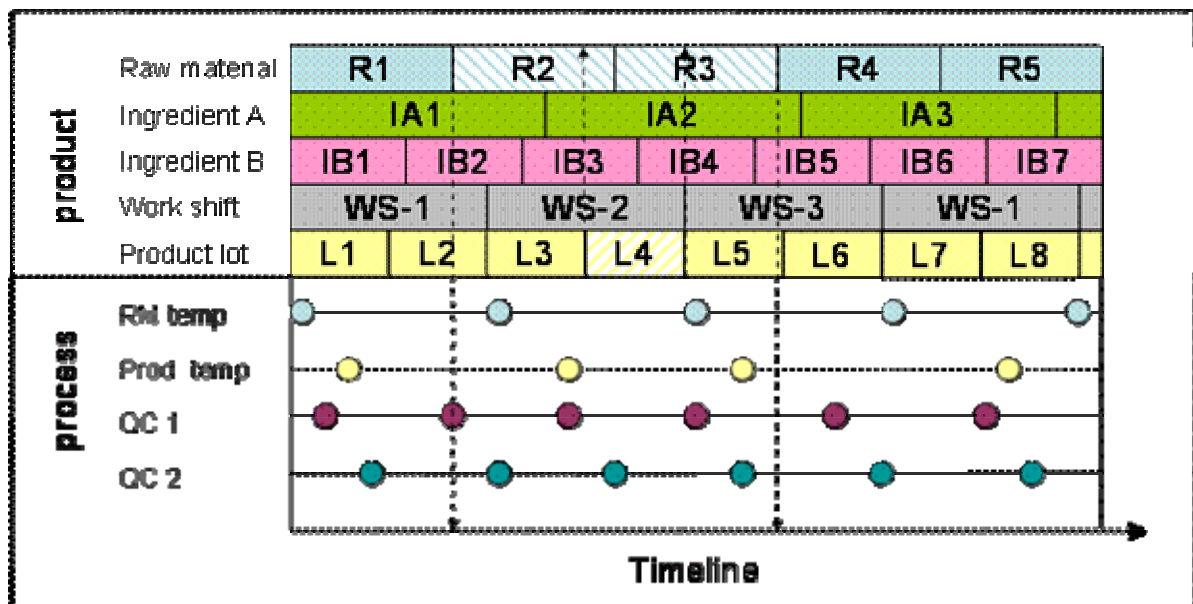


Figure 5. Traceability timeline showing which raw material batches were potentially affected and what was happening in the factory while they were in production.

Batch size

From Figure 5 it can be seen that the batch sizes of Ingredient A will determine the size of a withdrawal/recall (if the cause of the fault is unknown). By decreasing the size of each identity, the level of traceability can be improved, thereby decreasing the risk of large recalls/withdrawals.

Frequency of quality control measurements

Measurements are performed in order to ensure the quality of the product. By relating these measurements to the traceability as demonstrated in Figure 5, it can be seen that some of the production lots have no temperature measurements attributed. Thus, if an error in temperature level is detected and a recall/withdrawal must be performed, the neighbouring lots have to be recalled as well. By adjusting the measurement frequency in relation to the size/"length" of the lots, a potential withdrawal/recall can be decreased with a very small effort.

Risk evaluation

There are two types of hazards concerning traceability: loss of identity for a specific material and some uncontrolled parameter (quality or safety related) linked to a specific identity.

A traceability system could work very well in theory. However, in practical situations, it is important to evaluate the risk of losing an identity or risk of any other failure related to the quality system. For example, large batches in combination with a risk of losing the identity or a large risk of any other failure could be devastating.

In conclusion, the consequence of this discussion is that everything that is measured and recorded (manually or automatically) should not only be linked to the process step and time, but also needs to be linked to the temporary batch identity or end lot identity. The combination of identity based traceability and identity linked process information will secure the ability to have an internal traceability system, where it is possible to transfer suitable information to chain traceability environment. The timeline approach will help to identify critical traceability points taking into account a broader scope of information than what is normally used.

1.8 Article – Integrating traceability and food safety

1.8.1 Introduction

One of the main tasks in this project has been to discuss models for and suggest how traceability and food safety can be integrated in a food production company.

A case study was carried out at a dairy, where the Nordic researchers tried to record hygiene and other quality related data in the TraceFish data recording forms. The trial showed that this effort was not very applicable. The list of data that is recorded in each food sector varies a lot, hence further development of the TraceFish forms for recording of internal production data would need major sector specific adjustments.

This experience led to further discussions on how traceability and food safety can be integrated in the different software systems in a food business.

Both discussions and output of this work are covered in a scientific paper that will be sent to Journal of Food Engineering. The abstract of the article is presented below.

1.8.2 Abstract

This article discusses unique identification in data recording as a means for the interaction between the different production, safety and quality management systems in the food processing industry. The discussion is based on a case study of an Icelandic fish processing plant. Process and product information differ in the way they are uniquely recorded in companies today. Information in food safety systems and quality management systems is typically identified by time and physical place and is therefore process oriented. In production systems however, information is typically identified by

traceable units (unique numbers, batch/lot numbers) and therefore product oriented. The conclusion is that companies must be aware of the intrinsic differences of the systems and that they can combine the information from all systems by using a “timeline approach”. Their systems must be able to transfer information to each other and in case of a recall of a certain batch, the time-based information connected to the production, safety and quality systems must be connected to the unique batch number. Companies can make a thorough analysis of all systems and standardise the way information is recorded. Analysis methods and standard formats are available today that can aid the process of connecting all internal information in a company, but the timeline approach is a new way to look at companies’ information structure. In the long term, information transferred in the whole production chain should be standardised in order to make utilisation of chain information possible for optimised chain performance and cost-effective recalls.

2 Data Capture Technology

2.1 Introduction

Objective: Initiate and promote development of data capture technology to be able to collect and exchange information according to the TraceFish recommendations and the technical TraceFish data exchange format.

The aim of introducing RFID tags on the packaging and the carriers is to improve several functions such as:

- More accurate identification of cargo units
- Conduct faster data capture
- Being able to sort the cargo more easily
- Record historical data through the food chain (e.g. food safety related information such as temperature)

Supermarkets like Wal-Mart, Metro, Sainsbury's and Marks & Spencer have had their own RFID projects and shown great interest in implementing this new technology in their supply chains.

The main focus of this activity is the testing of equipment for automatic identification and data capture (AIDC) using state-of-the-art RF technology. One major goal is to evaluate technical and economical advantages/disadvantages in the distribution chain for farmed fish compared to the use of bar codes and traditional temperature loggers. The testing includes transfer of data between equipment for data capture and information systems.

The work carried out in this part is done in cooperation with the following projects:

1. IFSAT
2. Seafood Plus
3. Telop Trace
4. SPINK
5. Fælles normer for sporbarhed og implementering af sporbarhed for fiskeprodukter i Norden
6. Innova RFID
7. KMB Competitive processing (Norwegian project)

The IFSAT data capture technology activity mainly consisted of four parts:

- Initial survey of available technology
- Establish functional specifications
- Arrangement of workshops as an arena for sharing experience and discussions
- Conducting tests of RFID tags in a realistic environment

2.2 Initial survey on existing data capture technology

2.2.1 Introduction

This part recommends technology and equipment for initial tests based on the current status in 2004 for standards, technology and functional specifications for selected steps

in the salmon distribution chain. The salmon value chain was the first chain to be investigated in the SEAFOODplus and TelopTrace projects.

Note that this survey was carried out in the beginning of the project period in 2004, meaning that findings are not up to date today.

2.2.2 Methodology

Information and views on current status and future developments have been gathered by going through material from international standards organizations, research organizations, major technology suppliers and major companies in important supply chains.

To conclude the information gathering phases, SINTEF hosted the workshop 'Technology in chain traceability' in Trondheim in June 2004, with selected lecturers representing both technology users and providers.

Following this workshop, functional requirements for AIDC equipment for the fish distribution chain was discussed with selected companies. This forms the basis for recommending equipment for the initial tests.

2.2.3 Status and trends

2.2.3.1 Technology and market

Today, the dominating technology used for identification of logistic units and trade units is bar codes. The use of EAN-UCC barcode standards is recommended by the Tracefish standard and by major producers, wholesalers and retailers (for example in ECR D-A-CH, ECR France & ECR Spain, 2004).

However, both EAN-UCC, government bodies, and major companies in manufacturing and retail are looking at RFID technology to replace or supplement the use of bar codes. The major reasons for looking into this technology are:

- Several RFID tags can be read at the same time
- Line of sight is not required for reading
- Less exposed to mechanical damage than barcode labels
- Smaller in size than barcode labels
- Possible to store more information, and also add/update information
- Possible to combine identification with environmental data (e.g. RFID tags with temperature sensors)

However, there are some obstacles:

- Costs for tags and readers (expected to decrease with increasing volumes)
- Work on international standards is still in progress
- Physical constraints related to reading distance, type of goods (metal, liquids), interference, etc.

The technology has been on the market for several years, and products are developed with functionality for a wide range of applications. Naturally, increasing functionality corresponds to a higher price per tag (see Figure 6).

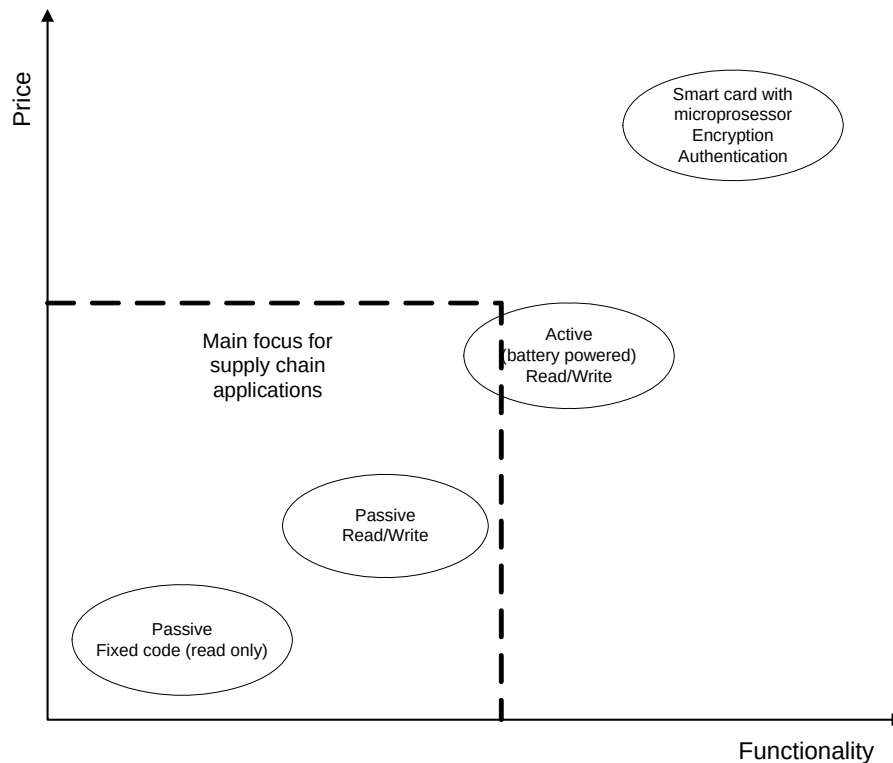


Figure 6. Tag categories.

The current focus for use in the consumer goods supply chains is on the use of passive tags in the HF and UHF frequency range. The vision of item-level tagging using low cost, read-only tags with a fixed Electronic Product Code (EPC) was developed by MIT Auto-ID Center. Further developments based on the proposals by Auto-ID are now coordinated by EPCGlobal, established by EAN-UCC.

In supply chain applications it is common that a lot of tags (hundreds) are in the same area, this means that functionality for anti-collision is important.

Tags with writable memory are more expensive, but can be more flexible:

- The need for online database access is reduced (more information can be stored in the tag)
- Information can be added to the tag on selected stages in the distribution chain

Active tags (battery powered) also have some important applications, especially where higher read ranges are required (for example tracking of containers in large yards) or where tags are combined with sensors (temperature, pressure etc).

2.2.3.2 International standards

A more detailed summary of technology issues and status on relevant standards can be found in a separate SINTEF report. Table 1 shows the topics addressed in the ISO standards most relevant to the use of RFID tags in the distribution chain for fish.

Table 1. Overview of the most relevant ISO standards.

ISO Standards	Description
ISO-IEC 15693.1-3	The standards are developed for the use of vicinity cards, but the technology has also been used extensively for logistics applications. The standard defines physical properties, radio communication requirements, anti-collision handling and data transfer protocols.
ISO-IEC 15961 ISO-IEC 15962 ISO-IEC 15963 In process	The standards respectively describe the protocols for transfer and storage of data on RFID tags used for identification of physical items: • The instruction set and the data syntax for exchange of information between an application and the RFID tag • Data storage formats in the RFID tag memory • Numbering system for tags with permanent unique ID The standards are independent of the radio communication interfaces described in the ISO-IEC 18000 series.
ISO-IEC 18000.1 ISO-IEC 18000.2-n In process	The standards describe the communication interfaces between RFID tag and RF interrogator (reader). 18000.1 describe the functionality and parameters to be defined for each of the frequencies to be used for RFID tags. The standards 18000.2-n describe how the functionality should be implemented for the different frequency ranges. Frequency ranges currently in process: • 18000.2: 135 kHz and below • 18000.3: 13.56 MHz • 18000.4: 2.45 GHz • 18000.5: 5.8 GHz (currently withdrawn) • 18000.6: 860-930 MHz • 18000.7: 433 MHz

In parallel with the work in ISO, there is a lot of effort on technology and standards development for simple RFID tags used in the supply chains for consumer goods. This work is driven by large retail chains, their suppliers and leading electronics equipment manufacturers. EPCGlobal is established by EAN-UCC to coordinate this work, which was started by the MIT Auto-ID Center. The specifications currently published from EPCGlobal are:

- EPC Tag Data Specification Version 1.1
- 900 MHz Class 0 Radio Frequency (RF) Identification Tag Interface Specification
- 13.56 MHz ISM Band Class 1 Radio Frequency (RF) Identification Tag Interface
- 860MHz – 930 MHz Class 1 Radio Frequency (RF) Identification Tag Radio Frequency & Logical Communication Interface Specification
- Physical Markup Language (PML) Core Specification, Extensible Markup Language (XML) Schema and Instance Files

The main difference between Class 0 and Class 1 tags is that it is possible to write to a Class 1 tag, while Class 0 tags are factory programmed with a unique ID. Version 2 of the Class 1 specification will soon be published.

EAN-UCC has also developed guidelines (GTAG) for implementing the EAN-UCC barcode standard data elements on read/write RFID tags (for example GTIN – Global Trade Item Number, SSCC – Serial Shipping Container Code etc).

So far, the EPCGlobal and the ISO SC31 WG4 standards proposals have some differences. However, the need for common global standards is evident, and efforts to coordinate the work have already started. Another challenge for worldwide use of the technology is the use of common radio frequencies and signal strengths. For example, in some parts of the world the UHF frequency range is reserved for other purposes. Work has also been started to resolve these issues.

2.2.4 Functional specifications

2.2.4.1 Introduction

The functional specifications are based on the Tracefish standard. In addition to identification of trade and logistics units, food safety related information like temperature data are important elements in the standard. These data must be captured, linked to the relevant trade units and be available on request.

2.2.4.2 Identification of trade/logistical units

Introduction

The initial testing should involve at least three businesses in the distribution chain for farmed salmon:

- Processing plant for farmed salmon
- Transport company (including both truck transport and terminal handling)
- Retailer

Fresh and frozen salmon is shipped in boxes stacked on EUR pallets. Boxes with fresh salmon are filled with ice. The use of passive RFID tags should be tested on both individual boxes and on whole pallets. In an operational situation, RFID tags are expected to supplement the existing labels. For the tests, RFID inlays can be integrated in existing labels or attached in addition to existing labels.

Details on the parameters to be included in the tests will be discussed with participating companies.

Data captured automatically, using either bar code or RFID technology will later be exchanged electronically, using the Tracefish Technical standard.

Processing plant for farmed salmon

The salmon is slaughtered, and fresh salmon is packed in boxes with ice. Some of the salmon are frozen, stored, and then packed in boxes before shipping to customers. The packaging is done according to customer orders, and labels with text and barcodes are attached to each of the boxes.

There are two main alternatives for information content in the RFID tags:

- Only a unique ID
- The same information content as in the existing labels (existing labels follow the recommendations in the Tracefish standard and the corresponding EAN.UCC guidelines).

It is desirable to test both these types of RFID tags at the following stages in the internal flow:

- Single cases on a conveyor belt (simulate a sorting operation between packing in boxes and palletizing)
- Pallet truck transport of stacked boxes on a pallet from the palletizing area to the load staging area (simulate control of pallet content, routing information to the pallet truck driver etc.)

Fixed readers should be used for both these test cases, for the pallet truck transport a gate or portal might be necessary.

Transport

The salmon is loaded on trucks for transport either directly to the customer or via a distribution terminal. The truck driver needs to verify that the correct pallets are loaded on the truck.

To simulate this verification, the pallet RFID tags should be read using a handheld reader. This means that the reader must be able to distinguish between the pallet tags and the box tags.

Customer or distribution terminal

In principle, the same operations are carried out in the receiving docks of a distribution terminal and at a customer site: The truck is unloaded, and the load content is verified. Verification is normally based on electronically transferred information from the previous step in the distribution chain (for example in the form of an ASN – Advanced Shipping Notice).

It could be argued that testing at a customer site or distribution terminal is comparable to the testing in the processing plant. However, it is considered important to verify that the tags 'survive' the truck transport (they are still attached to pallets/boxes, there is no physical damage).

The RFID tags should be read during pallet truck transport from the dock to the receiving area (simulate verification of pallet content). Fixed readers should be used for this test.

2.2.4.3 Temperature data

Introduction

The initial testing should involve at least three businesses in the distribution chain for farmed salmon:

- Processing plant for farmed salmon
- Transport company (including both truck transport and terminal handling)
- Customer

The TraceFish standard describes in detail the recommended temperature checks for each business involved in the distribution chain. In the standard, there are different methods for recording temperature data:

1. Temperature information for the product holding areas is recorded by each business in the chain (processing plant, terminal, transport company etc)
2. The temperature is recorded by data loggers following the product (for example placed in the box with the product)
3. Spot checks on the product temperature (for example on receiving a logistic unit)

The technical solutions for internal data communications and exchange of data can vary between the different businesses in the chain, and will be defined as part of detailed test descriptions for data exchange.

Table 2. Examples of Tracefish data elements for temperature logging.

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Processor, for each unit received	Logistic or trade unit	CPR08 Temperature check	Spot check on surface temperature	Manual entry in local database
Processor, for each unit received	Logistic or trade unit	CPR09 Temperature record	Affixed recording device in one trade unit (box) or logistic unit (pallet)	Read recording device, store temperature/time log in local database
Processor, for each unit received	Product holding area	CPR12 Temperature record	Selected temperature sensors in the building logged by the local SCADA ¹ system	Automatic storage in local database
Processor, for each new unit created	Production area	CPR30 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database
Processor, for each new unit dispatched	Product holding area	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database

¹ SCADA – Supervisory Control And Data Acquisition

Processing plant for farmed salmon

Table 2 shows the Tracefish data elements and the corresponding method of logging temperature data for this part of the distribution chain for farmed fish.

Temperature loggers should be attached to trade units or logistic units during packaging. Exact locations for the loggers must be discussed in detail (placed inside boxes, on top of a pallet etc.). For test purposes, the loggers will be read in the product holding area (load staging area). This will also make it possible to compare data from building sensors with data from the temperature loggers. Both fixed and handheld readers should be used.

Logging by building sensors will be tested by checking the status of the devices and by extracting temperature logs for a suitable time period.

The temperature data elements must be linked to the appropriate trade/logistic units. The principle of internal data flow for temperature data for a processor business is shown in Figure 7.

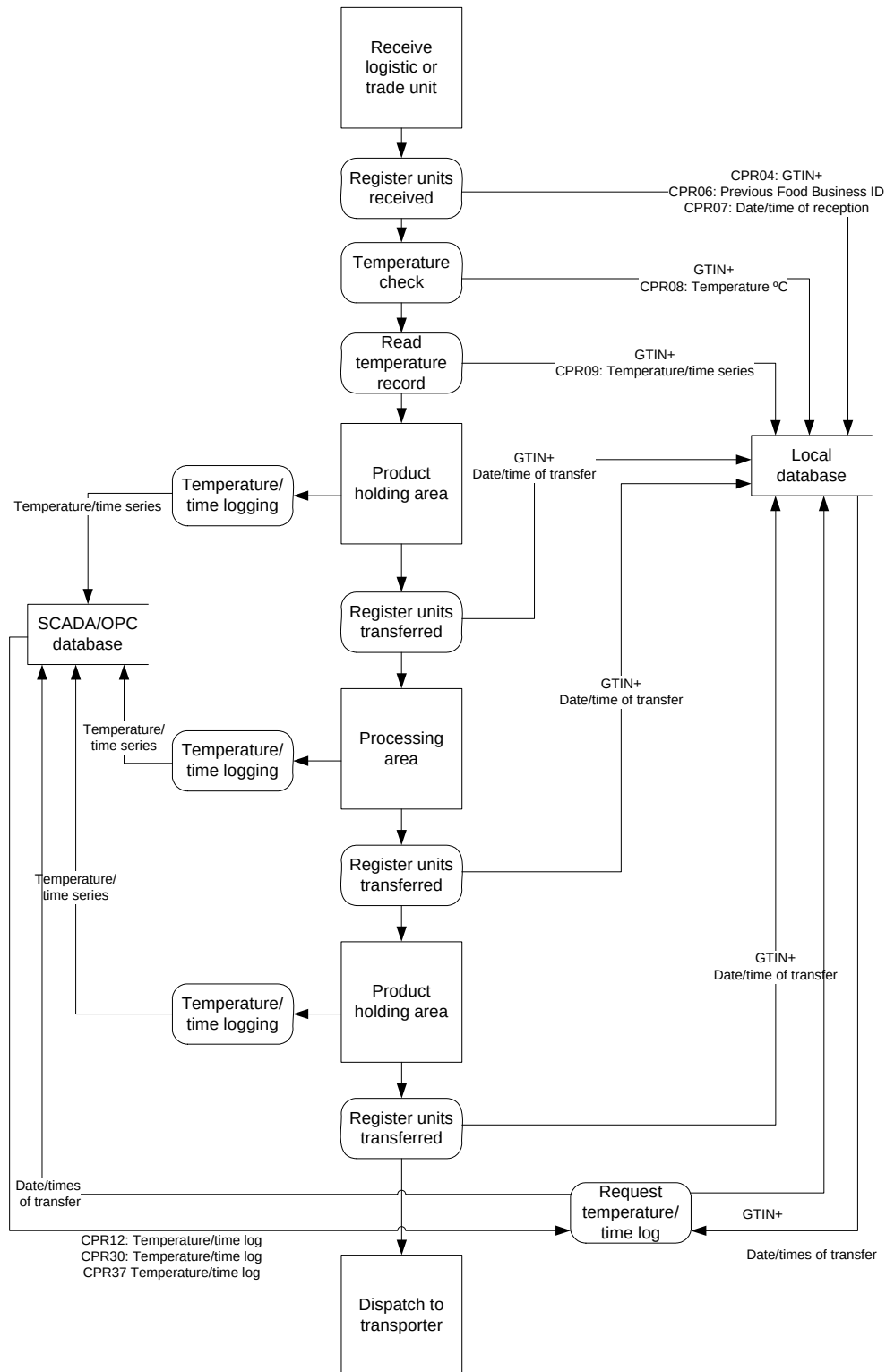


Figure 7. Temperature data flow for business type processor, Tracefish data elements.

The figure shows GTIN+ as the ID for linking temperature data to trade units; in some cases it can be more appropriate to link the data to logistic units (for example pallets, using the SSCC number). This will be discussed in more detail before the tests start.

Transport

Table 3 shows the TraceFish data elements and the corresponding method of logging for this part of the distribution chain for farmed fish.

Table 3. Examples of Tracefish data elements for temperature logging.

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Transporter, for each unit received	Logistic or trade unit	CTS09 Temperature check	Spot check on affixed recording device	Automatic storage in local database
Transporter, for each unit dispatched	Product holding area	CTS14 Temperature record	Truck transport: Logging of temperature sensors in the truck, with transfer to the transporters main office	Automatic storage in local database

The salmon is loaded on trucks for transport to customers, and the truck driver needs to verify the temperature of the cargo. To simulate this operation, temperature loggers on trade/logistic units should be read using a handheld reader.

Customer (wholesaler) or distribution terminal

Table 4 shows the Tracefish data elements and the corresponding method of logging for this part of the distribution chain for farmed fish.

Table 4. Examples of Tracefish data elements for temperature logging.

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Wholesaler, for each unit received	Logistic or trade unit	CTW09 Temperature record	Affixed recording device in one trade unit (box) or logistic unit (pallet)	Read recording device, store temperature/time log in local database
Wholesaler, for each unit dispatched	Product holding area	CTW20 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database

The truck is unloaded, and the temperature loggers are read by the customer to verify the quality of the load. The temperature loggers should be read during pallet truck transport from the dock to the receiving area. Fixed readers should be used for this test.

2.2.5 Choice of technology/equipment

2.2.5.1 Introduction

Ideally, several types of equipment should be tested. This would allow comparisons between different solutions (standards) for technology and data communication interfaces, as well as measuring the performance of different types of equipment/technology. This should be done incrementally, using a limited number of

products for the initial testing to make sure that the technology is suitable for the demanding environments in the fish industry.

When selecting suppliers for participation, several criteria have been considered. Among these are:

- Available RFID technology (for example frequency range)
- Relevant experience (also from other industries)
- General background in the AIDC industry (including barcode equipment, traditional temperature loggers)
- Participation in standardization work and policy on conformance to standards

Essential is of course that the suppliers are willing to commit resources (equipment, personnel) to the project.

2.2.5.2 Identification of trade/logistic units

Barcode technology

The EAN-UCC barcode standards will be the basis for comparison with the use of RFID technology. Barcode technology is well proven, and the EAN-UCC standards are well known. The emphasis on barcodes in this project will be more on whether the potential for improving traceability is realized, not technical tests.

The use of 2D barcodes is quite limited in supply chain operations compared to traditional barcodes, and will not be considered in this project.

RFID technology

International standardization efforts and product developments are currently focused on the UHF (860-960 MHz) and HF (13.56 MHz) frequency ranges. Different products have different characteristics, which make them more or less suitable for the demanding environments in the distribution chain for fish. Because of this, it is important to test equipment for both these frequency areas, and ideally also products from several suppliers.

The alternatives for equipment in the suggested steps in the distribution chain are shown in Table 5.

Table 5. Alternatives for ID capture equipment.

Food business	Tracefish data element	Equipment category	Supplier
Processor	CPR14 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
		RFID passive R tag RFID passive R/W tag	Willett/Sato

Food business	Tracefish data element	Equipment category	Supplier
		Stationary reader HF frequency range (ISO 18000.3)	
	CPR33 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
Transporter	CTS04 Unit ID	RFID passive R tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
Customer or distribution terminal	CTW04 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
		RFID passive R tag RFID passive R/W tag Stationary reader HF frequency range (ISO 18000.3)	Willett/Sato

Detailed configurations and installation plans must be worked out in cooperation with the suppliers as part of detailed test plans.

2.2.5.3 Temperature logging

The tests will be based on a combination of existing equipment (building sensors, truck sensors) and RF temperature loggers from cooperating suppliers. RF technology is chosen because of the potential for reducing the manual labour needed for reading data.

The alternatives for equipment in the suggested links in the distribution chain are shown in Table 6.

Table 6. Alternatives for temperature logging equipment.

Food business	Tracefish data element	Equipment category	Supplier/model
Processor	CPR09 Temperature record	Affixed recording device in one trade unit (box)	Elpro/Hamster R
			KSW Microtec /TempSens
	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Depending on the current infrastructure of the business. Interface via OPC ² server is desirable.
Transporter	CTS09 Temperature check	Spot check on affixed recording device	Elpro/Hamster R
			KSW Microtec /TempSens
	CTS14 Temperature record	Truck transport: Logging of temperature sensors in the truck, with transfer to the transporters main office	Depending on the equipment currently installed in the trucks
Customer or distribution terminal	CPR09 Temperature record	Affixed recording device in one trade unit (box)	Elpro/Hamster R
			KSW Microtec /TempSens
	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Depending on the current infrastructure of the business. Interface via OPC server is desirable.

The Elpro/Hamster R logger operates on 868 MHz (Europe), while KSW Microtec/TempSens operates on 13.56 MHz.

Detailed configurations and installation plans must be worked out in cooperation with the suppliers as part of detailed test plans.

References

CEN Tracefish Workshop Agreement (CWA): Traceability of fishery products – Specification of the information to be recorded in farmed fish distribution chains.

² OPC – Open Connectivity, standards in industrial automation

CEN Tracefish Workshop Agreement (CWA): Traceability of fishery products – Specification of the information to be recorded in captured fish distribution chains.

ECR D-A-CH, ECR France & ECR Spain, 2004. ECR - Using traceability in the supply chain to meet consumer safety expectations. ECR (Efficient Consumer Response) Europe.

EAN-UCC: Global Tag GTAG™ Technical Specification Draft V0.2, August 2002.

EAN-UCC: Traceability of fish guidelines, November 7, 2002.

EPCGlobal: Working documents available at the time of writing.

ISO/IEC JTC 1/SC 31/WG4: Working documents available at the time of writing.

Klaus Finkenzeller: RFID Handbook Fundamentals and Applications in Contactless Smart Cards and Identification, Second Edition, 2003.

SINTEF Report: RFID Technology for fish distribution chains – An overview.

2.3 Workshops

In the project period there have been conducted 3 workshops, in cooperation with Seafood Plus, SPINK and the Innova RFID project, discussing new solutions for automatic data capture technology and traceability software applications:

1. Trondheim June 14, 2004
2. Granville, October 6, 2005
3. Trondheim, November 20, 2006

Together with experiences done in practical testing, these workshops have led to a good dialogue between food companies, equipment providers and researchers, and resulted in improved knowledge on the area.

2.4 Test of RF temperature loggers at Fjord Seafood Herøy, Norway

2.4.1 Background

This memo contains a description of the test for an initial evaluation of the use of RF temperature loggers in the farmed salmon chain. The tests are done as a part of two research projects:

- SEAFOODplus
- Telop Trace

The loggers were placed inside cases with salmon on ice. The loggers can in theory be identified and the log transferred to a computer by using radio frequency (RF) readers. This will be an advantage over current systems, because loggers placed inside cases can

be read or monitored at critical points in the distribution chain without breaking the pallets/cases.

The tests were done at the Fjord Seafood production plant at Herøy in Norway, and aimed to confirm whether current technology can be used like this in a real life environment.

Two different products are tested:

- Elpro Hamster R loggers, with reader/antenna from Elpro, 868 MHz
- KSW Microtec TempSens loggers, with reader/antenna from Scemtec, 13.56 MHz

More detailed specifications are shown at www.elpro.com and www.ksw-microtec.de.

2.4.2 Functionality to be tested

The basis for the tests is the Tracefish standards, where two types of temperature data are defined:

- Temperature check
- Temperature record

Typically, the temperature check is performed when goods is received, while a temperature record can include data from several links in the distribution chain.

The time used for data transfer is an important parameter, and the tests include both the readout of current temperature (a single value with a timestamp) and the complete log.

For all tests, the amount of data transferred is the maximum storage capacity for the loggers:

- Elpro Hamster R: 32 kBytes, corresponding to about 13 000 registrations
- KSW Microtec TempSens: 1 kByte, corresponding to about 64 registrations

2.4.3 Parameters expected to influence the results

In general, the use of RF technology is subject to influence from a large number of parameters. Some parameters relevant for these tests are:

- The location of the logger inside a case
- The location of the case with logger on the pallet
- The orientation of the logger relative to the reader antenna
- Number of loggers in the reader field at the same time
- Distance from logger to reader antenna
- Direction of travel relative to the reader antenna
- Speed past the reader antenna
- Environment (building material, technical installations, moving objects, radio noise sources, etc.)

The initial tests did focus on the influence of a few of these parameters, while the others were kept constant. The parameters that were investigated are described in section 2.4.4.

The results can also vary if other types of equipment are used, this can be investigated further at a later stage.

2.4.4 Test procedures

The tests were done using a pallet of fresh salmon on ice in cases of expanded polyester, with dimensions 800x400x200 mm (LxWxH). The pallet had 9 layers of 3 cases each, i.e. a total 27 cases. The net weight of salmon in each case is about 20 kg, there is about 4-5 kg of ice in each case.

Tag location on pallet and orientation relative to reader antenna

Initial laboratory tests using the Elpro loggers have shown that the loggers can be read when placed inside a case, but they should be placed adjacent to a sidewall. The reason for this is of course that the absorption rate for radio communication in the UHF range is higher when passing through organic materials. Another issue is that the loggers should be reused due to the cost, and it will be easier to spot them when they are placed at a sidewall.

As shown in Figure 8, placing the logger at the centre of a sidewall gives 4 possible locations. This does not seem to be a lot of alternatives, but there are three cases for each layer on a pallet (see Figure 9).

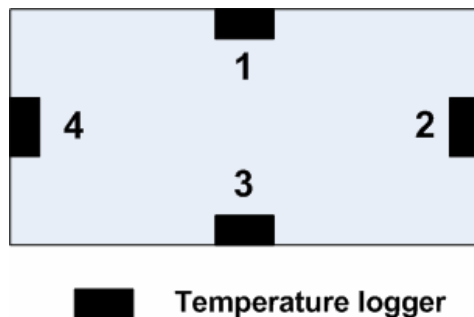


Figure 8. Possible locations inside a case (top view).

Within a pallet layer we have 12 possible locations. If we multiply this with 9 layers of cases on each pallet, the number of possible locations on a pallet is 108. Note also that the layers are stacked in alternating patterns (see Figure 10).

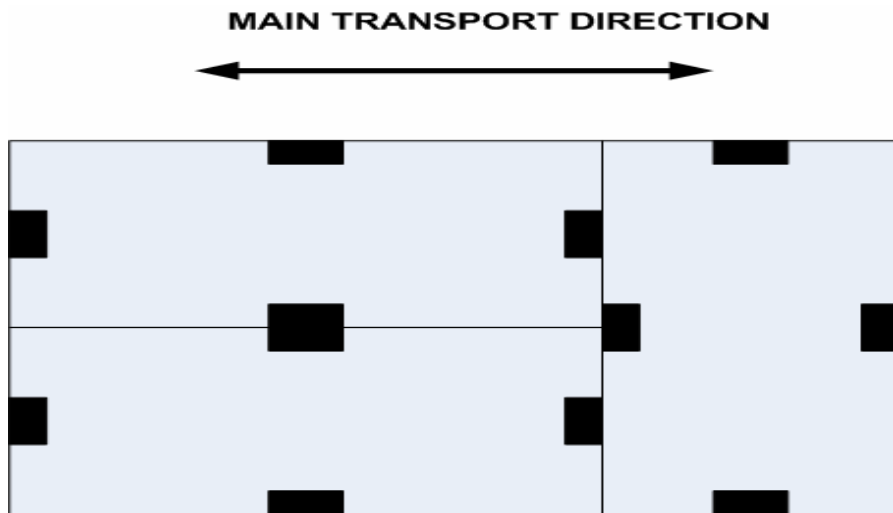


Figure 9. Possible locations on a pallet layer (top view).

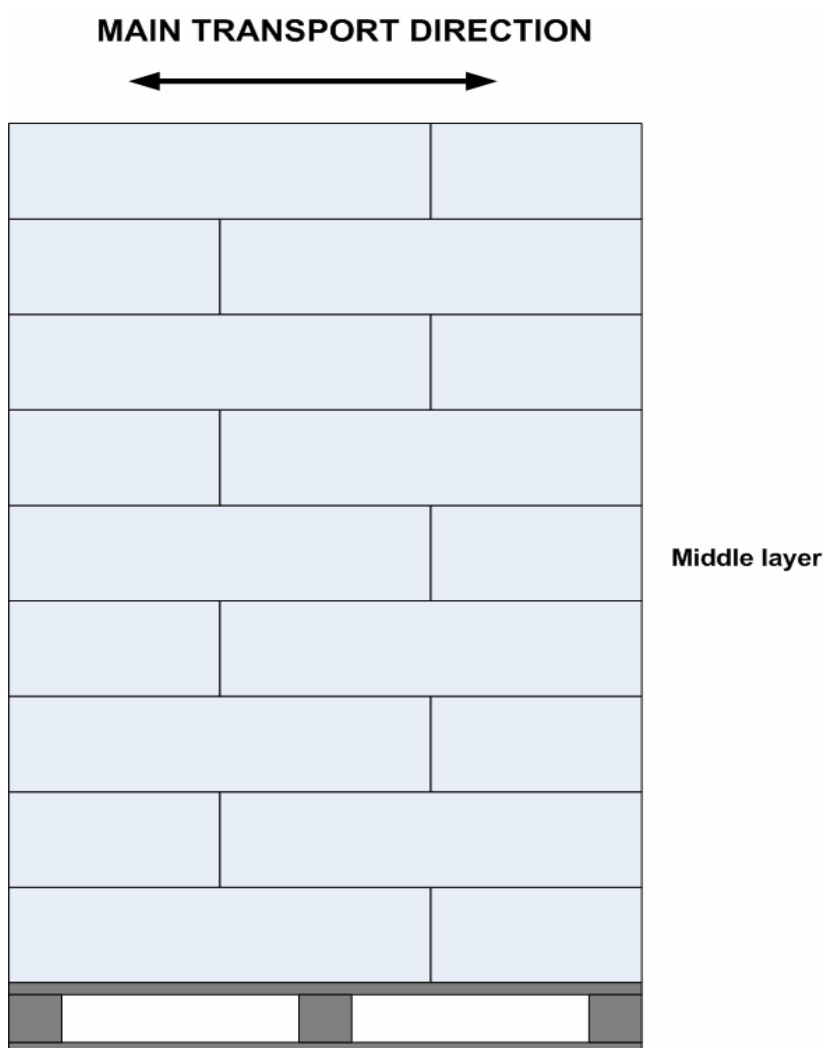


Figure 10. Pallet side view.

For practical purposes, the number of alternatives had to be reduced for these initial tests. Placing the loggers in the middle layer of the pallet should give representative temperature recordings. Within this layer, the tests included a total of 6 different logger locations relative to the antenna (see Figure 11).

In an operational environment, it is expected that the current cost levels of loggers will allow for a maximum of one logger on each pallet. Thus, all the tests are done with only one logger on the pallet. If several loggers are in the reader field simultaneously, the total time for reading each logger will increase. This needs to be investigated further.

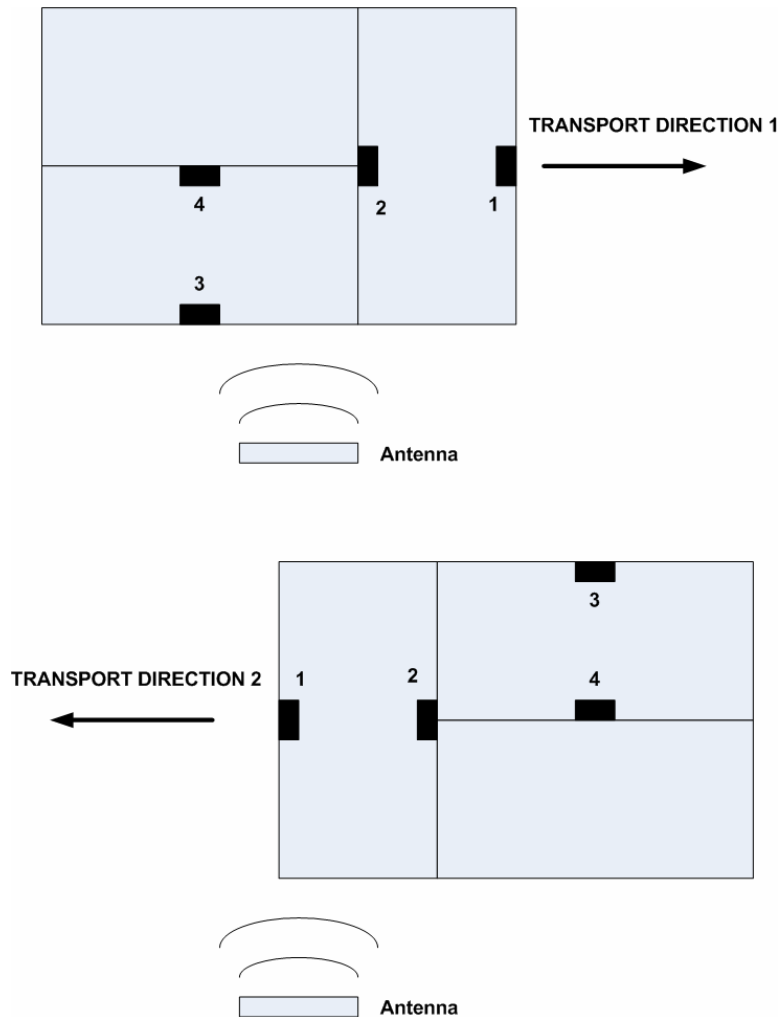


Figure 11. Tag locations used for testing.

Distance from logger to reader antenna

The two types of loggers used for these tests have quite different characteristics. The Elpro logger operates on the frequency 868 MHz (UHF) and is active, i.e. the power supply in the logger is also used for transmitting to the reader. The theoretical maximum distance is stated as 100 meters.

The KSW Microtec logger operates on the 13.56 MHz frequency (HF) and is passive, i.e. depends on generating power for return transmissions from the reader radio signals. The theoretical maximum distance is in the area of 1 meter.

Because of the difference in performance, the Elpro loggers are tested for a larger number of distances.

Speed past the reader antenna

The amount of time the loggers are in the reader field is important for a successful communication. In a terminal area, pallets are usually transported using a pallet jack or rider pallet truck. The tests are carried out with rider pallet truck that had a speed of 0,8 – 1 meter per second.

2.4.5 Results

Apart from the frequencies, there was one major technical distinction between the loggers: The Elpro logger used active communication, while the KSW logger was semi-passive. This means that the Elpro logger used internal battery power for communication with the reader, while the KSW logger depended on power generated from the radio waves emitted from the reader. This naturally influence the reading distances obtained.

The ID of the Elpro logger was readable at all box/pallet positions (see Figure 12). The temperature log was only readable from stationary pallets up to a distance of 20 metres.

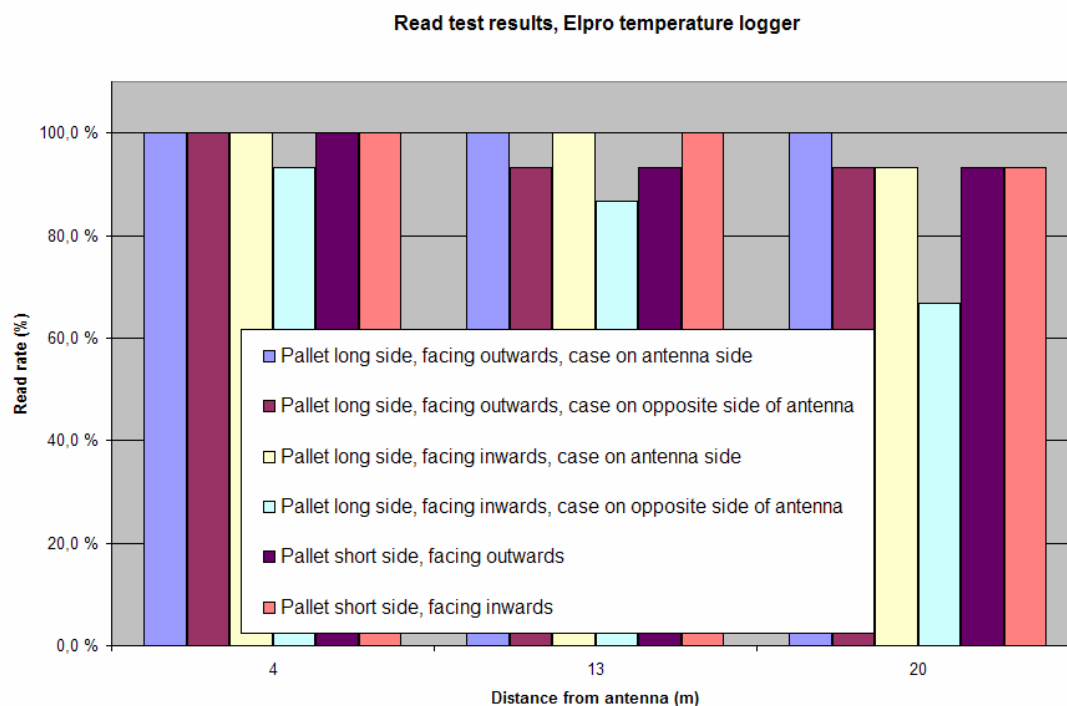


Figure 12. Test results from testing the Elpro tag at all locations.

The KSW TempSens reader had no contact with the tag when the pallet was moving. The logger could only be read when the pallet was stationary in front of the antenna, at a distance of about 20-25 cm.

2.4.6 Conclusion

The results were very good for the Elpro logger. This type of logger can be used in real life conditions for monitoring temperatures inside a case of salmon.

The reading range of the semi-passive KSW TempSens was too short to be used in the actual industrial environment.

This test is also documented by video recordings.

2.5 Testing of RFID tags with integrated temperature sensors on steel load carriers in the meat processing industry

2.5.1 Introduction

Traceability systems form an important basis of information for production control and food safety. To improve the amount and granularity of information about movements and temperature history on load carriers, RFID may be an effective technology. However, it is known that RFID technology has some limitations in readability when installed and used close to steel, fluid and meat products.

The project “Pilot Study - Competitive Food Processing in Norway”, financed by the Norwegian Research Council, includes pilot studies of temperature sensors integrated with RFID tags. Two pilot tests are defined:

1. Readability of combined RFID/temp sensor tags on steel trolley
2. Readability of combined RFID/temp sensor tags during loading/unloading and transport

2.5.2 Objective

To determine if the chosen RFID/temp sensor technology is applicable for reading ID and temperature on steel load carriers in the meat processing industry.

2.5.3 Materials

The trolleys (vemavogn; see Figure 13) that were used in this preliminary test are used for short internal transport and intermediate storage of temporary products. The trolleys are used by several food businesses in Norway including GILDE.



Figure 13. The steel container that were used in the preliminary tests (vemavogn).

2.5.4 The tags

The active tags used in the test were supplied by ACT Logimark and where produced by Identech Solution. These active tags include a memory chip, a temperature sensor and a power supply. The power supply facilitates the temperature logging and strong response signal strength. The readability is quoted to be 100m.

2.5.5 Methods

The tags were positioned both in front and under the trolleys (see Figure 14).



Figure 14. The tags were positioned in pairs at each of five steel trolleys: one tag in front and one tag under the trolley.

The setup and test method was designed to evaluate the readability of ID, and temperature through out normal handling of the trolleys. Trolleys with tags were positioned at different locations relative to the reader.

Tests were carried out with three different setups of trolleys as shown in Figure 15 and 16.

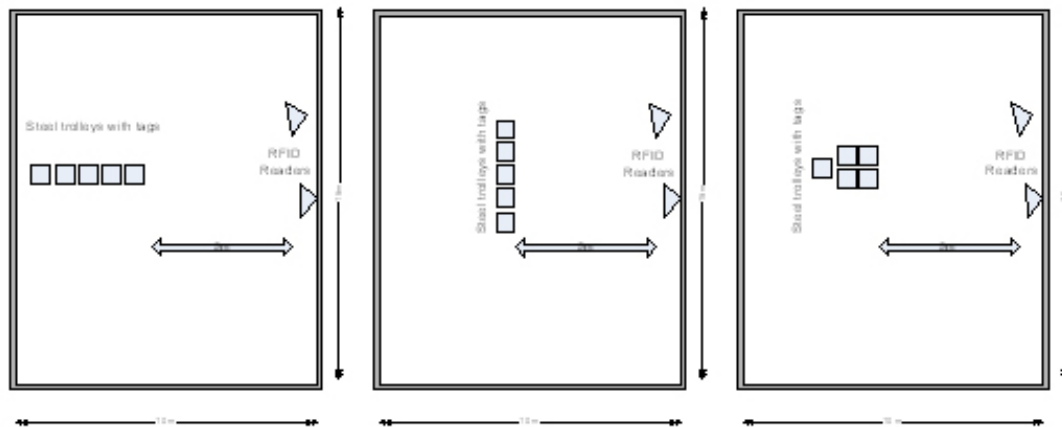


Figure 15. Setup of trolleys for test one, two and three.



Figure 16. Pictures of two different setups of trolleys.

Test four and five used the setup from test tree but one of the trolleys in front was filled with 10 cm of water. The position of this trolley was changed between the test four and five.

2.5.6 Results

Reading range	Successful readings for all tags in the three setups (5-9m).
Position of tags	All tags were successfully read.
Sensitivity to water	Signal strengths from the tags in the shadow of the water filled trolley were slightly reduced (too few readings to give statistically significant information).
Use of standards	Identec Solution uses proprietary protocols for exchanging information between reader and tag.
Anti collision	The i-Q32T tags from Identec Solution have anti collision functionality for simultaneous reading of 100 tags per sec. Simultaneous readings of 14 tags were demonstrated.
Temperature readings	Temperature records were read at stationary tests (Figure 17).

Temperature logs were read from four tags that were placed under the trolleys during test number one, two and three (Figure 17).

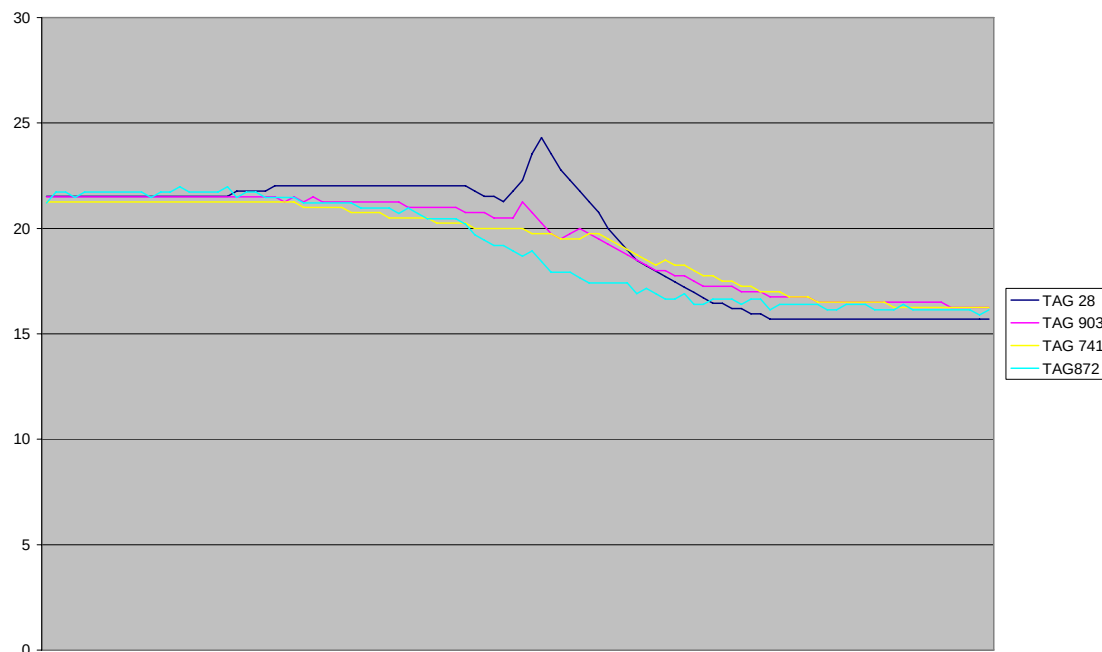


Figure 17. Temperature records from four of the tags.

2.6 Preliminary tests of readability of RFID/temp sensor tags during loading/unloading transport of meat products

2.6.1 Objective

The objective of test 2 was to determine if the actual RFID technology was applicable for reading ID, and temperature on load carriers in the food industry.

2.6.2 Materials

The load carriers were plastic bins used by GILDE. The measurements of the bins are 40cm x 60cm x 20cm. Pallets including 24 plastic bins with meat products were used in the case study (see Figure 18).



Figure 18. Plastic bins stacked on a pallet.

2.6.3 Method

Fourteen tags were distributed on two pallets, with 8 and 6 tags in each. The tags were placed between the meat products and the plastic walls of the bin as shown in Figure 19.



Figure 19. The tags were placed between the meat products and the plastic walls of the bin as illustrated in the centre of this picture.

Reader and computer were installed (Figure 20) in a strategic position in the terminal area as shown in Figure 21.



Figure 20. Setup of computer and reader/antenna.

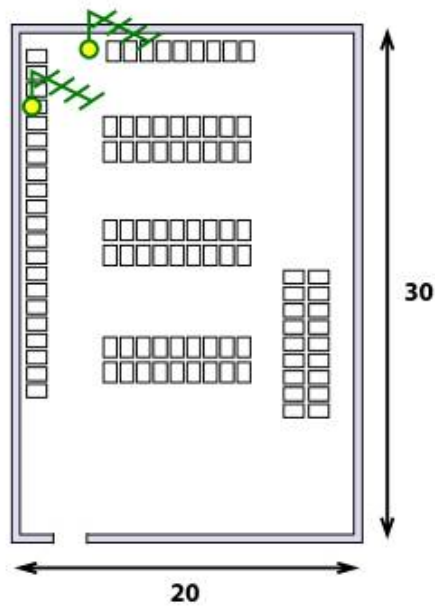


Figure 21. Position of reader/antenna in the dispatch area.

2.6.4 Test 1 readability test on mobile load carrier

The pallets were transported by a fork lift in the terminal area according to Figure 22. The readability of ID and temperature records was tested during the transport for all tags.

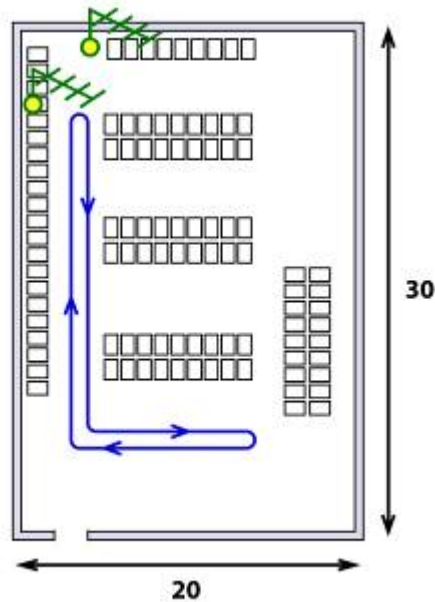


Figure 22. Transport route of load carrier on fork lift.

2.6.5 Test 2 Stationary readability tests

The two pallets were placed at two different locations in the storage according to Figure 23. The readability of ID and temperature records was tested for all tags at both positions. At test 2-A the pallets were placed at the far end of the expedition (20 m from the reader) area behind ordinary product pallets. At test 2-B the pallets were moved to a closer location (8 m from the reader) but still hidden behind ordinary product pallets. The ID and temperature records from those tags that were silent in test 2-A were read in test 2-B.

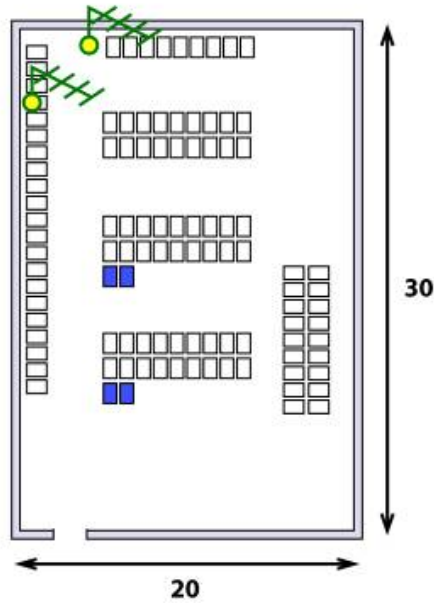


Figure 23. Position of the two pallets for stationary tests.

2.6.6 Results

Reading range	Successful readings of ID for all tags when they were mobile. Only 9 out of 14 were readable at 20 meters in the stationary test. All 14 tags were readable at 8 meters in the stationary test.
Position of tags	5 of the 8 tags in the layer 1 and 3 were not read but all tags on the top layer were read at 20m (Test 2-A). All tags were read at 8 m (Test2-B).
Use of standards	Identech Solution uses proprietary protocols for exchanging information between reader and the tags.
Anti-collision	Thei-Q32T tags have an anti-collision functionality for simultaneous readings of 100 tags per sec. Simultaneous readings of 14 tags were demonstrated.
Temperature readings	Temperature records were tested and read from all tags on the pallets as shown in Figures 24 and 25.

Figures 24 and 25 both shows tags with different temperature regimes. This was reported by Identech Solution as a result of incomplete restart of the actual tags at the initiation of the test. These tags therefore present temperatures from before the start of the test.

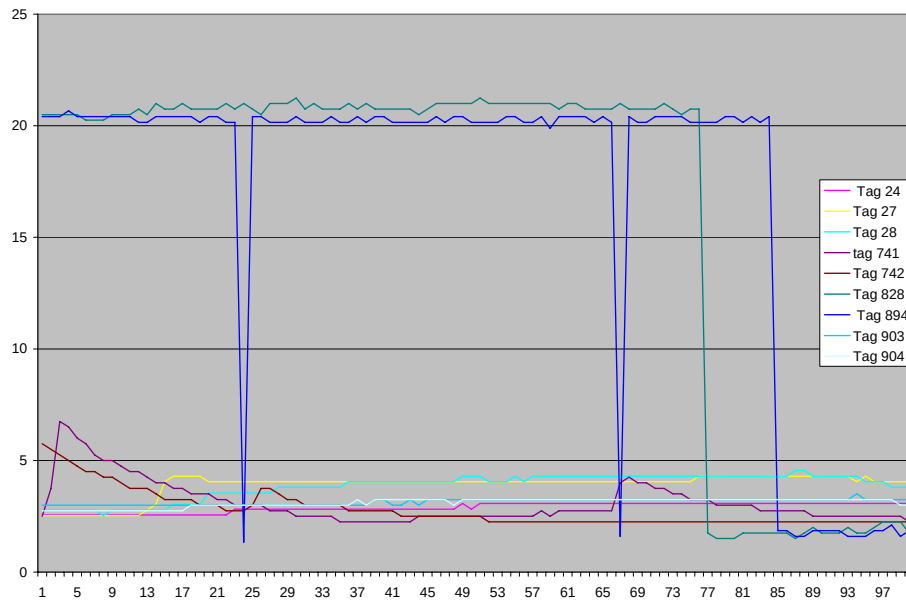


Figure 24. Temperature records read from 9 tags out of 14 at test 2A.

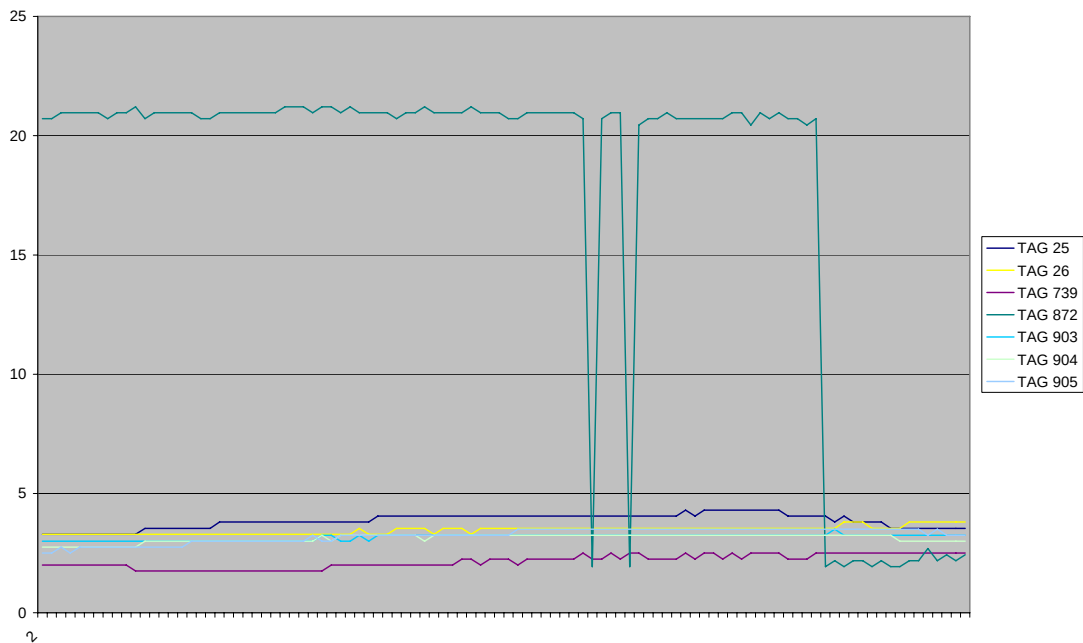


Figure 25. Temperature records read in test 2-B (from all tags that were missing in the test 2-A).

2.6.7 Conclusion

The preliminary test shows that the Identec Solution technology is operational at steel trolleys and at plastic bins with meat products stacked on a pallet. The detected reading range >8m is regarded as good. The reading range in combination with mobile readability and temperature recording makes this technology interesting for industrial use. Future challenges regarding this type of RFID/temperature sensors will be to establish knowledge about the position of the tags to record representative food product temperatures.

The fact that the price is relatively high and the size of the tags is relatively large makes it suitable only for use on large load carriers as trolleys and pallets. The technology is also interesting as a tool for use in scientific work where focus is on temperature monitoring and individual traceability of items.

However, the lack of standards for information exchange will give major challenges for applications in an industrial environment and in a supply chain. For smaller load carriers in high numbers, other solutions should be investigated.

2.7 Demonstration/preliminary test of RFID tags with integrated temperature sensors on load carriers in an industrial meat processing environment

2.7.1 Introduction

Traceability systems form an important basis of information for production control and food safety. To improve the amount and granularity of information about movements and temperature history on load carriers, RFID may be an effective technology. However, there is known that RFID technology has some limitations in readability when installed and used close to steel, fluid and meat products.

The project “Pilot Study - Competitive Food Processing in Norway”, financed by the Norwegian Research Council, includes pilot studies of temperature sensors integrated with RFID tags. Two demonstration topics were defined:

1. Readability of combined RFID/Temp sensors on steel trolley
2. Readability of combined RFID/Temp sensors in plastic bins with meat products

2.7.2 Objective

To determine if the chosen RFID/temp sensor technology is applicable for reading of ID, and temperature on load carriers in an industrial meat processing environment.

2.7.3 Materials

The trolleys (vemavogn; see Figure 13) that were used in this preliminary test are used for short internal transport and intermediate storage of temporary products. The trolleys are used by several food businesses in Norway including GILDE.

The tags from RFSAW are passive tags with no internal power supply. They use Surface Acoustic Waves (SAW) to generate the response signal. Due to the fact that the SAW is sensitive to the surrounding temperature it is also possible to detect the present

temperature at each reading of the tag. The SAW technology also give these tags an increased response signal that increases the reading range and thus the reading abilities in environments that includes water, meat and metal (Hartman et.al. 2004).



Figure 26. Plastic bins used as load carrier by GILDE.

2.7.4 Methods

Position of tags on the trolley

The RFSAW tags were positioned both outside and inside the trolley (See Figures 27 and 28). Additional tests where the tag was embedded into the meat products were also carried out (see Figures 26 and 29).



Figure 27. RFSAW-tag inside the steel trolley. This test also includes meat products inside the trolley.



Figure 28. The RFSAW tags outside and inside an empty trolley.



Figure 29. RFSAW-tag embedded among the meat products.

The setup and test method was designed to evaluate the readability of ID and temperature during normal handling of the trolleys. Trolleys with tags were positioned at different locations relative to the reader. Trolleys were also moved past the reader to test the tag readability during motion (see Figure 30).

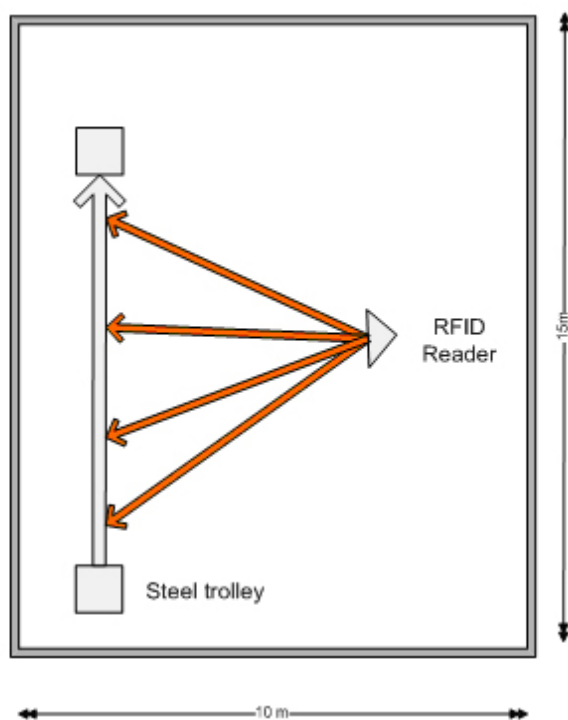


Figure 30. Steel trolley and plastic bins with tags were moved past the reader at about 0,5 -1,5 m/sec. or they were placed at different locations for stationary reading.

2.7.5 Results

Reading range	The reading range was adequate for industrial use (0,5 –12m) both for steel trolleys and plastic bins Signal waves seems to reflect in contact with metal and concrete Meat absorbs the signal and decreases reading range
Position of tags	Readable when tag was positioned outside the trolley, and inside the trolley Not readable when completely embedded in meat products Readable when placed with some distance to meat at one side of the tag
Use of standards	No international standard for SAW information exchange
Anti collision	The RFSAW tags do not have anti collision functionality for simultaneous reading of multiple tags.
Temperature readings	Temperature was read as long as the ID was read. Only instantaneous values are possible (the tag has no functionality for logging the temperature).

2.7.6 Conclusion

The time and resources in this pilot test was not sufficient to carry out a full scientific technology test of the RFSAW technology. These results are a summary of a product demonstration made by Clinton Hartman from RFSAW during a short visit here in Trondheim the 25th of September 2006.

The demonstration shows that the SAW technology is operational at steel trolleys and at plastic bins with meat products. However, the lack of standards for information exchange and the absence of anti collision functionality will give major challenges for applications in an industrial environment and in a supply chain. New readers with possibilities of simultaneously reading of > 30 tags is under development.

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<http://www.rfsaw.com>

C. S. Hartmann, P. Brown, and J. Bellamy. Design of Global SAW RFID Tag Devices. *Second International Symposium on Acoustic Wave Devices For Future Mobile Communication Systems*, Chiba University, Japan, March 2004.

Clinton S. Hartmann. A Global SAW ID Tag with Large Data Capacity. *Reprint from Proceedings of 2002 IEEE Ultrasonics Symposium*, Munich, Germany, October 2002.

2.8 Test configuration of RFID-tagged fish crates in Denmark

2.8.1 Background

The biggest Danish fish crate owners have created a new company that has developed a new type of fish crate with embedded RFID tags. The RFID tags give each fish crate a unique number, which ensures that the company can run a business with a deposit on each fish crate. The number ensures that the fish crates are returned after they have been in Southern Europe and ensures that the company does not lose money if others (exporters or importers) lose the crate. Until now, the fish crate companies have lost millions of kroner each year due to lost crates in Southern Europe.

The use of RFID tags in the fish industry is new, but they have been used for several years for internal traceability in slaughterhouses. Their experiences with regards to the utilization of RFID tags are positive, but not without problems. For example, it is seen that moisture can come through the plastic embedment and disrupt the functioning of the RFID tag until the tags are dried. Other problems are the presence of metal and water near the tags. These can limit the readability of the tags. Since the nature of the product which the tags are to be used with can influence the readability of the tags, the tags must be tested together with each type of product.

In the near future, the fish crate company plans to produce 250 000 RFID-tagged fish crates, each of which is expected to have a lifetime of seven years. Before such a large investment is made, it is important to make sure that the RFID-tags in the crates still will function after continuously being exposed to the harsh environment in the fish industry. This includes exposure to salt water, sunlight, strong alkaline cleansing, temperature

variations, and mechanical stress. The first part of this project will characterize the interfaces (tag-fish crate) of three different types of tag-moulds in order to choose the tag-mould with the least problematic interface. Thereafter, fish crates will be produced with the chosen tag-mould. The objective of the second part of the project is to test the readability of the tag, embedded by using the chosen tag-mould, after the crates have been exposed to the typical environments that they may encounter over a simulated seven year period. In addition, the effect of different contents in the crates on the RFID-tag readability will also be investigated.

Please note that only the first part of the project has been carried out due to circumstances beyond our control.

2.8.2 Part 1: Quality of insert moulded identity tags in fish crate handles.

For identification during tracing of fish crates (“from catch to consumer” principle) copper antennas with onboard integrated circuit called a “tag” (a chip for registration of time and place, and data transmission) have been moulded in an unknown polymer, and, subsequently, inserted into the handles of the fish crates. The fish crates themselves are manufactured in high-density polyethylene (HDPE).

The study of “from catch to consumer” principle is a long-term project, and, naturally, a long life-time of the tag is desired, preferably about 7 years. A fish crate is exposed to salt water, strong alkaline cleansing, light, air, and temperature variations, and may additionally encounter punches, bending, and sharp or rough items (work gauntlets). Consequently, the tag must be well protected to avoid corrosion and destruction of either antenna or the onboard chip-set.

In relation to a new production of fish crates with tags a qualitative estimation of three different tag-moulds is made from a materials science viewpoint, with respect to the inserted tags and the different environments a fish crate is likely to encounter.

Experimental details

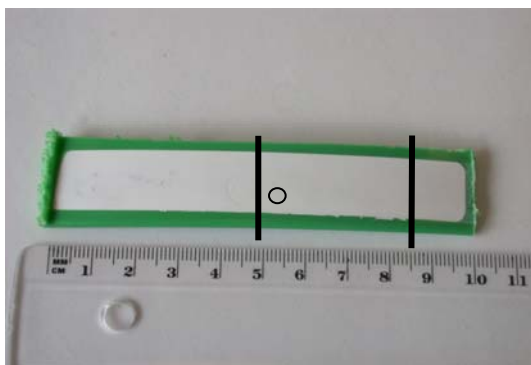


Figure 31. Tag from handle. The black lines indicate the sections cut for microscopy, and the black circle indicates the place of the onboard integrated circuit (chip).

The handles of the fish crates were cut off and subsequently cut in smaller pieces for microscopy. This is visualized in Figure 31, where the black lines indicate the sample cuts.

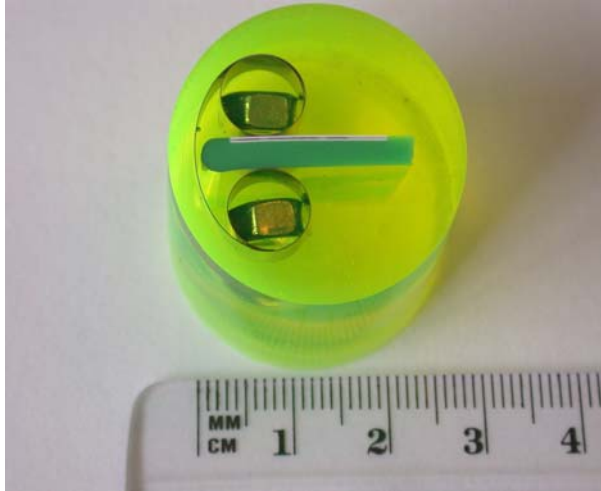


Figure 32. Tag and crate handle in epoxy mould. Notice the actual size of the tag (white insertion within the green HD polyethylene).

The samples were then placed in a holder with its cross section downwards and moulded in epoxy as visualized in Figure 32. Normally, microscopy samples are moulded in resins at 170°C and a pressure of 15-30 kN, however, this would deform and devastate the polyethylene sample and tag as well.

The samples were polished applying grid size paper from 220# to 4000#, and subsequently 3 and 1 μm crystal size diamond paste. In the latter step, a normal oil lubricant was applied (green colored) as the other lubricants were ethanol based.

Results

In Figure 33, the inserted mould is observed at higher magnification than that of Figure 32. The integrated circuit (left) is clearly visible, and it is noted that both chip and antenna is mounted on another intermediate layer (most likely a polymer), and, for all tags, the chip and antenna faces downwards from the surface. On Figure 33 (right), the antenna area is observed and the ‘shadows’ between the two white layers are the copper antenna.

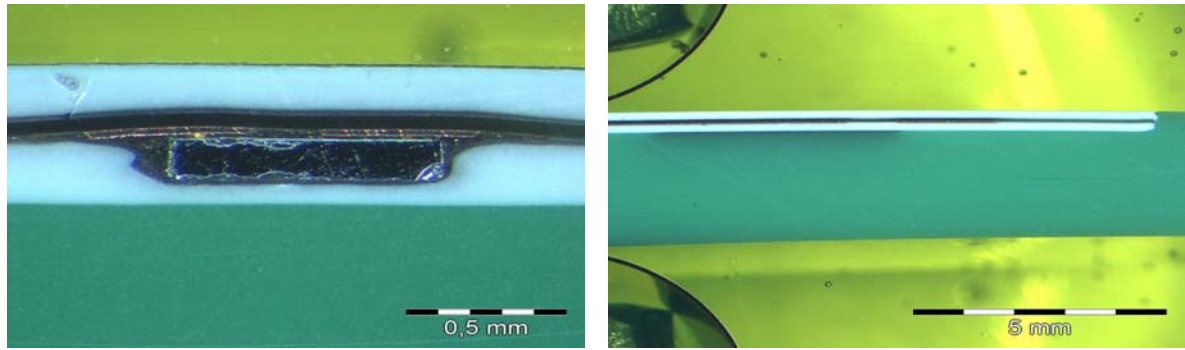


Figure 33. Tag C. Left: integrated circuit of tag C attached (onboard) to the copper antenna which is placed on a substrate. All is enclosed in white polymer on top of the green HD polyethylene. Right: overview of the antenna area of tag C. The antenna is observed in between the two white layers.

Tag numbers applied in this investigation are:

A: 7.2 and 7.1

B: 5.1 and 2.2

C: 10.1 and 5.2

The polymer layers

In Figure 34, the chip of sample C is observed. The approximate dimensions of the layers are given. It should be notice that the white polymer layer towards the polyethylene varies in thickness because of the integrated circuit.

It is observed that the white polymer encloses a (possibly) polymer onto which the antenna and chip is placed. Antenna, chip and center polymer is then encapsulated in a 20 μm thick substance, which could be polymer as well. The reason for assuming that all except the antenna and chip is polymer and not metal is the homogenous height after sample preparation (had a layer been of metal or ceramic material, a difference in height between this layer and the polymer would have been visible due to difference in wear behavior and hardness).

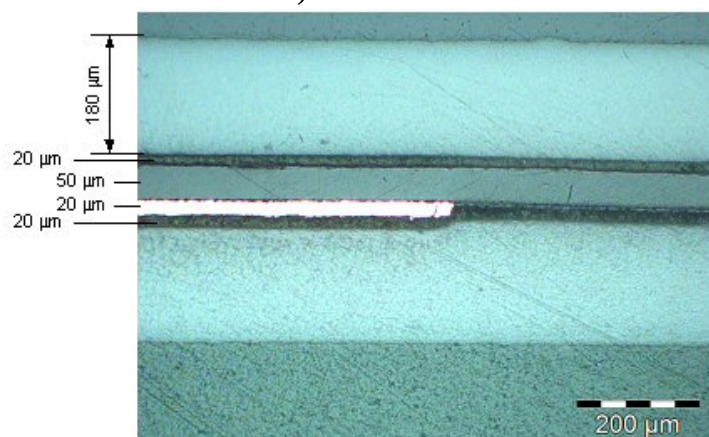


Figure 34. The antenna of tag C with approximate measures of the thickness of the various layers. Apparently, a total of six layers constitute the tag.

Adhesion and interface quality of ‘white polymer’/HDPE and ‘white polymer’/antenna-chip interfaces

In Figure 35A-C, the ‘white polymer’-polyethylene interface is observed along the edge for the three different tags (A, B, and C).

It is observed that tag A has little adhesion on the side to the surrounding polyethylene. This is at least the case for the upper half of the insertion, whereas the lower half adheres well to the polyethylene (as does the long (bottom) interface between the white polymer and the polyethylene). The resulting crevice can function as a transport channel for aggressive ions like chloride, and corrosion of the antenna is possible (and with time the chip will be reached).

For tags B and C, the upper half of the tag appears to be better embedded in the polyethylene, and the same crevice as observed for tag A is not observed.

Comments

It must be recommended to carefully consider the conditions, which the fish crates are exposed to. Often fish crates are cleansed in hot, strong alkaline liquids, and polymers (and especially polymer insert moulds) could suffer a great deal under such treatments. Also, mechanical influences such as scratching, bending, shaking (during transportation) and abrasive wear could damage the handles/tags, as could mere storage of the crates in outdoors conditions (UV light). Polymers are fairly easy and cheap to use in manufacturing, however, long-time effects of external influences are not well-known, and a combination of multiple factors could have a detrimental effect on the polymer construction and, thus, also on the identity tag.

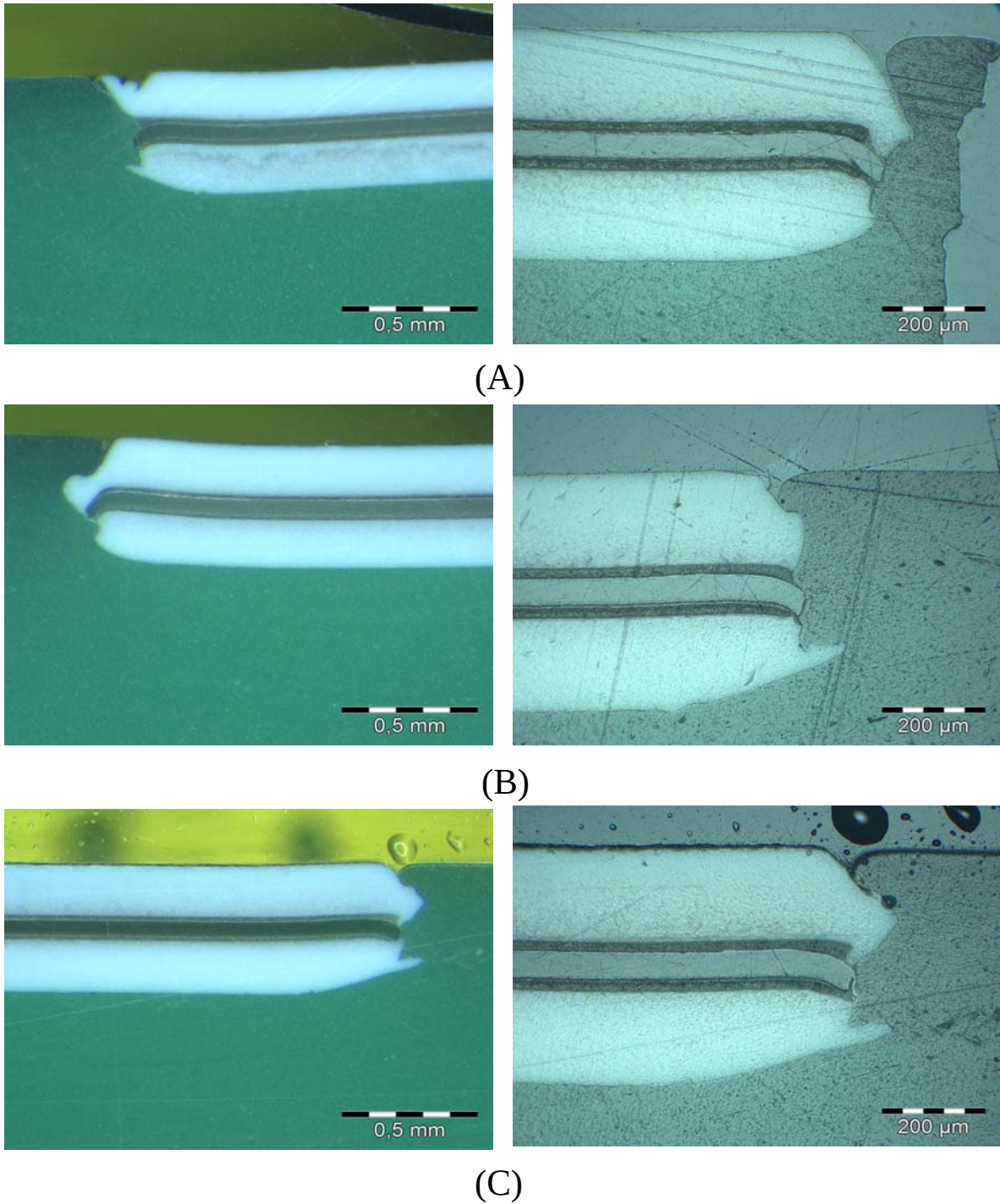


Figure 35. A-C. Interface between insert mould and HD polyethylene along the edge: (A) tag A, where the sides of the insert tends to ‘de-bond’ from the polyethylene, and thereby creating a crevice in which chloride ions easily could travel, (B) tag B, no gap between white polymer and polyethylene with almost vertical sides, and (C) tag C, where the insertion is pressed into the polyethylene.

Conclusions and further work

It is conclusive that the better embedding of the tag, the greater the possibility for a longer life-time. On that statement, tag A should be excluded, but whether tag B or C should be applied is inconclusive.

It should also be noticed that the main problem may be the very thin coverage of the antenna/chip component, and whether this thin polymer can withstand the environments the fish crates are exposed to.

For further analysis of the sustainability of the inserted mould towards salt water, temperature variations, UV light, mechanical influences and cleaning procedures (strong alkaline liquids), life cycle studies should be carried out including those factors, to which the fish crates are expected to be exposed to.

2.8.3 Part 2: Readability tests of RFID-tagged whole fish crates and acceleratedly aged RFID-tagged fish crate handles; Microscopical analyses of the tag-fish crate interface of acceleratedly aged RFID-tagged fish crate handles

Materials

High-density polyethylene (HDPE) fish crates with embedded RFID-tags (Class 1, Gen 2, 96-bit EPC, 915 MHz from UPM Raflatac, Finland) will be used.

RFID-tagged whole fish crates with different contents will be used for the readability tests on a forklift. The RFID-tagged handles of the fish crates will be used for the accelerated ageing treatment, the readability tests on a conveyor belt and microscopical analyses.

Methods

Readability tests of whole crates with different contents (empty, with water, with ice) will be performed while the crates are transported on a forklift. Ten crates will be tested.

Readability tests of acceleratedly aged RFID-tagged fish crate handles will be performed on a conveyor belt before, midway, and after the accelerated ageing treatments. A total of 96 handles will be tested.

The purpose of the accelerated ageing treatments is to simulate all the treatments (both in type and in quantity) that the fish crates will encounter in their seven year lifetime. A full factorial design with five design variables (the five treatments) and three non-design variables (the three readability measurements at the start, midway, and end of the simulation period) will be conducted. The design consists of 32 combinations of the five treatments and these will be performed in three replicates each. The results will be presented as an analysis of effects using the software The Unscrambler.

Descriptions of the five treatments:

Washing: The handles will be washed in an industrial-type washing machine (Type 3100, KEN A/S, Broby, Denmark) with a KOH-based detergent (CIP ALKA 169, Novadan, Kolding, Denmark) with a minimum concentration of 0,4% and pH 12,1 for 126 times.

Freezing: The handles will be placed in a -40°C freezer room for at least 2 hours, after which the handles will be thawed. This will be done 70 times.

UV-light: The handles will be exposed to 44 W/m² UV-irradiation (measured with UV Radiometer UVR-365, Topcon, Tokyo, Japan), (UV tubes: Cleo Performance 40W, 60 cm, 310-400 nm (Philips, Eindhoven, Holland) 40 cm above the handles). The UV-exposure will be equivalent to the UV-irradiation the crates receive during 20 days per year for seven years in Denmark.

Torsion: The handles will be exposed to mechanical stress by twisting each handle with two clamps in opposite directions. The handles will be twisted for 20 seconds during each of 126 treatments. Salt water: The handles will be immersed in a 3,5% salt solution (table salt, tap water) for 5 seconds. This will be done 126 times.

Microscopical analyses identical to those in Part 1 will be performed on the tag-fish crate interface of RFID-tagged fish crate handles. The analyses will be performed before, midway and at the end of the accelerated ageing treatment. Two types of crates will be analyzed: (a) crates that have been exposed to all five treatments mentioned above and (b) crates that have been exposed to all five treatments mentioned above except UV-light.

Results

Unfortunately, it has not been possible to carry out neither of the readability tests (whole crates and handles exposed to accelerated ageing) or the microscopical analyses because the fish crate company has not yet produced the crates with the chosen RFID-tag mould that are needed for the investigation. Part 2 of this project will continue under co-funding by the SEAFOODplus project and the interim results will be presented at the NICE seminar in August 2007.

2.9 Experiences with RFID tags from the Faroe Islands

2.9.1 Description of study

The focus is on how robust a given RFID technology is when exposed to the fish industry environment. Our objective is twofold:

- To gain insight into the experiences from the use of RFID technology in the fish industry.
- To get knowledge on what is that good practice when implementing RFID in the fishing industry.

In this specific case we will look at the experiences made with RFID tags at the tub pool distribution Kassamiðstöðin (KMS) in the Faroe Islands. From a research perspective this use of RFID is interesting because the tubs from KMS circulate through all steps from vessel to export and are exposed to wide variety of environments such as salt water, temperature variation and so on.

2.9.2 Tasks

The task is split into the following subtasks:

1. Describe the RFID technology used. This includes both RFID readers and tags.
2. Provide information on how well the given technology performs.

2.9.3 Organization

The work is done as part of the Nordic project entitled "Fælles normer for sporbarhed og implementering af sporbarhed for fiskeprodukter i Norden", number 661045-30171, supported by Nordisk Ministerraad. The project is organized by Oluf Færø, JFK Ltd., and done in cooperation with Marine-Tech and Kassamiðstöðin.

2.9.4 Time frame

The project started on 1st of May and continued through 2004.

2.9.5 Summary

The primary use of RFID at KMS is to test which technology and construction is most suitable of tubs in the fishing industry. All new tubs which KMS buys have built-in RFID tags and are constructed by Sæplast in Iceland. Their first construction received in 2003 was not very successful but they are expecting better results from the subsequent tub deliveries. The main cause of the failure of the first construction was the encapsulation of the RFID chip.

Unfortunately no accurate evaluation has been done so far on how robust the RFID technology as KMS is. But later in 2004 KMS will have better measurements on exactly how well the current construction performs. It will therefore be interesting to follow the RFID development at KMS as the wide distribution of these tubs exposes the RFID tags to a wide range of environments in the fish industry.

2.9.6 Profile of Kassamiðstöðin

Kassamiðstöðin (KMS) is by far the largest tub pool distributor company in the Faroe Islands. It is located next to the largest fish auction hall by the harbour in Toftir. The shares in the company are split equally between the Faroese Raw Fish Buyers' Association and the Faroese Raw Fish Sales Association which each own one half.

The majority of all tubes which circulate in the Faroese fish industry are supplied by KMS. Traditionally this distribution has been financed through a collective deposit system but recently it has also been possible to rent tubs for a given period. In the collective deposit system each participating company is charged based on the total weight of fish he has received. The tubs can then circulate in the industry and are only occasionally returned to KMS. In the second system the tubs are rented to a specific company which then returns the tubs back to KMS. The company is then charge based on the length of the renting period.

Being the major tubs distribution in the Faroes KMS has an interest to be up front with the latest technology which can provide the best possible service Faroese fish industry. One such effort has been a pilot project to supply tubs with RFID tags. The project is a

cooperation between KMS and the Faroese software solution company Marine-Tech Ltd (MT).

Currently there is no significant use of RFID tags in the Faroese fish industry. But with the increasing focus on traceability it is likely to become an issue in the near future. KMS wants to be upfront in this development and has therefore started to test which equipment and technology is best suitable for tub labelling in the fish industry. The RFID implementation at KMS is currently used to test which technology and construction is most suitable for its purpose.

KMS provides several types of tubs ranging from small 75 litres tubs to large tubs that can take 1000 litres. Each tub is labelled with an id number which is assigned sequentially to each new tub that KMS acquires. The ids are unique within the scope of the tub type. Figure 36 shows a picture of a 460 litres tubs with ID number 4961.



Figure 36. 460 litres tub with ID 4961.

2.9.7 RFID technology and equipment

All tubs which KMS has bought with RFID tags have been supplied by Sæplast in Iceland. Sæplast has in this case both produced the tubs and labelled them with RFID tags.

The information on the RFID tags is written to the RFID tags by Sæplast and uses an internal format. The format is 9 character long string where the first two characters refer to the company id, the next to characters the tub type and the remaining digits denote tub id. Table 7 shows the information stored on the 460 litres (type 4) tub with number 4961.

Table 1. Information string stored on RFID tag

Company Id		Tub Type		Tub Id				
K	A	0	4	0	4	9	6	1

Marine-Tech has informed³ that the tags are of the brand Omron, model V720-D52P02/V620S-D13P02, and support the ISO 15693 standard⁴.

³ The technical specifications of the RFID tags used by Sæplast can be found in the 2003 project report, chapter 2.4.

⁴ The data sheet on the tags can be downloaded from the Omron website at <http://www.omron-ap.com>

In all tub supplies from Sæplast the main RFID tag have been placed at the center under each tub as shown in Figure 37. In a recent 100litres supply there were additionally tags on two of the sides of the tub. All tags on the same tub have identical information stored on them.

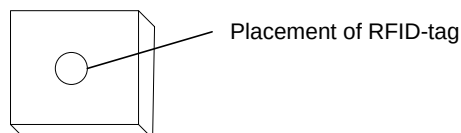


Figure 37. Placement of RFID tag under tub.

The RFID antenna was placed over the conveyor belt at the end of the tubs washing machine as shown in Figure 38. The tubs travel left to right through the washing machine with the bottom up. As a tub leaves the washing machine it passes under the RFID antenna and the RFID reader captures the information stored in the RFID tag in the tub. The tub id and the time stamp is then stored in a database. This information can then be accessed through for example the internet where it is possible to see how often a given tub has passed through the washing machine⁵.

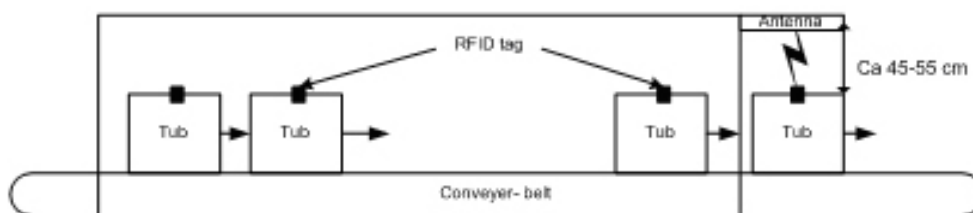


Figure38. Placement of the RFID antenna at the end of the tub washing machine.

The RFID reader and antenna is of the brand EMS. The reader is model LRP820 Long-range reader/writer⁶ and the antenna model LRP820-08⁷.

2.9.8 Experiences with RFID setup

Below is a collection of the experiences which KMS has had so far with the RFID setup. The results were collected on a meeting at KMS in May 2004 with participation of Oluf Færø, JFK Ltd, Kári í Garði, director of KMS, and Thomas Hansen, director of Marine-Tech.

2.9.9 Reading equipment

In the initial setup the distance between the antenna and RFID in the tubs was around 45-55 cm. This distance later had to be reduced to a few centimetres because the reader frequently was unable to detect some of the RFID tags. At KMS they think the reason for the problem is water which gets collected on some of the tubs as they pass

⁵ See <http://www.kassi.fo/fyribils/rfid1.asp>.

⁶ See <http://www.ems-rfid.com/products/hms820-830.html>

⁷ See <http://www.ems-rfid.com/support/lrp820830-08sup.html>

through the washing machine. This water seems to significantly reduce the reading distance. Because according to the RFID antenna specification 45-55 cm should be a reasonable reading distances.

2.9.10 First tub implementation

The first supply of tubs with RFID tags to KMS was made in 2001 and consisted of 3000 tubs each with a 460 litres capacity. The tubs were labelled with numbers in the range from 8000 to 11.000 and used in the collaborative deposit system. With the acquisition of these tubs around one third of the 460 litres tubs in the collaborative deposit system had RFID tags. On each tub the RFID tag was encapsulated in a red, hollow plastic container consisting of two parts joined together. This plastic brick with the RFID tag was then engraved into the bottom of the tub.

A problem with these tubs has been the plastic encapsulation of the RFID tags. After a period the encapsulation starts to leak which destroys the RFID tag.

Experiences from KMS shows that this currently means that around 30% of the tags are unreadable⁸.

2.9.11 Second tub implementation

All additional orders of tubs from Sæplast were constructed differently with respect to the RFID tags. These tubs were

- 2000 tubs with 460 litres capacity labelled from 11000 to 13000 to the collaborative deposit system received in 2004.
- 300 tubs with 1000 litres capacity for renting received in 2004

These tubs use the same RFID tag technology as the previous construction from Sæplast, but with the difference that the RFID chip now is covered with a material called epoxy. The encapsulation is the same, but the RFID chips are supposed to be much more resistant.

At KMS they have not detected any failure on these new tags so far. And Sæplast has informed KMS that they consider this construction very reliable. But these results are not based on any strict test performed at KMS and need to be validated.

2.9.12 Future work

No real measurements have been made on how robust the current RFID construction is. According to Sæplast the epoxy covering is supposed to make the implementation very stable. But during 2004 KMS will evaluate this claim by monitoring the behaviour of tags in the rented 1000 litres tubs. These tubs are easier to evaluate than the tubs in the collective deposit system. This is because they are rented out in large bulks which arrive simultaneously at KMS. It requires more effort to measure the performance of the RFID tubs in the collective deposit system which are mixed with tubs with no RFID

⁸ Source Kári í Garði, Director at KMS

tags. A staff person must for a given period continually monitor the tubs that pass under the RFID antenna, check if the tub had an RFID tag and check if the tub was detected by the RFID reader.

By the end of 2004 KMS will make the results of their measurements available. This will enable a more precise evaluation of the suitability and robustness of the RFID technology used in the tubs.

2.10 List of other tests conducted

In addition to the test presented above, SINTEF has been doing several other tests together with the food industry, and the equipment suppliers (Table 8). Details from these tests still remain confidential. However, since superior results from the tests have been presented at the workshops, one might receive more information about test results at SINTEF.

Table 8. List of relevant technology tests.

Test period (Year)	Equipment	Industry/ Application area	Responsible	Reference to SEAFOODplus Intranet folder
2004	ISO 15963 RFID tags (HF) on plastic crates	Deep sea trawler to wholesaler via fish auction	AZTI, Siemens	Workshop2004June_D1.2
2004-2005	Proprietary VHF tags on plastic crates (Hitachi)	Meat processing plant, internal transport on conveyors	SINTEF	Workshop2005October_D2.2
2004-2005	2D Datamatrix codes imprinted on plastic crates	Meat processing plant, internal transport on conveyors	SINTEF	Workshop2005October_D2.2
2005	RFID tags (LF) on live from birth	Live animal identification from farm to slaughterhouse, Iberian pork	AZTI	Workshop2006November_D5_D6
2006	EPC Global Gen 2/ISO 18000.6-C (VHF) tags on plastic crates	Meat processing plant, internal transport on conveyors	SINTEF	Workshop2006November_D5_D6
2006	ISO 15963 RFID tags (HF) on fish pallets	Atlantic mackerel fisheries to wholesaler	AZTI	Workshop2006November_D5_D6

2.11 Conclusion

When starting up the projects dealing with RFID technology 3-4 years ago (Seafood Plus, SPINK, IFSAT), we soon discovered that the RFID UHF tag technology was less mature and applicable than expected. In most cases we had problems to read the tag ID in the fish chain environment. This was due to the especially challenging conditions in

the fish chains (ice, water, organic materials with high absorption rates for UHF radio signals).

However, the last 1-2 years a lot of effort has been put into the development of both international standards and the technology. The ISO 18000.6-C (EPC Gen 2) was approved in 2006, and the current tags and readers show very promising results, with read rates approaching 100%. This is due to efforts in several areas, e.g. tag antenna design, non-collision protocols, readers, etc.

It is expected that the EPC Gen 2 tags will continue to improve, and with increased focus on developing tags for use in harsh environments. This includes tags for moulding into plastic crates, pallets and tubs. This means that the EPC Gen 2 will be the preferred standard also in the value chains for fish. Even so, the ISO 15963 (HF) tags will still be used for special company internal applications.

In the SEAFOODplus project we are doing more RFID testing, especially testing tags with sensors. Our aim is to develop guidelines for good data capture practice, by the end of 2008.

3 Implementation of food safety oriented traceability procedures

3.1 Introduction

Objective: Define Good Traceability Practice and implement traceability in each case company by using instructions given in the TraceFish standard, e.g. regarding; unique identification of trade units, attach food safety related data to its trade unit ID, keeping track of all transformations, etc.

One of the applications of a traceability system is to aid food safety related actions like recall and withdraw of contaminated products. In the EU projects Trace and SEAFOODplus the TraceFish standards are further developed to cover all food types. The necessary components needed for this are gathered in the so called TraceFood Framework, shown in Figure 44 in section 3.4.1. In connection to this, recommendations for Good Traceability Practice are presently being written to aid implementation of a traceability system. These guidelines have been discussed in detail in the IFSAT network, and the researchers have brought in valuable input to this work.

Our recommendations for good traceability practice are now being implemented in several pilot projects. Related to the IFSAT project, there has been carried out 2 implementation activities, one together with the SEAFOODplus project and one together with the Norwegian project Trains Pelagic:

- Good traceability recommendations have been implemented in a custom-made software for pelagic fishing vessels (see section 3.2).
- A pilot implementation of the standard electronic infrastructure, for exchange of traceability information called TraceCore XML, has been done in the Norwegian pelagic industry (see section 3.3).

3.2 Implementation - Pelagic Information Programme (PIP)

Development of data capture technology in the pelagic sector is essential to be able to collect and exchange information.

According to researchers “story telling” will be one of the main keys to success in the fish business in the future. A story about a fish product can for instance contain the catch date, the catch area and the name of the fishing vessel. Traceability is a must in order to tell a trustworthy story.

The main challenge for information interchange in the chain from fishing vessel to retailer/consumer is the vessel link. There are hardly any incitements for the vessels to invest in equipment for traceability because the link is often broken between the first hand sale and the producer/retailer. One way to overcome this is to make a freeware traceability programme that is able to record and transfer traceability information from the vessel to the other actors in the fish business chain with very few costs. A screenshot from the PIP program is shown in Figure 39.

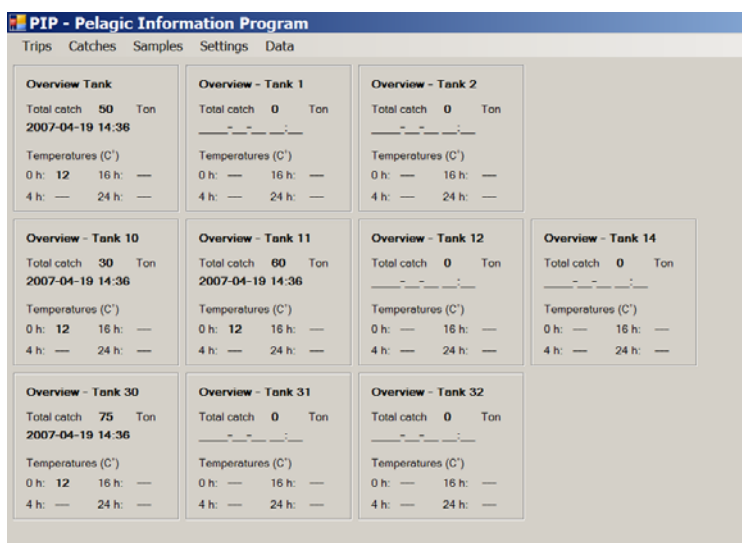


Figure 39. Status screen from the PIP program of the catch of a pelagic vessel.

The vessels do not have to invest anything because the programme runs on a standard pc with Microsoft XP. The vessels must also have an Internet connection to make transfer of data possible. Data generation will suddenly be possible onboard pelagic fishing vessels in a standardised way without any costs and make chain traceability a possibility in this fishing sector throughout the EU. Besides data generation and traceability, the programme can also be used to plan future fisheries based on previous catches. A map-based tool has been included to facilitate the planning of future fisheries.

The first version is developed in English and Danish, but the programme will later be able to “speak” most other EU languages and Norwegian. Besides transferring data to shore, it is also possible to plan future fisheries from registered catches. From an overview map, it is possible to look for alternative catch possibilities.

The present program uses XML for transferring data to shore and the Tracefish standard (www.tracefish.org) has been used to format the data. The receiver of the data can get and utilise the data if his software uses the same Tracefish standard. Then no mistakes will happen and you do not have to explain your data format because it is already standardised in the Tracefish standard.

Only a few utilise the Tracefish standard today but work is in progress in the Trace project (www.trace.eu.org) to make standards for other foodstuffs, too - in the same way.

The pelagic sector is under hard competition on the market and this is perhaps a way to make it possible to differentiate the products from a standard bulk product (commodity) to a higher product category.

In the beginning of 2008, the present system will be available for free downloading from the SEAFOODplus website and www.difres.dk after it has been tested in practice for a period of time.

The programme has been developed in two projects: Nordic Innovation Centre project “Integrating Food Safety and Traceability” IFSAT and the EU project SEAFOODplus “Project 6.2 Implem”.

3.3 Implementation of an electronic traceability system in the pelagic sector

3.3.1 Introduction

The project “Developing electronic traceability based on TraceCore XML in the pelagic industry” will make sector specific TraceCore XML files (Tracefood.org, 2007) for information transaction between all links in the case chain (Figure 40). A consistent traceability practice and numbering system is a prerequisite to implementing electronic chain traceability. Such a system is described in the TraceFish standard (CWA14660, 2003).

This document describes the material and information flow through each of the links. The information is based on a traceability survey of a pelagic chain (Digre et al., 2004).

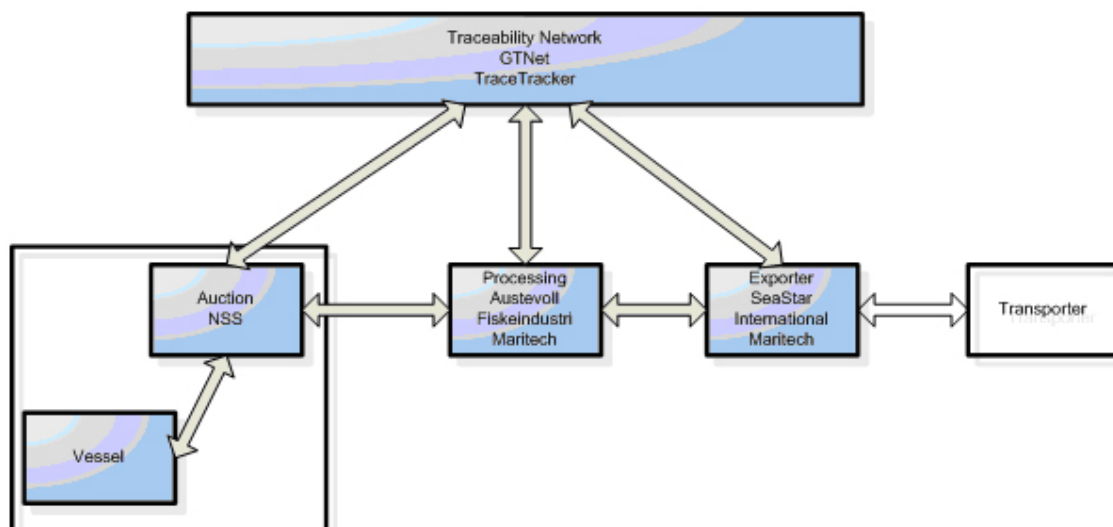


Figure 40. The pelagic traceability project chain.

3.3.2 Description of information and material flow from fishing vessels to NSS

Fishing vessel

The fish enters the vessels in hauls. The haul is the traceable resource unit (TRU) that are recorded in the official log on the fishing vessel. Each haul is placed and stored in one or multiple tanks onboard the vessel. When the fishing vessel stops fishing, they report the catch as one or separate it into multiple batches and reports to the Norwegian

cooperation for pelagic fisheries (NSS). This batch(es) is identified by a SSCC and a SGTIN (Figure 41). This information transaction is today carried out by phone or fax.

NSS

Information about the catch are entered manually into the NSS databases and presented at their Web based auction system. This information is necessary for the fish buyer for estimating the bids. When the auction bidding is completed the ship will go to the location defined by the buyer. After the auction knock down, information about the catch are required by the fish buyer to plan the production process and subsequently sales. Some of the information such as quantities is regarded as estimates at this stage of the chain. NSS also conduct services to the fishing fleet like statistics on quotas, reporting to the Norwegian Directorate for fisheries etc.

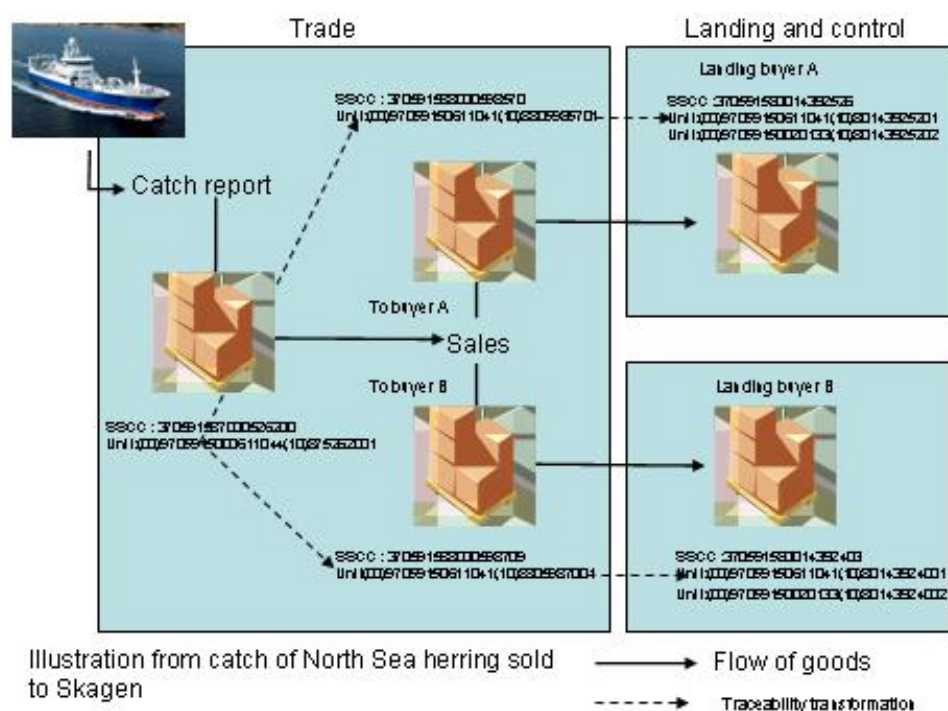


Figure 41. Flow of goods, information and the identification of TRUs between fishing vessel, the NSS and the fish buyer.

The TRU of sales is identified with a SSCC and a SGTIN in the XML. One catch TRU may be split into several sales TRUs (Figure 41).

After the landing⁹ is completed a landing ticket is made and both vessel and fish processor receives a copy of this ticket in addition to the Norwegian Directorate for fisheries. The sales TRU may be split into several landing TRUs and are identified by a SSCC and SGTIN.

⁹ Landing is the process where the fish is received by the fish buyer. At this process the fish is weighed and this quantity will be regarded as the real quantity for price and governmental reporting.

A summary of flow of goods in the pelagic supply chain is shown in Figure 42. This figure does not describe all the diverging cases of flow that may exist, but aims to present a typical situation.

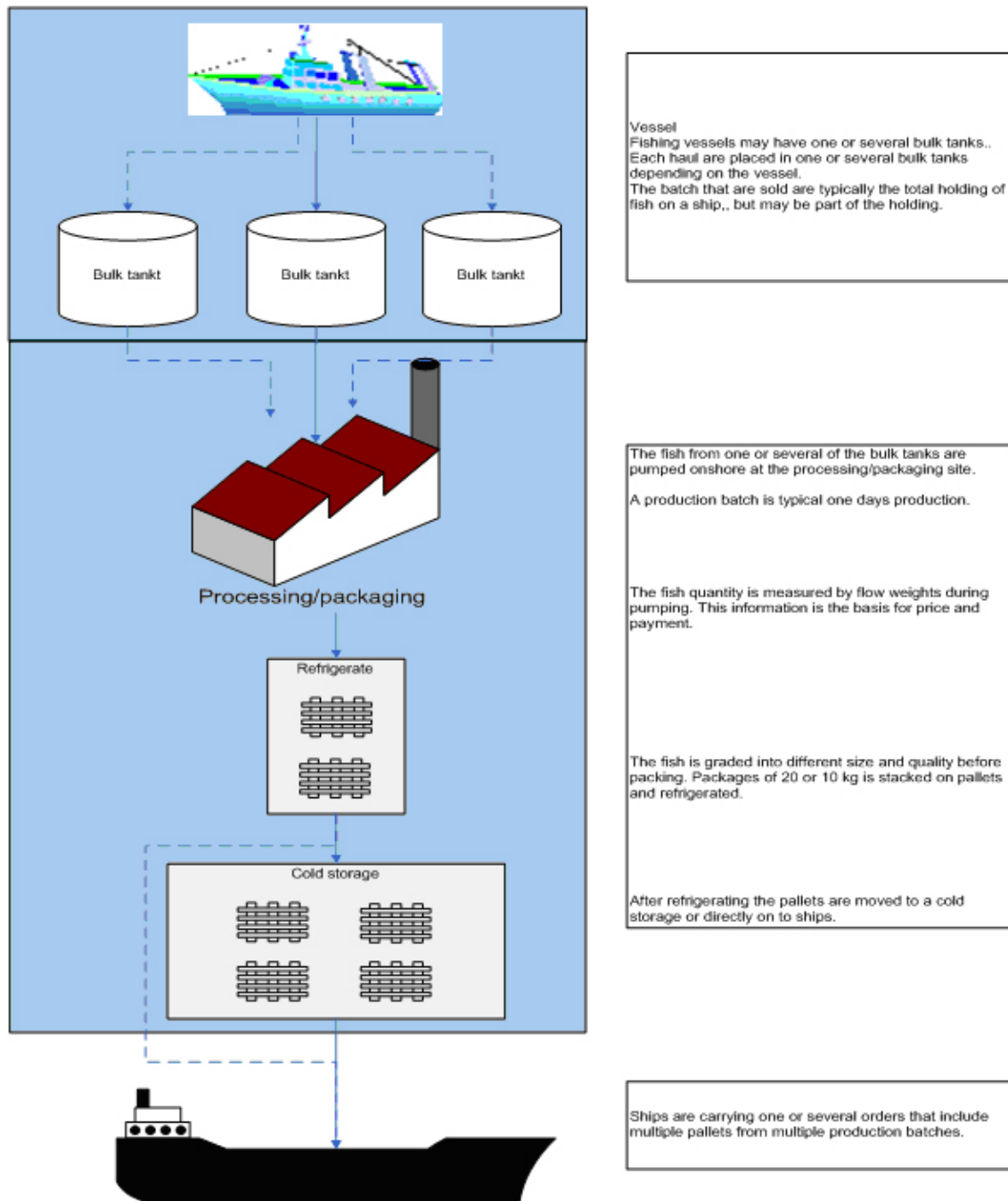


Figure 42. Flow of goods in the pelagic supply chain.

In the perspective of traceability information flow NSS carry out 3 functions. They receive and confirm the catch report. They run the web based auction and they conduct control of the landing information.

This gives the following cases of information exchange between NSS and the fish buyer:

1. A file that may be used to exchange pre landing information including estimated information (Sales report)
2. A file that may be used to exchange post landing information including measured and verified information. (Delivery note)

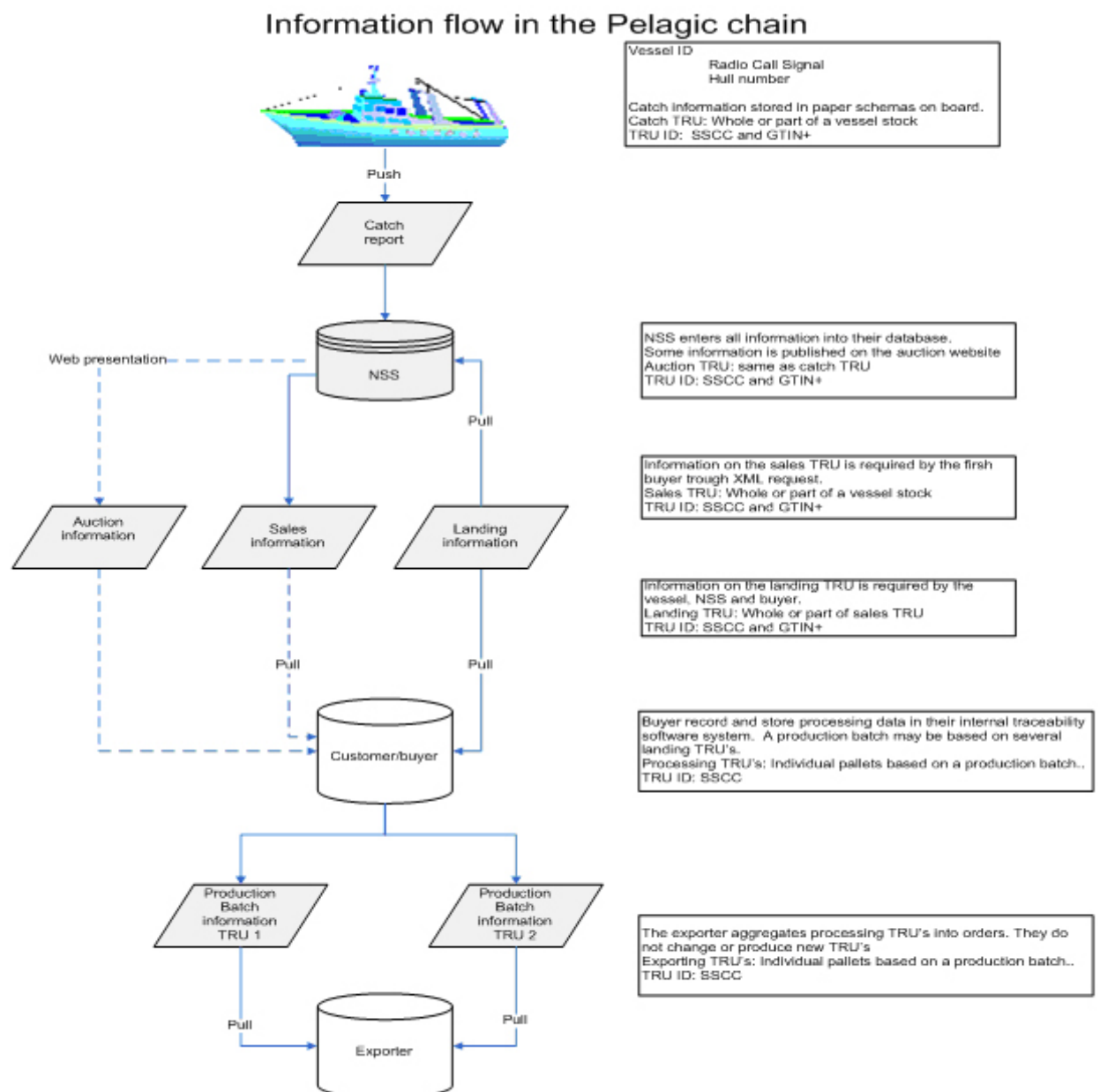


Figure 43. Information flow and TraceUnit ID's in the pelagic project case 1 and 2.

3.3.3 Short case description

Figure 43 shows a buyer, who has bought a whole shipment/catch through the NSS web-auction system. At the sale, the buyer will have access to the sales SSCC and SGTIN. The buyer wants to have electronic information about the catch to prepare his production system in advance and sends an TraceCore XML request to NSS about information linked to the actual SSCC.

The buyer receives a TraceCore XML file including requested information (Sales Report). This is a pull based information exchange.

Table 9. Information that is recorded and displayed in the catch report.

Information element name	Description	Example	Type
Catch ID	Five digits	23245	ID
Catch ID detail	ID on subset of catch	1	Info
CatchRegDateTime	Date and time of reception of catch report from fishing vessel	2007-05-23T22:36:50	Info
CustomerAssignedAccountID	Internal customer identification in NSS	436889	ID
PartyIdentification	National company vat number	NO 929270657	ID
PartyName	Name of ship owner	Kolbjørn Ervik og Sønner AS	ID
PostalAddress	City Name, postal zone, Country		ID
VesselName	Name of the actual vessel	Svanaug Elise	ID
Vessel ID	National identifier, seven alphanumeric letters	ST-0019-F	ID
Hull Id	Hull identification number for fishing vessels made by the Norwegian Directorate for fisheries	2001016541	ID
RadioCallSignal	ID assigned by the radio frequency band provider. Globally unique	LLRD	ID
Flag State	The stat where the ship is registered. Two letter code	NO	Info
Vessel Type	Descriptive code of type of vessel that are used	RINGNOT	Info

After landing the buyer receives a new XML file that includes the official quantity information (Delivery note). This is a push based information exchange. A table of the information elements included in the XML file is found in Table 9.

Pelagic versions of the TraceCoreXML files “Sales report” and “Delivery report” have been made and commercial testing are carried out during 2007. Further development and testing of TraceCoreXML files in the rest of the chain will also be carried out.

References

CWA14660. (2003). Traceability of fishery products. Specification of the information to be recorded in captured fish distribution: Pronorm AS.

Digre, H., Forås, E., & Hancke, R. (2004). Chain traceability for pelagic fish, specification of information recording in the pelagic supply chain, traceability guideline (STF80 F045075): SINTEF Fiske og akvakultur.

Tracefood.org. (2007). TraceCore XML: TraceFood.

3.4 TraceFood Framework and TraceFood Good Traceability Practice Guidelines

3.4.1 TraceFish and TraceFood

Tracefish was a concerted action EU project and ran from 2000-2002, full name “Traceability of Fish Products” (QLK1-2000-00164). The outcome of the project was three standards for voluntary recording and exchange of traceability information in the seafood chains;

1. The farmed fish standard describes what information should be recorded, how and where in the farmed fish supply chain (CEN, 2002 a).
2. The captured fish standard describes what information should be recorded, how and where in the captured fish supply chain (CEN, 2002 b).
3. The technical standard describes how the information should be coded, transmitted or made available in electronic form. The first application of the standard was in the fish industry, later on it has been extended to apply to food in general; TraceCore eXtensible Markup Language (XML) is a widely supported traceability standard for electronic interchange of traceability information in the food industry.

The information in the farmed and captured fish standards are categorized in “shall”, “should” and “may”. “Shall” are information elements necessary to identify and trace the movement of the products as they move through the supply chain. “Should” are information elements required by law or crucial parameters relating to food safety, labelling or quality. In the “may” category optional data elements possibly relevant for internal or external reporting may be found.

TraceFish is incorporated into the TraceFood framework (Figure 44). This is a framework for traceability which consists of principles, standards and methods for implementing traceability in the food industry. TraceFood is based on work done in EU

projects TraceFish, SEAFOODplus and TRACE funded by the European Commission under the in the 5 Framework Programmes and 6 Framework Programmes. Guidelines and standards have been, and are being developed for numerous food sectors, including fish.

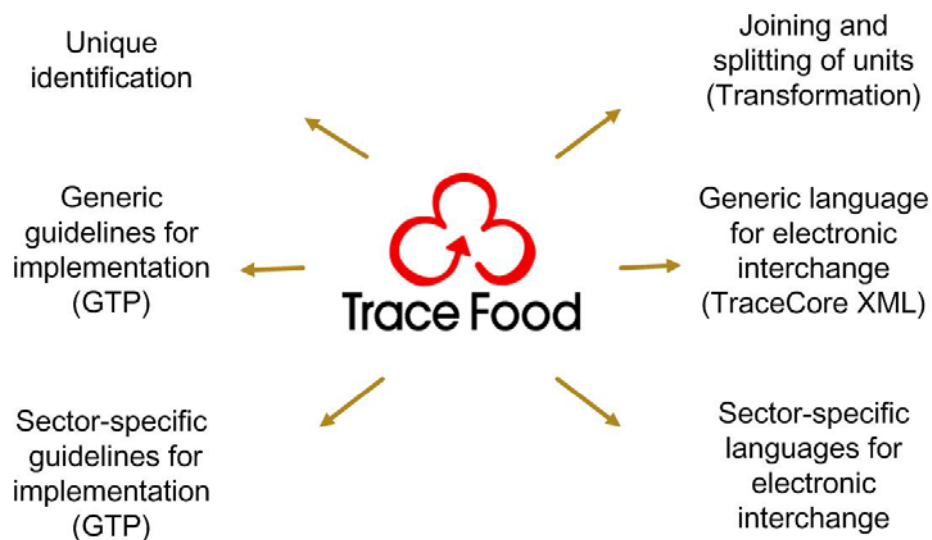


Figure 44. The TraceFood framework components.

The TraceFood Framework components are as follows:

Unique identification.

To achieve referential integrity and true traceability, TraceFood requires globally unique identification of each trade unit. The number series chosen for this purpose is referred to as Global Trade Item Number (GTIN+) (or Serial Global Item number (SGTIN) which is a type of GTIN+). Definition and unique identification of the traceable units using GS1 codes (GTIN+).

Documentation of joining and splitting the units (transformation).

Recording the relationship between batch, trade unit and logistic unit is an important traceability principle to be able to trace a product both back and forward in the supply chain. This includes a unique numbering system and method for keeping track of transformations

Generic Guidelines for implementation (GTP).

Generic Good Traceability Practice in the food industry in general.

Sector-specific guidelines for implementation (GTP)

Additional guidelines for Good Traceability Practice in specific food sectors, addressing the particular needs and considerations in the given sector, supplementing the generic guidelines including GTP for fish.

Generic language for electronic interchange (TraceCore XML)

TraceCore XML is a standard way of exchanging traceability information electronically in the food industry, both format and data.

Sector-specific language for electronic interchange.

The sector-specific XMLs are used to extend the TraceCore XML and contain a specification of the data elements only relevant in that particular food sector including the fish sector. These data which are related to origin, properties and processes, shall make possible accessing of product information linked to a trade unit, and to communicate with other supply chain partners. The sector specific standards specify where and when the various data elements to be recorded, in illustrative forms.

3.4.2 TraceFood Good Traceability Practice Guidelines

3.4.2.1 Introduction

The guidelines are developed in co-operation between the Trace and SEAFOODplus projects. During the development phase the recommendations have been discussed in detail in the IFSAT network, and the researchers have brought in valuable input to this work.

The document will be continuously revised based on experiences done in these projects. The newest version of the GTP you will find on the website www.tracefood.org. (see Figure 45). A final guide to Good Traceability Practice in the Food Industry will be published at the end of the TRACE project in 2009 (www.tracefood.org).

Our aim is that these guidelines shall become THE global guide to chain traceability, and constitute a major part of the TraceFood framework.

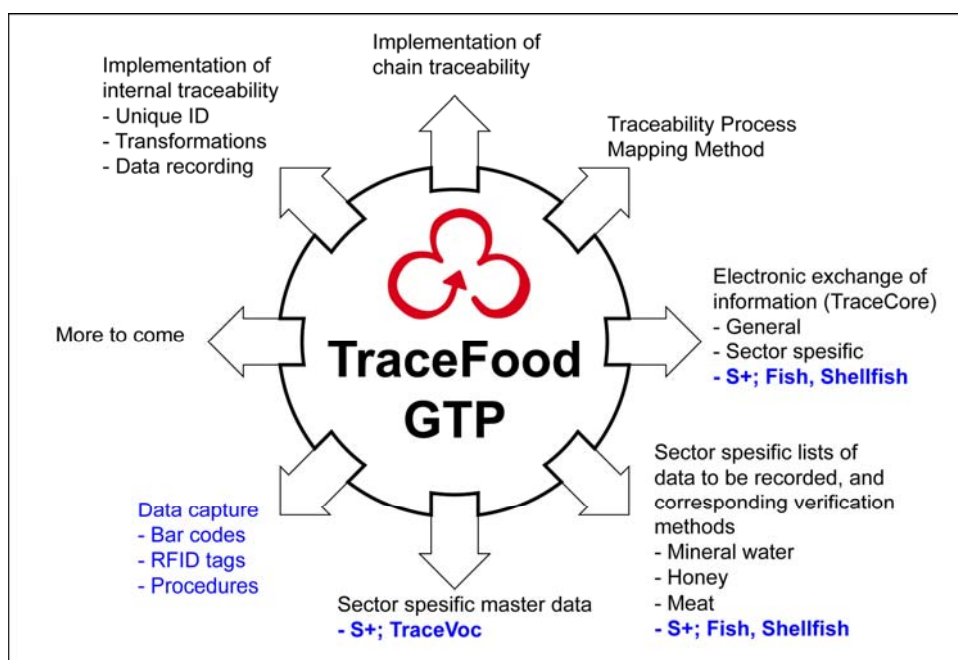


Figure 45 The Good Traceability Practice Guideline contents

3.4.2.2 A guide to defining a traceable units

The concept of traceable units is a key concept in chain traceability in general, and in the TraceFood standards in particular. A Trade Unit (TU) is defined as ‘any item upon which there is a need to retrieve predefined information and that may be priced, or ordered, or invoiced at any point in any supply chain’. In practice (and in TraceFood) it often refers to the smallest traceable unit that is exchanged between two parties in the supply chain. A crate of fish or crate of meat is often a TU.

A Logistic Unit (LU) is defined as ‘an item of any composition established for transport and/or storage that needs to be managed through the supply chain’. In practice (and in TraceFood) it is made up by one or more separate TU’s. In some cases, the trade unit and the logistic unit are the same. A Logistic Unit is often a pallet of fish/ meat crates being distributed from one producer to a receiver.

3.4.2.3 A guide to unique identification of traceable units

The TraceFood Framework requires that the traceable units shall be uniquely identified. Furthermore it requires that a minimum of additional information shall be linked to the traceable units throughout their lifetime. Later on these data may be accessed via the unique identification number. Common practice for creation of the smallest traceable unit varies in different industries. In the fish farming business a bucket of roe, a full containment of a well boat or a fish crate are typical TU’s. In the meat sector a crate of meat is a typical TU.

3.4.2.4 How to uniquely identify the Logistic Unit

GS1 provides a globally unique data element for the identification of a Logistic Unit, called SSCC (Serial Shipping Container Code). A pallet of fish crates or 40 feet containers of fish are typical logistic units. TraceFood requires that the IDs of the separate TU’s within the LU shall be linked to the LU identifier, in practice to the SSCC.

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

3.4.2.5 How to uniquely identify the Trade Unit

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

To uniquely identify the particular crate, one has to add one or more predefined data elements. In the TraceFood standard this identifier is called GTIN+, where the + indicates that additional information is needed for this purpose (Table 10).

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

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

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

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

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

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

(01)07038010000065(8008)040915125603

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

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

Table 10. An extract of Table 2 in the NSF –CWA 1459 (TraceFish standard). The table covers ID numbering.

FHA0 4	Unit ID	SSCC (n2+n18) (if received as a Logistic Unit) or GTIN + (10) + (21)(if received as a separate Trade Unit)	SSCC: (00) 235467985462312345	x		
FHA0 5	Trade Unit ID	If received as a Logistic Unit; the IDs of the Traded Units that make up the Logistic Unit	List of GTIN+	x		
FHA1 3	Unit -ID	SSCC (n2+n18) (if dispatched as a Logistic Unit) or GTIN + (10) +(21) (if dispatched as a separate Trade Unit)	GTIN+: (01) 07012345000001 (10) 0000000125 (21)1234567890	x		

3.4.2.6 A guide to keeping track of transformations

Below a five step implementation guide to chain traceability according to the TraceFood recommendations are listed:

1. Define the Trade Unit in the business under examination.

2. Record IDs of received Trade Units (raw materials and/or ingredients).

Here are two alternatives; 1) If the received Trade Unit has a unique ID, record it. 2) If the received Trade Unit do not have a unique ID, allocate one to it.

If alternative 2, the TraceFood standard requires recording of some more information, specified in a table called 'Bringing in supplies from outside the TraceFood domain'.

3. Record the ID of the Trade Units that go into the production, and give all produced Trade Units a unique ID.

In practice, the ID of Trade Units that goes into production will at that stage be linked to a production batch (cf. Batch number). Every produced Trade Unit must be allocated a unique number (cf. GTIN+). In this way the ID of received Trade Units will be linked with the ID of produced Trade Units. This practice ensures forward traceability inside the business.

Where possible and relevant, it is also recommended to record the fraction (%) and/or the net weight of each Trade Unit that goes into production.

4. Record the ID of all Trade Units dispatched.

Fulfillment of requirements in step 2-4 provides both a link between received and dispatched Trade Units (and the other way around), via the production process (called internal traceability), and a link to previous and next food business operator (called chain traceability). In the TraceFood standard the mapping of these relations are called transformation information. Figure 46 shows how relations are linked both ways through a business. Entire Trade Unit 11 is input factor in Trade Unit 21, while TU 21 is also made up by TU 12. Both fractions (%) and Net weight are indicated. In this figure the production step is removed, and only relation between received and dispatched TUs are shown.

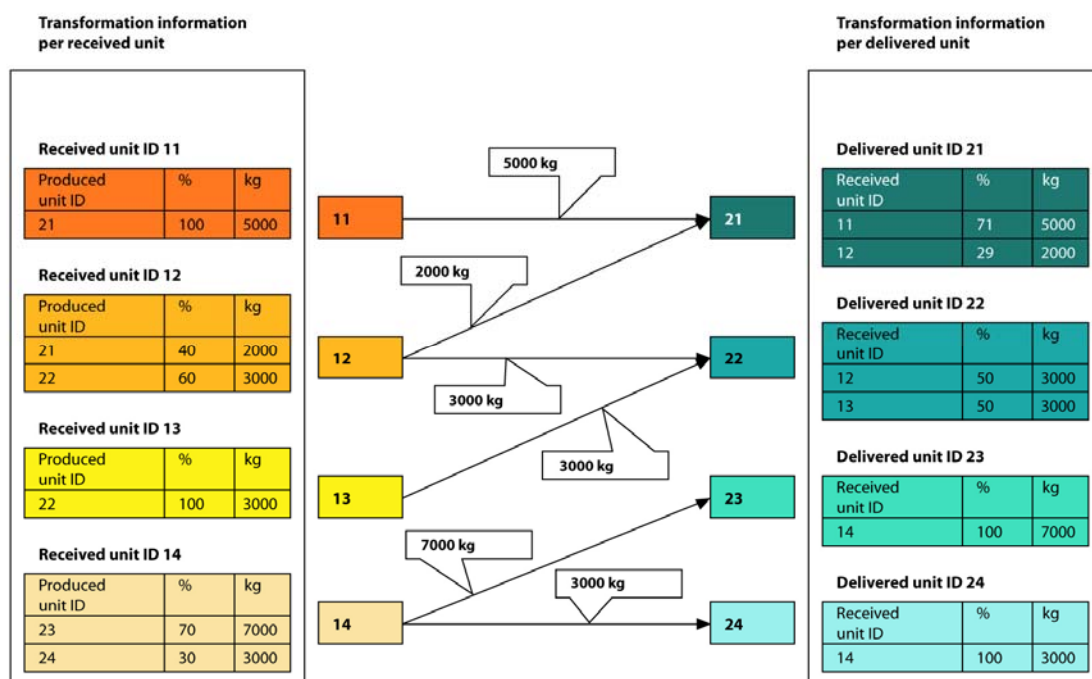


Figure 46. Relations between received and dispatched Trade Units are indicated. Arrows indicates goods flow.

3.4.2.7 A guide to (further) data recording (i.e. food safety data)

According to ISO, traceability is defined as The ability to trace the history, application or location of an entity by means of recorded identifications. Hence, information related to history (i.e. temperature record, production process related information), application (property related information like weight, species, fat percentage, etc) and location (distribution route) should be recorded and linked to a traceable unit. Figure 47 shows how traceability related information can be split into different categories. Within each of these categories there is one or more data element(s) to be recorded in the forms presented in the sector specific standards (see Table 11 below).

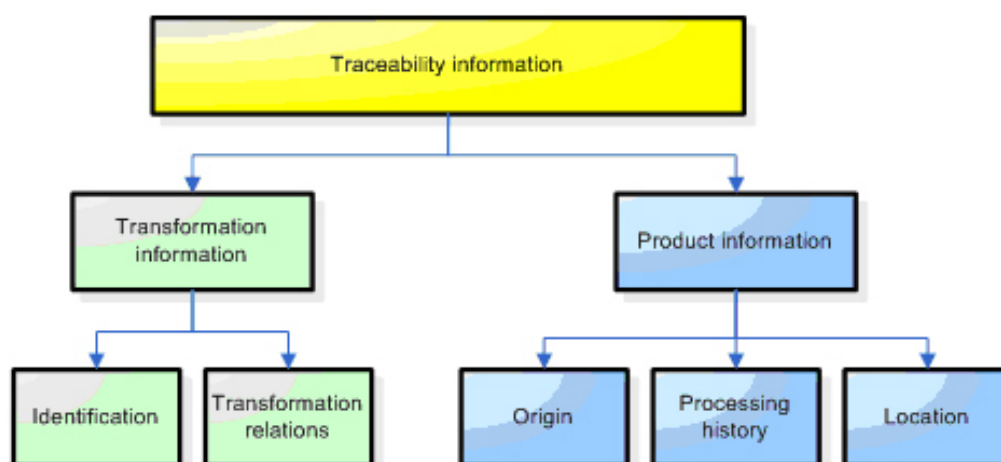


Figure 47. Different information categories within the traceability concept.

According to premises given by the European Standardization Body CEN (www.cenorm.be/cenorm/index.htm), the sector specific data recording standards divide the traceability information into 3 groups: **Shall**, **Should** and **May**. The **Shall** information in our case is considered to be fundamental traceability data. These data are required if we want to trace back and forth through all paths a product or fraction of a product has been through in the supply chain, and hence be able to surgically withdraw products from the market. The **Should** and **May** categories cover relevant information related to process/handling and product properties. These data are frequently used in the business and may have importance for the detection of the cause of a recall.

Table 11. A snapshot from a sector specific data recording form from Table 3 in the NSF –CWA 1459 (TraceFishFarmed Fish standard standard).

Table 3 — Detailed information requirements for fish farms

Data element		Description	Examples	Categorisation		
				Shall	Should	May
FISH FARMS						
FFF01	Food business ID	Name and address or GLN (n3+n13) of food business that operates fish farm establishment	Fjord Harvest Ltd 67345 Bergen Norway	x		
FFF02	Fish farm establishment ID	Name, address and registration number or GLN (n3+n13) of fish farm establishment	Fjord Harvest Ocean site 2 67345 Bergen Norway NTFS0003 NO	x		
FFF03	Fish farm GMP certification	Names of fish quality or food safety GMP schemes by which fish farm is certified	Debio			x
FOR EACH UNIT RECEIVED						
Identities						
FFF04	Unit ID	SSCC (n2+n18) (if received as a logistic unit) or GTIN+ (n2+n14+AI's) (if received as a separate trade unit)	GTIN+: (01) 07012345000001 (10) 0000000125	x		
FFF05	Trade unit IDs	If received as a logistic unit, the IDs of the trade units within the logistic unit. List of GTIN+ (n2+n14+AI's)	List of GTIN+	x		
Source						
FFF06	Previous Food Business ID	Name, address or GLN (n3+n13) of previous food business from whom the unit was received. (Hatchery or transporter, etc.).	Salmogen Breeding station 1 1234 Trondheim Norway	x		
FFF07	Date and time of reception		2002-09-28T12:00	x		
Control checks (either on logistic or separate trade units)						
FFF08	Temperature check	Temperature °C i.e. in received unit	4,0 °C		x	

3.4.2.8 A guide to traceability friendly production

A traceability oriented implementation process includes both re-engineering of data recording, material flow and production processes. There are two main ways of dealing with traceability:

1. You can document a poor or complicated material flow.

Or

2. You can simplify your material flow based on traceability friendly criteria, and document this.

Design of optimal cost effective production processes and purchase policy has through many years been a major part of the improvement process in the food industry. Due to this, modern food factories are streamlined with specialized production of narrow products (i.e. cutlets, fillets, etc). Given low risk, it is not necessarily very profitable to implement a traceability friendly production regime. However, if there is a substantial risk for contamination of food stuffs, it is possible to implement procedures for handling of input factors and production which simplifies traceability. Such a traceability friendly practice may help to isolate contaminated items and recall these efficiently, and hence reduce direct cost. The various food scares show that there are serious risk present, both for hazards and subsequent loss of money and reputation.

When considering re-engineering of existing production practice in a more traceability oriented manner, the following corrective actions should be considered:

- ***Reduction of the size of input factors*** (raw materials and ingredients). This is especially important for long lasting ingredients like; salt, spices, flour, etc. If contamination is first identified after lengthy use of such input factors, this may have strong negative effects on products made over a long.
- ***Use of small(er) production batches***. In principle, you are free to define the size of your production batch. In a food scare case, such a practice can lead to withdrawal of enormous amounts of products. Contrary, if splitting the production into small batches (i.e. one day's production), just limited numbers of would be affected.
- ***Minimum mixing of raw materials with different origin***. A contamination is often not detected before a Trade Unit is out in the shops. If probability for cause of contamination can be placed on raw materials, it can be hard to tell which raw material that is the source. If fractions/parts of these raw materials also have been applied in other productions, it is likely that products made of "clean" raw materials would be recalled. Due to this, one should avoid mixing of raw materials with different origin in a production batch.

Decisions taken when dealing with the issue of traceability friendly production should be based on risk analysis and cost/benefit calculations.

3.5 Conclusion

Guidelines for Good Traceability Practice (GTP) are being developed in cooperation between this project and the Trace and SEAFOODplus projects. These guidelines include definitions and suggestions on how to identify the different types of units and how to record this data.

The recommendations for good traceability practice have been implemented in two activities, namely the newly-developed software called Pelagic Information Programme (PIP) and the standard electronic infrastructure TraceCore XML. PIP is a data capture software which facilitates the collection of information onboard pelagic fishing vessels and the exchange of this information with land-based steps in the chain. TraceCore XML has been implemented for the exchange of traceable information among different steps in a pelagic chain in Norway. Further testing of both implementations is taking place in the Trace and SEAFOODplus projects and will be concluded by 2009, as will the final GTP guidelines.

References:

www.tracefish.org

www.tracefood.org

www.gs1.org

http://www.fda.gov/oc/po/firmrecalls/recall_defin.html

4 Food safety oriented preparedness test

4.1 Introduction

The objective of the food safety oriented preparedness test is to evaluate the level of preparedness in the seafood industry in the different Nordic countries in case of a food safety initiated recall. The preparedness test is a simulated recall, which will give objective information on the effectiveness of the present Nordic traceability systems in performing recalls in the event of a food scandal. The work includes developing a harmonized research method for the preparedness test, carrying out the test in different Nordic countries and writing a scientific article on the findings. The developed method and the results of the test are described below. In addition, an article entitled “Simulated recalls of fish products in five Nordic countries” has been submitted to the journal *Food Control* in April 2007.

4.2 Preparedness tests in the Nordic countries

4.2.1 Introduction

During a product recall situation, it is useful to have a high level of traceability since this makes it easier to establish the batches to which the product belongs at the individual steps in the chain and thereby to find the origin of the product. This facilitates the location of the affected products that will have to be removed from the market.

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 in Norway 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 (Danish Standards Association, 2003a; Danish Standards Association, 2003b), and the use of electronic information transfer.

In this study a simulated recall of fish products in five Nordic countries is carried out in order to test how prepared the fish industry is to successfully recall a product. This will give a picture of the levels of traceability in the industry at present.

To accomplish the test, a given number of products at the retail level will be chosen. Thereafter, for each product, the objective is to determine:

- a) the last traceable step in the chain (in other words, how far back towards the origin it is possible to trace the product)
- b) the size of the batch at the last traceable step in the chain (in other words, how much will have to be located in case the cause of a recall is due to unfortunate conditions at the last traceable step)
- c) the time necessary to determine a) and b)

4.2.2 Methods

Preparedness tests were performed in five Nordic countries in 2006-2007 based on a modified version of the method developed by Karlsen and Senneset (2006). However, the present method does not map the product information against the Tracefish standards (Danish Standards Association, 2003a; Danish Standards Association, 2003b) or investigate how batches are identified throughout the supply chains (i.e. what kind of traceability systems the companies use). In addition, Karlsen and Senneset (2006) report the number of times they communicated with the companies, which is not an aspect of interest to the present study. The two methods make use of similar traceability logs.

Due to some alterations of the method, the present method is described step-wise below and schematically in Figure 48. The step numbers refer to the steps shown in Figure 48.

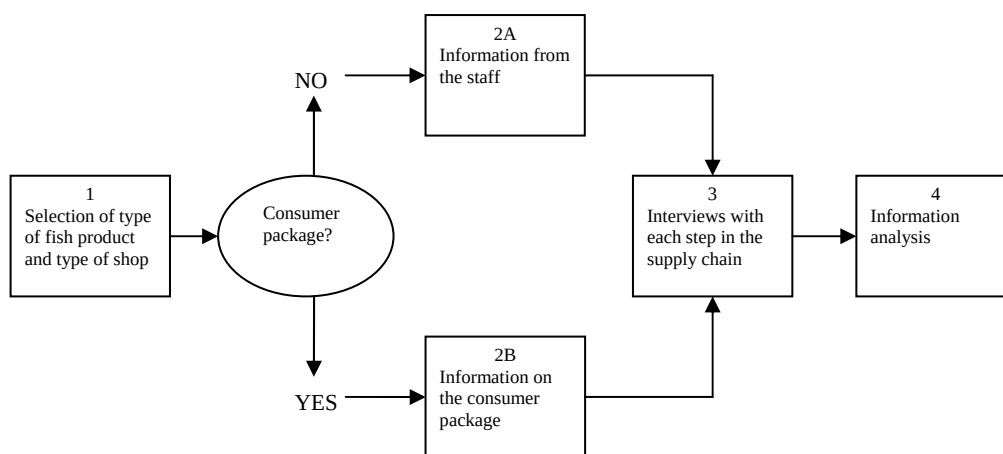


Figure 48. Outline of the survey method. Modified after Karlsen & Senneset (2006).

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 study, 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: Information that could be used to trace the product was noted down (Table 12). If the product was not in a consumer package, the shop personnel were interviewed.

Table 12. Examples of information on the consumer package or received from the shop personnel.

Information on the consumer package	Information received from the personnel
Name of brand owner	Species of the main ingredient
Name and telephone number of producer	Name and telephone number of the shop/wholesaler, from whom the fish was bought
Species of the main ingredient	Invoice no.
Country or area of origin of the main ingredient	Batch size received from the previous shop/wholesaler
Internal batch number	
Production date	
Best before date	

Step 3: The brand owner/producer and each successive step back thereafter 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
- b) the size of the batch, which includes the given product, that was received from that company
- 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. The companies contacted were informed that this test was part of a research project in all 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 (Table 13). For each country, the test results were summarized (Table 14). Thereafter, the test results from the four countries were collected and assessed according to points a), b) and c) mentioned in the introduction.

Table 13. Example of a traceability log. (A collector prepares the fish for auction by unloading the vessel, size-grading the fish and rating the fish according to freshness.)

Date of selection of product		Aug. 22, 06						
Shop/fish monger		Supermarket A, Street B, City C						
Information on the consumer package								
Product (incl. species)		MAP fillets of plaice						
Product number in Table 3		3						
Brand owner		Company D						
Producer, address		Company D, City E, Denmark						
Producer's tel.no., homepage		12 34 56 78, www.companyD.dk						
Authorization no.		DK 1234						
Country/area of origin		Northeast Atlantic Ocean						
Country of processing		Denmark						
GS1 number		1234567890123						
Internal batch number		No labelling						
Production date		Aug. 17, 2006						
Best before date		Aug. 24, 2006						
Step	Company and contact person	Aid	Date	Time start	Time end	Estimated or measured time	Information received	
Retailer	Name of supermarket A	of Purchase in shop	Aug. 22, 06	18.25	18.28	3 min.	On label (see above)	
Producer	Name of company D, Contact person F	Telephone	Aug. 23, 06	11.00	11.04	60 min. (estimated by company D)	Called company D. Required an email.	
Producer	Name of company D, Contact person F	E-mail	Aug. 23, 06	11.05	11.20		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	Sept. 5, 06	7.33	7.33		Received mail from F. Plaice bought at fish auction G, 2975 kg plaice, size 4, Aug. 16, 06	
Auction market	Name of fish auction G, Contact person H	Telephone	Sept. 5, 06	11.05	11.10	5 min.	Company D bought 2975 kg plaice, size 4 from collector I on Aug. 16, 06. Fish auction G sold in total 17 863 kg plaice, size 4 for collector I Aug. 16, 06.	
Collector	Name of collector I, Contact person J	Telephone	Sept. 5, 06	12.47	12.49	2 min.	Received unknown quantity of plaice from 32 different vessels in one harbor Aug. 16, 06. The fish was caught over several days.	

Table 14. Example of results of the simulated recalls in one country (Denmark).

Product no.	Product description	Farmed/captured		Degree of processing		State of fish		Last traceable step	Batch size at the last traceable step	Est. time necessary
		Farmed	Captured	Processed	Unprocessed	Chilled	Frozen			
1	Fresh cod fillet, from fresh food counter (fish monger)		x		x	x		20 small vessels in Øresund	Cod landed by 20 small vessels (one day's catch)	60 min.
2	Frozen saithe fillets, consumer package		x		x		x	One specific vessel	45 235 kg saithe	60 min.
3	MAP plaice fillets, consumer package		x	x		x		32 vessels in one harbor	Plaice landed by 32 vessels from a fishing trip lasting several days	70 min.

4.2.3 Results and discussion

The results show that the levels of traceability differ from one product to the next (Table 15). 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.

Table 15. Summary of the results of the simulated recalls of fish products in the five Nordic countries divided into a) fresh fish products, b) frozen fish products and c) optional fish/seafood products. (C&P = cooked and peeled; MAP = modified atmosphere packed)

a) Fresh fish products

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

b) Frozen fish products

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

c) Optional fish/seafood products

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

The last traceable steps vary from one vessel to 50 vessels. It is worth noting that in ten 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). 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 it is also possible to achieve a larger batch size, which is reasonable, yet cost-effective in terms of a recall.

All 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 (Anon., 2002), since it requires, as a minimum, the ability to establish which group of products is supplied from which group of suppliers (The Standing Committee on the Food Chain and 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 story-telling for marketing purposes. 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 small boats 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; Anon., 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 tons. 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 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 different batch size that would be recalled than if the unfortunate conditions were on the fishing vessel. 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. Of course not all the products have been traced back to their origins within this time period. If this was possible for those products, then the time needed would be prolonged. Despite that, the reported time indicates that the traceability systems at each step, whether paper-based or computerized, work. 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 product 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 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.

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 industry in other countries are for a recall.

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 fish in that batch have been delivered. This will provide even more information on the preparedness of the fish industry for a recall.

4.2.4 Conclusion

Around half of the investigated supply chains were able to trace a product back to one fishing vessel or one fish farm. Batch sizes at the last traceable step varied from 5 kg to 600 tons, indicating that the fish industry should reconsider their batch sizes at the beginning of the supply chains (fishing vessels and auctions) 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 hours, 20 minutes, suggesting that the existing traceable information is relatively easy to find. As a whole, the fish industry in the Nordic countries seems not to be prepared for a recall and the traceability of fish products can be improved.

4.2.5 References

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4.3 Abstract

Randrup, M., Storøy, J., Lievonen, S., Margeirsson, S., Árnason, S.V., í Ólavsstovu, D., Møller, S.F., & Frederiksen, M. Simulated recalls of fish products in five Nordic countries. Submitted to *Food Control*, 2007.

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 first step in the supply chain (raw material) vary considerably. However, the existing traceable information seems 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.

5 Selected validation methods

5.1 Introduction

Objectives: Evaluate two different methods - QIM (Quality Index Method) and SSP (Seafood Spoilage Predictor) - to inspect and validate the product information on freshness provided by a traceability system.

The evaluation of two different methods to inspect and validate the product information on freshness provided by a traceability system will be reported in the following. The two methods are the sensory evaluation method called the Quality Index Method (QIM) and the software entitled Seafood Spoilage and Safety Predictor (SSSP). QIM will be used to test farmed salmon exported from Norway to Denmark. The salmon will be assessed by a sensory team from DIFRES and the QIM scores will be evaluated to see whether the degree of freshness corresponds to what can be expected by reading the slaughter date on the box labels. The SSSP method will be tested in the lab to evaluate if it is useable to validate traceable data.

5.2 Quality Index Method (QIM)

5.2.1 Introduction

The quality index method (QIM) was used to inspect and validate the product information on freshness provided by a traceability system as “days in ice”. In this case it was the “slaughter date” stated on each fish box. QIM is used as an inspection tool to validate the information that is carried by different traceability systems.

QIM was used to measure the quality loss during transport and storage for salmon farmed in Norway and exported to Denmark for processing (smoking) or for domestic consumption. The salmon was reared in different fish farms, slaughtered and packed in polystyrene boxes in ice before they were transported to Denmark. In Denmark the salmon was received at smokehouses and at a processor. The salmon was followed by a sensory team from The Danish Institute for Fisheries Research (DIFRES) all the way to the retailers. No action was taken to improve the cool chain in this study. The purpose was to observe the current handling (or bad handling) practice, measure the actual quality by the QIM method and compare that to the ideal quality stated by the slaughter date.

5.2.2 Samples

Salmon (*Salmo salar*) reared in different fish farms, slaughtered and packed whole in polystyrene boxes in ice.

Study 1:

In total 43 salmon in four batches over a period of four weeks. The first three batches were divided into two. One was assessed Monday or Tuesday and another on Thursday at the smokehouse. The salmon were processed after the QIM assessment.

Study 2:

Over a six week period, each week ten salmon were sent from the fish farm in Norway to a fish industry in Jutland (Denmark), in total 60 salmon. The salmon were processed after the QIM assessment.

Study 3:

Salmon from two different fish farms in Norway were sent to a smokehouse in Jutland (Denmark) and seven salmon from farm A and six salmon from farm B were sent to DIFRES.

5.2.3 Method

The Quality Index Method

QIM is a scaling method, which establishes robust data reflecting the different quality levels of fish in a simple and well-documented way (Hyldig & Nielsen, 1997; Martinsdóttir et al., 2003; Hyldig & Green-Petersen, 2005). QIM is based on significant sensory quality parameters for whole fish using many weighted quality parameters and a score system from 0 to 3 demerit points. In the QIM scheme for farmed salmon (Sveinsdóttir et al., 2003), the quality parameters are skin, eyes, gills and abdomen. Each quality parameter is divided and there is a description of each quality parameter. The QIM scheme for farmed salmon is shown in Table 16. The scores for all the characteristics are added to give an overall sensory score, the so-called quality index (QI). A QI of zero is given for very fresh fish and increases as the fish deteriorate.

The QIM evaluation was conducted with three tested and trained sensory assessors from DIFRES.

Table 16. QIM scheme for whole farmed salmon (*Salmo salar*) containing descriptions for each parameter and the given scores in succession from 0 to 3.

Quality parameters		Description	Points
Skin:	Colour/ appearance	Pearl-shiny all over the skin	0
		The head is still pearl-shiny, but the rest less, perhaps yellow	1
	Mucus	Clear and not clotted	0
		Milky and clotted	1
		Yellow and clotted	2
	Odour ¹	Fresh seaweedy, cucumber	0
		Neutral to metal, dry grass, corn	1
		Sour	2
		Rotten	3
Eyes:	Pupils	Clear and black, metal shiny	0
		Dark grey	1
		Mat, grey	2
	Form	Flat	0
		Little sunken	1
		Sunken	2
Abdomen:	Blood in abdomen	Blood light red/not present	0
		Blood more brown	1
	Odour	Neutral	0
		Corn	1
		Sour	2
		Rotten/rotten kale	3
Gills ² :	Colour/ appearance	Red/dark brown	0
		Light red/brown	1
		Grey-brown, grey, green	2
	Mucus	Transparent	0
		Yellow, clotted	1
		Brown	2
	Odour	Fresh, seaweed	0
		Metal	1
		Sour	2
		Rotten	3
Texture:	Elasticity	Finger mark disappears immediately	0
		Finger leaves mark over 3 seconds	1
Quality Index (0 - 22)			SUM:

¹: Turn the salmon and smell the skin on the other side

²: Examine the side that has not been cut through

5.2.4 Results and discussion

First study

The salmon for the first study were sent from Norway to a smokehouse in Zealand (Denmark). There were four batches in four weeks, in total 43 salmon. The first three batches were divided into two. One was assessed Monday or Tuesday and the other on Thursday at the smokehouse. The QI (Quality Index) for the salmon are shown in Table 17.

Table 17. The QI for each salmon in the first study.

	QI						
	Week 1		Week 2		Week 3		Week 4
	Monday	Thursday	Tuesday	Thursday	Monday	Thursday	Monday
Days after slaughter	4	7	5	7	4	7	4
Fish no 1	7	11	10	9	10	13	13
Fish no 2	5	11	11	10	10	12	11
Fish no 3	6	8	11	10	10	11	10
Fish no 4	9	11	11	10	9	11	11
Fish no 5	6	10	11	10	10	11	12
Fish no 6	6	11	12	11		11	11
Fish no 7	7	12					

With QIM it is possible to:

- 1) Estimate the corresponding days in ice
- 2) Predict the remaining shelf life when the fish is stored in ice.

From the calibration curve for salmon, $QI = 0.692 \cdot \text{day} + 1.57$ (Martinsdóttir et al., 2001) the corresponding days in ice can be calculated. If the fish is kept in ice, the corresponding days in ice will be the same as days after slaughter (see Table 18).

Table 18. The QI and the estimated days after slaughter (days in ice) for each salmon in each batch in the first study.

	QI => the corresponding days in ice						
	Week 1		Week 2		Week 3		Week 4
	Monday	Thursday	Tuesday	Thursday	Monday	Thursday	Monday
Fish no 1	7 => 8	11 => 13	10 => 12	9 => 10	10 => 12	13 => 17	13 => 16
Fish no 2	5 => 5	11 => 13	11 => 14	10 => 12	10 => 12	12 => 16	11 => 14
Fish no 3	6 => 7	8 => 9	11 => 14	10 => 12	10 => 12	11 => 14	10 => 12
Fish no 4	9 => 10	11 => 13	11 => 14	10 => 12	9 => 11	11 => 14	11 => 13
Fish no 5	6 => 7	10 => 13	11 => 14	10 => 12	10 => 12	11 => 14	12 => 15
Fish no 6	6 => 6	11 => 14	12 => 14	11 => 13		11 => 13	11 => 14
Fish no 7	7 => 7	12 => 15					

The averages for the batches and the corresponding days in ice are shown in Table 19. It can be seen that there is a good correlation for week one, two and three.

Table 19. The average QI and the average estimated days after slaughter (days in ice) for each batch in the first study.

Week	Day	Days after slaughter	QI (average)	Average estimated days after slaughter (Days in ice)	± Std dev
1	Monday	4	7	9	1.5
	Thursday	7	10	13	1.8
2	Tuesday	5	11	14	0.8
	Thursday	7	10	13	0.9
3	Monday	4	10	13	0.6
	Thursday	7	12	16	1.3
4	Monday	4	11	14	1.4

Second study

In the second study, each week ten salmon were sent from Norway to a fish industry in Jutland (Denmark) over a six week period. All salmon in each batch were assessed at DIFRES (Table 20).

Table 20. The QI for each salmon in each batch in the second study.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Days after slaughter	8	4	3	7	4	5
	QI					
Fish no 1	11.7	12.0	9.5	10.8	5.8	9.2
Fish no 2	12.7	10.0	5.0	11.2	9.0	10.0
Fish no 3	13.7	8.7	7.3	11.2	9.0	7.6
Fish no 4	15.3	11.7	10.5	10.4	7.8	8.4
Fish no 5	14.0	10.7	8.8	9.8	6.6	8.8
Fish no 6	14.3	8.7	5.0	10.6	10.6	7.8
Fish no 7	11.0	7.3	9.0	12.0	10.4	9.0
Fish no 8	13.3	8.7	8.3	10.4	8.2	8.4
Fish no 9	15.3	7.3	9.5	10.4	8.2	8.8
Fish no 10	11.7	9.3	10.3	12.2	9.4	12.3
AVG QI	13.3	9.4	8.3	10.9	8.5	9.0

The estimated days after slaughter (days in ice) based on the QI for each fish examined are shown in Table 21.

Table 21. The estimated days after slaughter (days in ice) based on the QI for each fish examined in the second study.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Days after slaughter	8	4	3	7	4	5
	Calculated days after slaughter (days in ice)					
Fish no 1	15	15	11	13	6	11
Fish no 2	16	12	5	14	11	12
Fish no 3	18	10	8	14	11	9
Fish no 4	20	15	13	13	9	10
Fish no 5	18	13	10	12	7	10
Fish no 6	18	10	5	13	13	9
Fish no 7	14	8	11	15	13	11
Fish no 8	17	10	10	13	10	10
Fish no 9	20	8	11	13	10	10
Fish no 10	15	11	13	15	11	16
Average days	17	11	10	13	10	11

The averages for each batch are shown in Table 22. It is seen that the large variation in the estimated days in ice for each fish influence the standard deviation for each batch.

Table 22. The average QI and the corresponding average estimated days in ice for each batch in the second study.

Week	Days after slaughter	QI (average)	Average estimated days after slaughter (Days in ice)	± Std dev
1	8	13.3	17	2.2
2	4	9.4	11	2.4
3	3	8.3	10	2.9
4	7	10.9	13	1.1
5	4	8.5	10	2.2
6	5	9.0	11	1.9

Third study

In study three, salmon from two different fish farms in Norway were sent to a smokehouse in Jutland (Denmark) and seven salmon from farm A and six salmon from farm B were sent to DIFRES. All the salmon were assessed at DIFRES. The QI is shown in Table 23 and the estimated days after slaughter (days in ice) are shown in Table 24.

Table 23. The QI for each salmon from the two farms in the third study.

	Farm A	Farm B
	QI	QI
Days after slaughter	6	6 to 8
Fish no. 1	4	4
Fish no. 2	4	4.8
Fish no. 3	6.8	9
Fish no. 4	7.5	6.3
Fish no. 5	5.8	9
Fish no. 6	7.5	8.3
Fish no. 7	7.5	
Avg QI	6.2	6.9

Table 24. The average QI and the corresponding average estimated days in ice for each batch in the third study.

	Days after slaughter	QI (average)	$\pm$ Std dev	Average estimated days after slaughter (Days in ice)
Farm A	6	6.2	1.6	7
Farm B	6 to 8	6.9	2.2	8

The results from this study confirm that the stated slaughter date in both cases can be used as the quality given as days in ice (the variation is within the precision of the QIM method). Farm B only gave the information that “days after slaughter” is between 6 and 8. The stated quality is then 8 days in ice (the poorest quality is the stated quality in case of a mixed batch).

Results of all three studies

The collected results of the three studies are shown in Table 25.

Table 25. The days after slaughter, the estimated days after slaughter and the difference for all three studies.

Study no.	Time		Days after slaughter	Estimated days after slaughter (Days in ice)	Difference days
Study no. 1	Week 1	Monday	4	9	5
		Thursday	7	13	6
	Week 2	Tuesday	5	14	9
		Thursday	7	13	6
	Week 3	Monday	4	13	9
		Thursday	7	16	8
	Week 4	Monday	4	14	10
Study no. 2	Week 1		8	17	9
	Week 2		4	11	7
	Week 3		3	10	7
	Week 4		7	13	6
	Week 5		4	10	6
	Week 6		5	11	6
Study no. 3	Farm A		6	7	1
	Farm B		6 to 8	8	2 - 0

The standard deviation for the QIM method was in this study 0.6 and the variation between the individual salmon was 2.9, which is in agreement with the studies by Sveinsdóttir et al. (2002). Sveinsdóttir et al. (2002) concluded that by assessing 3 fish in a sample, the storage time could be estimated with a 2-day accuracy (at the 95% significance level), but examining more fish per sample might increase the precision.

5.2.5 Conclusion

The QIM measures the sensory quality at the point of evaluation. The results show that it is important to control the conditions during transport. In these studies, there has not been any measurement of the temperature during transport. When the boxes were received at the smokehouse or at DIFRES, the amount of ice was not the same in all boxes and some had only little or missing ice (around 50%). The QIM is a tool for following the sensory quality and can be used as a tool in a traceability system. The results show that when using QIM in industry studies, the standard variation is ± 3 days and that the method in this real industry case was able to detect either bad slaughter handling or bad cool chain management in 13 cases. In two cases, it confirms that the salmon quality is as stated. QIM is from this clearly a method that is able to be used as the objective tool to settle a discussion between two steps in a chain where the “stated quality” and corresponding “slaughter date” is the issue. QIM as an inspection tool in combination with traceability implemented in an effective cool chain management system are the necessary tools to assure the quality management. Cool chain

management was not the purpose of this study. However it must be mentioned that simple actions as an inspection if ice is present in the boxes at reception could improve the conditions. If no action is taken (re-icing of received boxes with only little ice and return of the salmon if the temperature at reception for instance is above 2°C), the condition will not be improved at all. The cost of improving quality by adding ice is nothing compared to the observed loss of quality by bad cool chain management.

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5.3 Prediction of shelf-life of fish by means of the Seafood Spoilage and Safety Predictor (SSSP)

The objective of this study is to predict the remaining shelf-life of fish by means of temperature profiles and the Seafood Spoilage and Safety Predictor (SSSP) (Danish Institute for Fisheries Research, 2005), and thereafter to evaluate the suitability of the SSSP-program to predict fish freshness, or the remaining shelf-life of fish, based on temperature profiles provided by a traceability system.

Temperature loggers were inserted into three cod immediately after they were caught in the North Sea. The loggers recorded the temperature of the fish every 5 minutes for 138 hours (5 days, 18 hours or 5.8 days). Thus, a temperature profile of the fish was

obtained from catch to retailer (Figure 1). The three fish were located in three different crates.

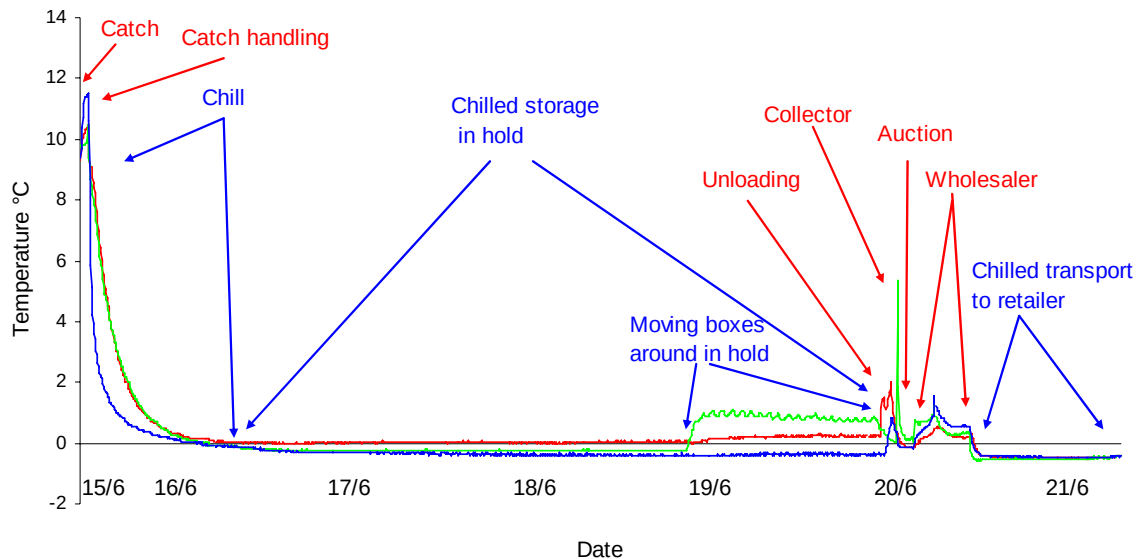


Figure 49. Temperature profile of cod in three different crates through the whole chain from fishing vessel to retailer (Frederiksen et al., 2002). Red curve = crate 1, green curve = crate 2, blue curve = crate 3.

The remaining shelf-life (RSL) as predicted by the SSSP-program's square-root spoilage model for fresh seafood from temperate waters is shown in Figures 50-52 for the fish from each of the three crates. Figure 53 shows the RSL of fish having a hypothetical temperature profile identical to the fish in crate 3 during chilling to 2°C (the first three hours), and thereafter having a constant temperature of 2°C for the rest of the 5.8 days. RSL-values read off the curves in Figures 50-53 are summarized in Table 26.

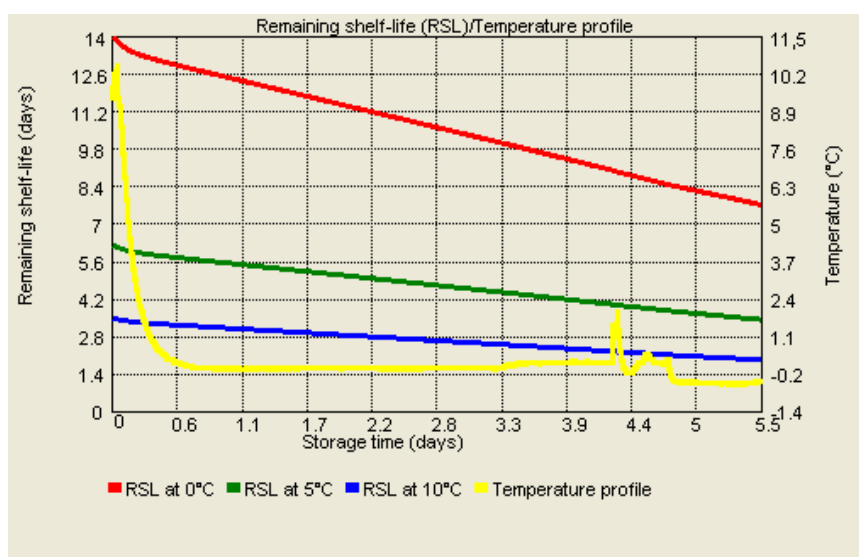


Figure 50. Remaining shelf-life and temperature profile of cod in crate 1.

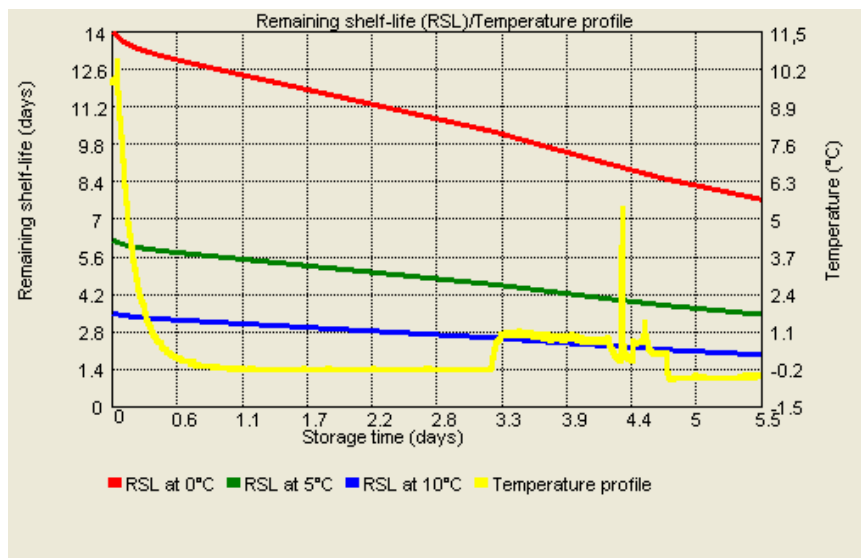


Figure 51. Remaining shelf-life and temperature profile of cod in crate 2.

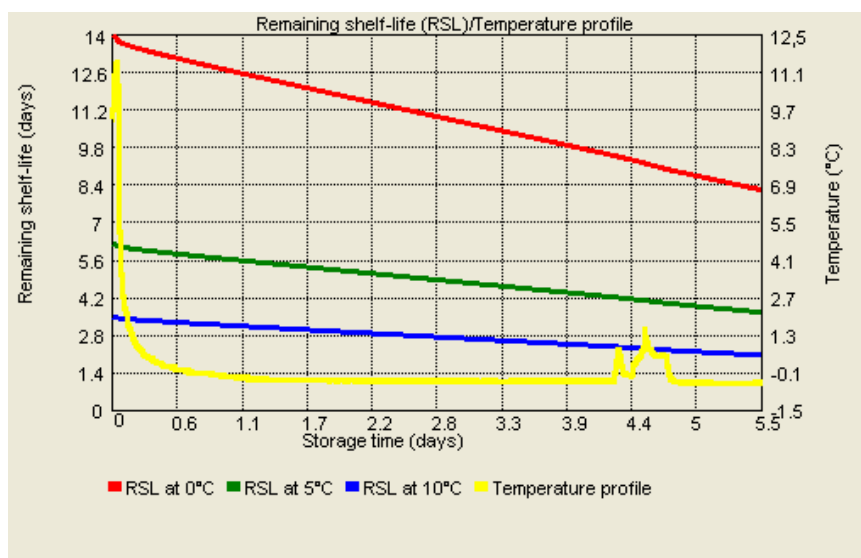


Figure 52. Remaining shelf-life and temperature profile of cod in crate 3.

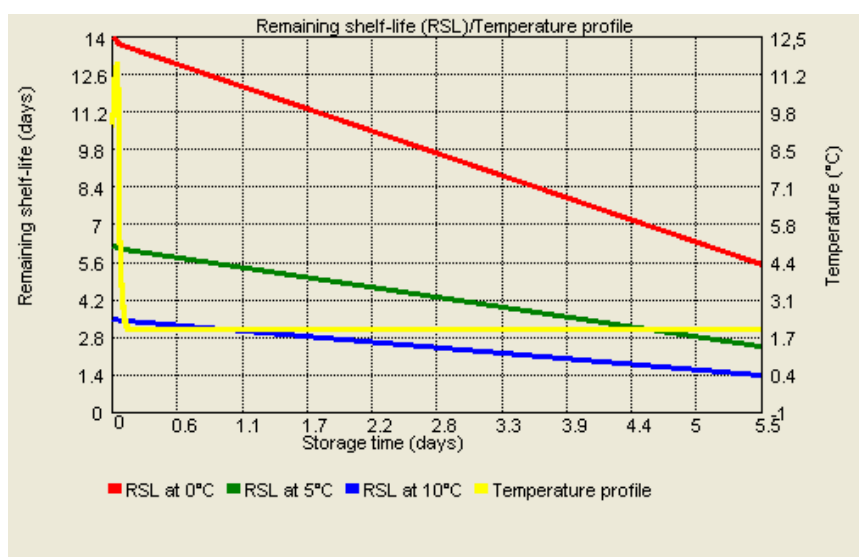


Figure 53. Remaining shelf-life and temperature profile of a hypothetical example, in which the fish has the same temperature profile during chilling (the first three hours) as the fish in crate 3, and thereafter has a constant temperature of 2°C.

Table 26. The remaining shelf-life (RSL) in days of cod from three different crates with the temperature profiles shown in Figure 49 and the RSL of a hypothetical example, in which the fish has the same temperature profile during chilling (the first three hours) as the fish in crate 3, and thereafter has a constant temperature of 2°C. The RSLs are read off Figures 50-53.

	Crate 1	Crate 2	Crate 3	2°C
RSL at 0°C after 1 day (24 hrs.)	12.5	12.5	12.7	12.4
RSL at 0°C after 5.8 days	7.7	7.8	8.2	5.5
RSL at 5°C after 5.8 days	3.4	3.4	3.7	2.5
RSL at 10°C after 5.8 days	1.9	1.9	2.1	1.4

In this study, the shelf-life of cod at 0°C is fixed at 14 days. Thus, subtracting the RSL from 14 days will give the time-temperature tolerance (TTT) or, in other words, the strain that the temperature profile over a certain time period has placed on the quality of the fish. The TTT is another way of interpreting the same data.

With a RSL of 8.2 days, the fish in crate 3 has the longest RSL at 0°C after 5.8 days among the fish in the three crates. As seen in Figure 49, the fish in crate 3 is chilled the quickest and maintains the lowest temperature in the hold. There is a difference of 0.5 days between the RSL at 0°C after 5.8 days of the fish in crate 1 and the fish in crate 3. This means that shelf-life corresponding to half a day-in-ice is lost. This half a day is made up of the following contributions: a TTT of 0.2 days from the first day of storage and a TTT of 0.3 days from the subsequent 4.8 days of storage. Thus, the temperature profile during the first day (ie. catch handling and chilling) has about the same influence on the RSL as the temperature profile during the next 4.8 days of storage (ie. chilled storage, sales and chilled transport).

The hypothetical temperature profile shown in Figure 53 is chosen to see if such a little increase in storage temperature has a measurable effect on the RSL of the fish. In addition, it is not unlikely to find such storage temperatures. As seen in Table 26, storage at 2°C strikingly reduces the RSL at 0°C after 5.8 days by a difference of about 2½ days compared to crates 1-3. It is thus economically wise to ensure that fish is stored at a temperature around 0°C.

The ideal RSL at 0°C after 5.8 days is $14 - 5.8 = 8.2$ days. This is also the RSL at 0°C after 5.8 days for the fish in crate 3, which means that the fish in crate 3 was handled almost “ideally.” The temperature deviations during handling of the fish around June 20 (Figure 49) thus do not have such a large influence on the RSL of the fish. A high temperature for a short time is not as important in keeping the cold chain intact as securing a low temperature for a long time.

As noted earlier, the variation of the RSL at 0°C after 5.8 days among the fish in the three crates is 0.5 days, which is within the accuracy of ± 1 day-in-ice of the QIM method (Jónsdóttir et al., 1993). Thus, in this study, using the temperature profile of just one fish to predict the RSL of the whole batch via the SSSP-program can be accomplished within the accuracy of the QIM method of predicting the RSL.

In conclusion, prediction of the RSLs of the three cod has been carried out using the SSSP-program, and this study has shown that it is suitable to use the SSSP-program to validate the product information on freshness provided by a traceability system when a temperature record is available.

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Part 2: MultiTask

Introduction

The role of the multi-disciplinary task force is to provide advice and guidelines on the implementation of chain traceability in the fish industry and to serve as liaisons to the many other ongoing national and international traceability efforts, projects and networks, both sectorial and general.

1 Objectives

1.1 Advice and guidelines for chain traceability

To provide advice and guidelines on the implementation of chain traceability in the fish industry so that functionality and granularity is comparable to that of the meat industry, and data content and quality is in a form that is suitable for quantitative risk analysis.

1.2 Liaisons to other projects in the field of traceability

To serve as liaisons to the many other ongoing national and international traceability efforts, projects and networks, both sectorial and general. The liaison role includes presenting work, results, recommendations and conclusions originating elsewhere in our forum, as well as presenting our Nordic work in other fora.

1.3 Harmonisation of work

To ensure harmonisation of work, shared knowledge and minimal duplication of efforts.

1.4 Use of experience from other foodstuff industries

Ensure that experience and current practice for traceability of other foodstuffs is taken into consideration when doing the implementation projects in the fish industry.

1.5 Dissemination of results of traceability work

Disseminate the pilot work done in the fields of traceability standardisation and electronic coding & transmission of traceability data in the fish chain to other foodstuff chains.

1.6 Risk analysis requirement

Ensure that risk analysis requirements for data availability, quality and accuracy are taken into consideration when doing the implementation projects in the fish industry.

1.7 Dissemination of new traceability data

The new traceability data that becomes available as a result of improved systems for chain traceability are made known to the risk analysis community, to form the possible basis of new or improved methods for risk assessment.

1.8 Web site

Setting up a web site where the task is to provide guidelines and advice for chain traceability to the sector, and to inform about ongoing national and international traceability efforts, projects and networks, both sectorial and general.

2 Progress towards objectives

The followed objectives are interconnected:

- Advice and guidelines on the implementation of chain traceability in the fish industry
- Liaisons to other projects in the field of traceability
- Harmonisation of work
- Use of experience from other foodstuff industries
- Dissemination of results of traceability work to other foodstuff chains
- Risk analysis requirement
- Dissemination of new traceability data

As these objectives are overlapping each other, they will not be separated into different tasks and deliverables. These objectives are fulfilled through conferences, presentations, surveys, workshops, meetings and training courses. In addition, the goal is to serve as liaisons to other projects in the field of traceability. The liaison role includes presenting work, results, recommendations and conclusions originating elsewhere in our forum, as well as presenting our work in other fora.

In the following, an overview will be given of the conference presentations, the surveys, the workshops, the meetings and the training courses relevant for IFSAT, followed by a description of the liaison role to other projects and initiatives. This section ends with a description of what has been done with the project's web site.

2.1 Conference presentations

Table 27. Overview of the conference presentations done in 2004.

Dates in 2004	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
October					
05.-06.10.2004	Seafood Plus 1st Conference, Copenhagen, Denmark. Title: "Choosing the works to have players in the traceability chain understand each other."	Conference participants	Europe	100	DIFRES, NIFA, SINTEF
14.10.2004	Traceability of seafood conference for the Faroe Islands, Torshavn, Faroe Islands. Title: "Traceability - competitive advantage for the Faroe Islands?"	Faroe Islands industry, government and research	Faroe Islands	30	NIFA
28.10.2004	"Integrating Safety and Nutrition Research along the Food Chain: the New Challenge" conference, Lille, France. Title: "The TraceFish project - Background, outcome and uptake of standards"	Conference participants	Europe	100	NIFA

Table 28. Overview of the conference presentations done in 2005.

Dates in 2005	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
February					
14.02.2005	Aquaculture Investor Conference, Swakopmund, Namibia. Title: "Traceability - market requirement or competitive advantage?"	Ministers, Officials, Investors, Seafood Industry	Namibia, Norway	80	NIFA
April					
18.-19.04.2005	TRACE 1 st Annual Conference, York, UK. Title: "Introduction to Traceability".	Scientists, Food Industry	Europe, Canada, US	120	NIFA, SINTEF
July					
24.06.2005	Norwegian-Japanese round table conference on Seafood safety research cooperation. Yokahoma, Japan. Title: "Traceability in the seafood sector".	Scientists	Japan, Norway	50	NIFA, SINTEF
October					
05.10.2005	Seafood Plus 2nd Conference, Granville, France. Titles: "RFID tags as technological traceability tools" and "Seafood traceability – information flow and information loss".	Research, industry, authorities	Europe	150	SINTEF, NIFA, DIFRES
23.10.2005	Traceability conference organized by Association of Greek Chemists, Athens, Greece Title: "Food traceability - in theory and in practice"	Chemists, Food Safety experts, Food Industry	Greece	50	NIFA
November					
06.-09.11.2005	50th Annual Atlantic Fisheries Technology Conference. 29th Annual Seafood Science and Technology Society of the Americas. Virginia, USA. Title: "Seafood Traceability Research within the European Union: An Overview of Present and Future Projects".	Researchers, Government, officials	USA, Denmark	200	DIFRES
December					
08.12.2005	"Food safety in a European perspective" - conference organized by Nordic Innovation Centre, Ski, Norway. Titles: "Integrating Food Safety and Traceability (IFSAT) ", "Introduction to the IFSAT program", "ChainTrace", "MultiTask", "Chain study".	Food Safety experts, Food Industry, Government	Nordic	100	DIFRES, NIFA, SINTEF, IFL

Table 29. Overview of the conference presentations done in 2006.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
January					
03/01/06	Biotrace workshop/seminar	Researchers	Europe	120	DIFRES
19/01/06	“Øresund Food Network” workshop/seminar	Researchers	Nordic	50	DIFRES
February					
27/02/06	Traceability course in Klaipeda, Lithuania workshop/seminar	Government industry and food Research	Lithuania	30	DIFRES
April					
24/04/06	“TRACE 2 nd Annual Meeting”, Prague, Czech Republic. Title: “Traceability – theory and practice.”	TRACE members, conference participants	Europe	100	NIFA
May					
09/05/06	AQUA 2006 in Florence	Researchers	World	80	DIFRES
June					
08/06/06	“Communicating Science and Technology” conference, Tromsø, Norway. Title: “Traceability – competitive advantage for food of the future”.	Science teachers	World	30	NIFA
August					
09/08/06	“Nor-Fishing Pressefrokost”, Trondheim, Norway. Title: “Sporbarhet som konkurransefortrinn for sjømat”.	Trade press journalists	Norway	20	NIFA
September					
11/09/06	Norwegian Supreme Court visit to Tromsø, Norway. Title: “Sporbar mat med lovlig opprinnelse”.	Supreme court of Norway	Norway	40	NIFA
20/09/06	“World Grains Summit -International Efforts to Guarantee Food Safety and Traceability” session, San Francisco, USA. Title: “Traceability models, systems and standards used for reducing systematic information loss in food chains”	US and international food (mainly grain) experts	US, others	80	NIFA
October					
05/10/06	“Value added Seafood” in London, Conference	Industry, research	Europe	150	DIFRES
05.-06.10.2006	WonderWorld 2006 , Conference in Stockholm Title of presentation : "Spårbarhet i livsmedelsindustrin, från krav till systemlösningar "	Conference participants	Scandinavia	200	SIK
November					
16/11/06	“International Coldwater Prawn Forum 2006”, London. UK. Title: “Traceability in the Coldwater Prawn Industry”.	Prawn industry, mainly	Europe, others	200	NIFA

		European.			
28/11/06	“Fisk2006” – Norwegian R&D conference for the fish industry, Tromsø, Norway. Title: “Sporbarhet som konkurransefortrinn”.	Fish industry, government, researchers.	Norway	200	NIFA
December					
13.12.2006	FAO/Danida conference	Government industry and food Research	World	60	DIFRES

Table 30. Overview of the conference presentations done in 2007.

Dates in 2007	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
February					
01.02.2007	International seafood trade: Challenges and opportunities Title: “Traceability – a necessary evil? “	Conference participants	Developing countries and Europe	100	IFL
08.02.2007	SigmaChain project meeting: Traceability definitions, drivers, projects, standards and challenges	Project participants	European	20	NIFA
March					
23.03.2007	Conference presentation at the European Fish & Seafood Conference 2007, London Title: “Seafood traceability to ensure consumer confidence	Food Research Industry	London	150	DIFRES
May					
29.05.2007	Conference presentation at the Polish fair 2007, Gdansk, Title: Seafood Traceability – monitoring seafood quality and packaging	Researchers Industry Government	Gdansk Poland	80	DIFRES
June					
05.06.2007	Conference presentation at the SEAFOODplus annual conference, Bilbao, Title: Utilisation of chain traceability – a possibility for SME’s to stay competitive in the future	Research Industry	Bilbao Spain	120	DIFRES

2.2 Surveys - Mapping the material- and information flow

The objective of the mapping is to ensure that the information loss in the chains from received raw materials and ingredients through production to shipping and consumption is minimal, and that the product can be traced both forwards and backwards through all links. Companies were visited and the process mapping study was carried out. The method "Analysis of traceability in food supply chains - Standard method" was used (Olsen, submitted). This method was developed for exactly this type of analysis. Reports describing material flow and information flow were produced, and these reports point out where information is lost in the current system, and recommend changes to existing routines and practices.

Table 31. Overview of the surveys – mapping the material- and information flow done in 2005.

Dates in 2005	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
May					
18.- 19.05.2005	TRACE Pilot Plant visit, Tolosa, Spain. Title: "Traceability of fish products - in theory and in practice"	Food industry and scientists	Ireland, Norway, Spain	8	NIFA
20.05.2005	Seafood Plus Pilot Plant visit, Bermeo, Spain. Title: "Traceability of fish products - in theory and in practice"	Seafood Industry	Spain	8	NIFA
September					
27.- 28.09.2005	TELOP TRACE Pilot Plant visit, Skagen, Denmark. Title: "Traceability of fish products - in theory and in practice"	Food Industry	Denmark, Norway	4	NIFA

Table 32. Overview of the surveys – mapping the material- and information flow done in 2006.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
April					
10-12/04/06	Traceability workshop at TRACE Pilot Plant, San Sebastian, Spain	Food industry and scientists	Ireland, Norway, Spain	8	NIFA

Table 33. Overview of the surveys – mapping the material- and information flow done in 2007.

Dates in 2007	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
June					
05.06.2007	“TRAINS Hvitfisk”, a Norwegian project. Analyse of traceability of fresh fish at Aker Seafood Baatsfjord AS, Norway	Seafood Industry	Norway	9	NIFA
12.06.2007	Analyse of traceability of meat at Aronmat AS, Norway	Food Industry	Norway	4	NIFA

2.3 Seminars

Table 34. Overview of the seminars done in 2004.

Dates in 2004	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
December					
01. and 04.12.2004	SEAQIP Traceability Seminar - Hanoi and Ho Chi Minh City, Vietnam. Titles: "Food traceability – what and why" and "Food traceability – how to implement using the TraceFish standards".	Seafood Industry, Officials	Vietnam	300	NIFA

Table 35. Overview of the seminars done in 2005.

Dates in 2005	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
May					
31.05.2005	Norway-Poland Food Safety Seminar. Warsaw, Poland. Title: "Traceability - Food safety tool and competitive advantage"	Food Industry	Norway, Poland	100	NIFA
July					
22.06.2005	Japanese fish traceability seminar, Tokyo, Japan. Title: "Tracefish: Traceability in the seafood sector in Norway".	Seafood Industry, scientists	Japan, Norway	350	SINTEF
November					
15.-16.11.2005	Confex-seminar: "Matvaretrygghet, merking-sporbarhet" – "Erfaringer fra sporbarhetsanalyser gjennomført i Norge og utlandet".	Food Industry, scientists	Norway	100	SINTEF

Table 36. Overview of the seminars done in 2006.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
February					
27.02.2006	Traceability course in Klaipeda, Lithuania workshop/seminar	Government industry and food Research	Lithuania	30	DIFRES

Table 37. Overview of the seminars done in 2007.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
January					
16.01.07	Seminar at Norwegian Fisheries Ministry. Presentation of traceability in general and the TraceFood Framework in particular	Government	Norway	12	SINTEF, NIFA
March					
08.03.07	Seminar for the Norwegian Meat industry (eTraceability project). Presentation of experiences from traceability implementation projects and European traceability projects	Industry	Norway	15	SINTEF, NIFA
14.03.07	Seminar for the Norwegian Food Inspection Service	Food inspectors	Norway	20	NIFA

2.4 Workshops

Table 38. Overview of the workshops done in 2005.

Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
April and May					
13.04.2005 and 10.05.2005	Norway-Serbia Traceability Workshop, Becej, Serbia. Titles: "Traceability – What, how and why?", "International Food Scandals", "New international legislation, retail requirements", " The Tracefish standards - a template for all food types", " Case surveys carried out int the Nordic countries", " Data capture, product marking and labelling".	Food Industry, Officials	Serbia	30	NIFA, SINTEF
September					
12.08.2005	TELOP Trace workshop, Trondheim, Norway. Titles:"Information about new demo-platform. New enhancements and possibilities in traceability systems", "Survey SSP", "Automatic data capture and temperature logging"	Food Industry, Scientists	German, Norway	25	NIFA, SINTEF
November					
02.-03.11.2005	Norwegian Traceability Workshop	Food Industry, Scientists	Norway	30	NIFA, SINTEF

Table 39. Overview of the workshops done in 2006.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
November					
24.11.2006	Traceability workshop	Industry	Denmark	14	DIFRES
December					
08.12.2006	Traceability workshop	Authorities/ Industry	Estonia	40	DIFRES

Table 40. Overview of the workshops done in 2007.

Dates in 2007	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
January					
25.01.2007	Traceability workshop	Industry	Denmark	12	DIFRES
May					
02.05.2007	MSC Chain of Custody (COC) Working Group. Title: "Traceability and IUU fishing"	Fish industry	UK, New Zealand, Norway, USA, France	22	NIFA

2.5 Meetings

Table 41. Overview of the meetings done in 2004.

Dates in 2004	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
July					
08.06.2004	Traceability meeting Kritsen Landivisiau, Brest, France, Title: "Traceability of fish products - in theory and in practice"	Kritsen representatives	France, Norway	5	NIFA
September					
15.09.2004	Traceability presentation to visiting Korean delegation, Tromsø, Norway. Title: "Traceability for fish products in general, the TraceFish standards in particular"	Korean delegation	Korea, Norway	10	NIFA
October					
03.10.2004	IFSAT meeting at 1st Seafood Plus conference, Copenhagen, Denmark. Title: "The MultiTask activity in IFSAT"	IFSAT group	Nordic	8	All partners in IFSAT
15.10.2004	Traceability meeting United Seafood, Torshavn, Faroe Islands. Title: "Traceability - competitive advantage for the Faroe Islands?"	United Seafood representatives	Faroe Islands	10	NIFA

Table 42. Overview of the meetings done in 2005.

Dates in 2005	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
January					
31.01.2005	Presentation at a industry meeting, vejle, Denmark	Industry	Denmark	50	DIFRES
February					
21-22.02.2005	A common IFSAT/Trace/Seafood plus meeting, Oslo, Norway. Title: "First meeting of Traceability Systems Group (TSG) in the TRACE Integrated Project"	Scientists, Food Industry	Iceland, Faroe Island, UK, Finland, Sweden, Norway	15	Partners in IFSAT
March					
09.03.2005	Presentation, Network meeting, invited speaker, Traceability in the food chain. Goteborg, Sweden	Researchers	Sweden	40	DIFRES
September					
09.-12.09.2005	Traceability presentation to visiting Korean and EU delegation during Akvanor 2005, Trondheim, Norway.	Korean and EU delegation	Korea, EU, Norway	15	SINTEF
28.09.2005	Traceability presentation to visiting Japanese NPO Aquam, Trondheim, Norway	Private company	Japan, Norway	8	NIFA, SINTEF
October					
06.10.2005	TRACE WP4/WP5 meeting, Granville, France	Partners in IFSAT and TRACE WP4/WP5	Denmark, Faroe Islands, Ireland, Iceland, The Netherlands, Norway, UK	12	DIFRES, IFL, JKF, NIFA, SINTEF
11.10.2005	Mattilsynet, open meeting: "Nasjonalt samarbeid om styrket matkjedeinformasjon". Presentation of results from traceability projects in the fish and meat industry.	Open meeting in Norway	Norway	30	SINTEF
22.10.2005	Scientific Committee meeting TRACE IP, Athens, Greece Title: "Status of the TRACE TSG"	Scientists and Industry	Belgium, Czech Rep., France, Germany, Greece, Ireland, Netherlands, Norway, UK	15	NIFA
27.10.2005	Kick-off meeting TRACE IP, Lille, France. Title: "TRACE Traceability	TRACE Scientific Committee	Belgium, Czech Rep., France,	15	NIFA

	Systems Group - Background, goals and activities"		Germany, Greece, Ireland, Netherlands, Norway, UK		
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Table 43. Overview of the meetings done in 2006.

Dates in 2006	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
January					
04.01.06	Presentation (TraceTracker). Title: Traceability in general	Industry	Norway	8	NIFA
11.01.06	Presentation for Nordic project IFSAT. Title: Traceability in general".	IFSATs participants	Denmark, Iceland, Sweden	5	SINTEF
February					
15.02.06	Presentation for Japanese delegation. Title: Traceability in general".	Food industry	Japan and Norway	8	SINTEF
March					
02.03.06	Presentation. Title: Traceability in general".	Industry	Norway	12	NIFA
06.03.06	Presentation. Title: Traceability in general".	Industry	Russia and Norway	12	NIFA
07.03.06	Presentation for Japanese delegation. Title: Traceability in general".	Food industry	Japan and Norway	7	SINTEF
08.03.06	Presentation. Title: Traceability in general".	Industry	Japan and Norway	4	NIFA
23.03.06	Presentation. Title: "Traceability in theory and in practice	Industry	German	4	NIFA
28.03.06	Presentation for Danish Meat Research Institute. Title: Traceability in general".	Research Institute	Denmark and Norway	10	SINTEF

Table 44. Overview of the meetings done in 2007.

Dates in 2007	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
February					
30/01/07	Presentation to National Standards Organization. International projects and standards for traceability of food	Industry	Norway	10	NIFA
February					
	IFSAT Project meeting, Denmark	Project participants	Skandinavia		IFSAT-Project participants
06/02/07	Presentation to Norwegian Department of Agriculture, Department of Fisheries and Food Safety Authority. International standardization work in the field of traceability	Government, industry and food research	Norway	40	NIFA
08/02/07	Presentation at SigmaChain project meeting. Traceability definitions, drivers, projects, standards and challenges	Industry and food research	France, Germany, Ireland, Italy, Netherlands, Norway, Poland	20	NIFA

2.6 Training courses

Table 45. Overview of the training courses done in 2004.

Dates in 2004	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
October					
25.10.2004	Eurofish traceability course, Burgas, Bulgaria. Title: "Traceability in the Fishery Industry."	Private companies, researchers, government officials	Bulgaria, Denmark	30	DIFRES

Table 46. Overview of the training courses done in 2005.

Dates in 2005	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
April					
18-21.04.2005	Presentation, Eurofish Traceability course in Braila, Rumania	Authorities and industry	Rumania	30	DIFRES
October					
17-21.10.2005	FAO-CIHEAM Traceability course in Zaragoza, Spain. Title: "Traceability of fish products: Technologies and management systems. The farmed salmon case."	Authorities and industry	Egypt, Cyprus, Algeria, Tunisia, Albania, Spain, Morocco, Italy, Croatia, France, Turkey	25	SINTEF

2.7 Liaisons to other projects in the field of traceability

One of the objectives of IFSAT is to serve as liaisons to the many other ongoing national and international traceability efforts, projects and networks, both sectorial and general. IFSAT has representatives from or liaisons to all the existing 6FP traceability IPs and other initiatives listed below, in particular through the PETER forum.

Table 47. Overview of other projects and initiatives with relationship to IFSAT.

AlcueFood	The overall objective is to establish, within the framework of the ALCUE S&T dialogue process, a permanent food quality and safety platform aiming to facilitate information development and sharing, promote a greater convergence in RTD and elaboration of food quality and safety policies, synergize technology transfer and trade and optimize the utilization of cooperation resources.
ChillOn	A 6FP Integrated Project (IP) in the process of being funded as a result of the 3 rd thematic call of the 'Food Quality and Safety' programme, topic 5.4.4.1 'Traceability processes along the production chain - Chilled and frozen supply chain'. The project has a major traceability component, and the topic text specifies that it should include

	<i>'sensors to register environmental factors, modern wireless transceiver technologies, spatial remote sensing platforms, data collection platforms, global navigation satellite systems, radio-frequency identification, open and scaleable software etc'.</i>
Co-extra	Co-Extra aims at developing comprehensive tools and methodologies and integrate them along with existing ones into embedded decision-support systems aimed at enabling co-existence between GM and non GM (conventional and organic) crops.
DNA-Track	The project concerns DNAs detection in raw materials and foods. Traceability of DNA tracts through the food chain will be studied. The project involves well-established methods based on PCR , advanced PCR methods real time PCR (RT-PCR) which allow precise quantitation, and new method development based on DNA microarrays. A new PNA-technology, actually aimed at biomedical diagnostics will be established as complementary to PCR, aimed at improving sensitivity, selectivity and increased detection limits in food. Validation of different methods will be performed, in order to provide updated criteria of choice in food control through the food chain.
FoodTrace	The primary objective is to develop this practical framework for Traceability of food and develop the means to plan, model, validate and implement. The framework must cover every aspect of traceability with the wellbeing of the consumer of paramount importance. It must be practical and worthwhile for businesses and the retail trade to implement and should be suitable for adoption by trading partners. The ultimate purpose of the framework is to support consumer enjoyment of a safe, diverse and high quality food supply.
GeoTraceAgri	The purpose of the GeoTraceAgri project is to define a methodology for the sampling, acquisition, utilization and processing of georeferenced data that will be used to generate agro-environmental indicators at various geographical scales.
GoodFood	The GoodFood Integrated Project, presented within the IST thematic area of EC VI FP, aims at developing an innovative tool based on MST/MNT and IST technologies for the full safety and quality assurance along the complete food chain in the agrofood industry.
GTIS-CAP	The aim of GTIS CAP is to define and to validate an integrated information system that will serve both the European and national administrative bodies in charge of the Common Agricultural Policy and the producers of vegetal products for consumers and for livestock. GTIS CAP will complete the IACS/LPIS data with other data obtained from remote sensing and will define simple geo-traceability indicators aimed at the management, control and monitoring of the CAP and which can also be used in integrated agricultural management systems.
Oliv-Track	The main objective of this project is to apply molecular technologies based on genomic and metabolic information to the traceability of origin and authenticity of olive oil produced and sold within the European Union. The purpose of this is to ensure the production of reliable quality olive oil for the consumers' health and confidence, to protect sustainable cultivation of olive trees and to authenticate their European region of origin.
PETER	The general objectives of PETER are to: - Provide an international forum for focussing and disseminating and exploitation EU research on food & feed traceability - Improve collaboration between European projects - Reduce potential duplication among ongoing projects - Maximise the effectiveness of project activities with reference to shared objectives and results - Create added value within PETER by providing information about gaps, redundancies and research needs after comparing the project complementarities - Achieve a higher level of dissemination and exploitation involving all projects (422 partners) through targeted stakeholder dissemination activities using a combination of dissemination vehicles (website, e-brochure, workshops, conferences and documents.)

Seafood Plus	A 6FP Integrated Project (IP) where the strategic objective is to reduce health problems and to increase well-being among European consumers by applying the benefits obtained through consumption of health promoting and safe seafood products of high eating quality. Seafood Plus has a major traceability component where the content-specific XML standards for seafood products are developed and extended, facilitating standard vocabulary for parameter values and automated translation between languages. There is no time or budget in Seafood Plus for a standardization process; only ad-hoc pilot implementations of traceability systems are planned. If TraceFood is funded, the implementations can be based on consensus-based standards, and the results and experiences will be significantly more reusable and relevant.
SigmaChain	SigmaChain objectives are to: - Develop a framework to identify and prioritise critical risks of the food chain regarding contamination with dangerous agents and substances. - Undertake a case study on chain mapping, its integrity and vulnerability, for four selected "high-risk" products; water, milk powder, poultry meat, farmed salmon. - Develop a risk model of the vulnerability of the chains to contamination; - Develop a protocol for the management of traceability and contamination vulnerability along the chains (particularly with respect to EU Regulation 178 (2002)) - Condense the outputs into a Stakeholders' Guide to the identification and management of contamination risks in the food and feed chains
TRACE	A 6FP Integrated Project (IP) where the objective is to improve the health and well-being of European citizens by delivering improved traceability of food products. TRACE also has a major traceability component where principles and guidelines both for generic traceability and for sector-specific traceability are formulated. TRACE only promise ad-hoc standards for the relevant chains (mineral water, honey, chicken, cereal, meat). If TraceFood is funded, the use of standards in TRACE can be harmonized with other initiatives, and the results and experiences will be significantly more reusable and relevant.
TraceBack	The strategic objectives of TRACEBACK are: 1. To improve the health and well-being of European citizens through the development of a traceability system, routinely applicable to all food productions, that will assure food safety and quality through the extension of tracing and tracking information to food parameters; 2. To increase consumer confidence in the food supply by developing new technological solutions for ensuring a trustworthy linkage between product flow and information flow along the entire food chain 3. To improve the competitiveness of the European food industries and small and medium-sized enterprises (SMEs) in the food sector
TraceFish	A 5FP Concerted Action, where a lot of the groundwork for standardized implementation of traceability in the seafood sector was done. TraceFish finished in 2003, and the tangible outcome was three European standards (CWA 14659, CWA 14660 and the TraceFish XML). The standards and general principles established in TraceFish have been proven sound, and now underlie many implementation projects. The sector-specific 'Good practice' recommendations formulated in TraceFood will be based on the principles in the CWA's, and the generic TraceFood XML core will be based on the core of the TraceFish XML.
TraceFood	An initiative from TRACE and Seafood Plus, supported by all the traceability projects under the PETER umbrella to develop a toolbox, and in particular a common electronic language that makes it easier to know where food products originate from and what has happened to them. TraceFood consists of principles, standards and methods for how to implement traceability in the food industry.

2.8 Web site

The web site www.ifsat.no was operational by the end of February 2006. On this web site you can get information about ongoing projects, laws and regulations about traceability, guidelines for implementing traceability, definition on traceability.

2.9 Other activities

Initiative has been taken within the IFSAT – MultiTask group to exchange and harmonize the use of some presentation materials. The common presentation materials have been made available on the web-site.

The IFSAT – MultiTask network has been used when formulating international traceability projects, to ensure or at least invite representation from the Nordic countries. In December 2006 the first call in the EU 7th Framework Programme was published, and the IFSAT network is being used to construct and expand consortiums relevant for participation in upcoming EU traceability projects.

3 Deliverables

The following are the deliverables of the MultiTask project:

- 3.1 At least one relevant external conference presentation of the project (in whole or in part) per task force member.
- 3.2 At least one relevant article (popular or scientific) describing the project (in whole or in part) per task force member country.
- 3.3 One annual report per project year where the task force activities and meetings are summarised. Particular emphasis is on documenting the advice given to the implementation efforts, to what degree it changed the decisions, and what the result was.

3.1 Conference presentations

See Section 2 Progress towards objectives.

3.2 Popular and scientific publications

A list of popular publications that have been published:

- Digre, H., Storøy, J. & Forås, E. (2004). Food law og sporbarhet – hva kreves?, Norwegian article. *Næringsmiddelindustrien*, 12:24-26. SINTEF Fisheries and Aquaculture, Norway.
- Karlsen, K.M. (2006). Myths and assertions about traceability. www.fiskeriforskning.no. 24.03.2006. Norwegian Institute of Fisheries and Research, Norway.
- Karlsen, K.M, Olsen, P., Storøy, J. (2006) Myter om sporbarhet. Norwegian article. *Matindustrien*, number 6, pp. 30-31.
- Olsen, P., Karlsen, K.M., Storøy, J. (2006). Data fra fjøs til fat. Norwegian article. *Dagens Næringsliv*. 20.03.2006. s. 4. Norwegian article. Norwegian Institute of Fisheries and Research, SINTEF Fisheries and Aquaculture, Norway.
- Senneset, G. & Forås, E. (2005). Hva er status for kjedesporbarhet i norsk fiskeindustri? Norwegian article. *Norsk sjømat*. 2:16-19. SINTEF Fisheries and Aquaculture, Norway.

A list of scientific publications that have been or are to be published:

- Arnarson, S.V. et al. (In prep., 2007) Interactions between traceability, food safety and enterprise resource planning systems – by combining the timeline approach and the concept of traceable units.
- Frederiksen, M., Larsen, E., and Børresen T. (2005). European traceability legislation in the context of seafoods. *The International Review of Food Science and Technology*

- Karlsen, K.M & Olsen, P. (In prep.). Traceability: Mapping the material- and information flow at a mineral water producer. Norwegian Institute of Fisheries and Research. Norway.
- Karlsen, M.K. and Senneset, G. (2006). "Traceability: Simulated recall of fish products". In: (Eds. J.B. Luten, C. Jacobsen, K. Bekaert, A. Sæbø, J. Oehlenschläger) *Seafood from fish to dish, Quality, safety and processing of wild and farmed fish*. ISBN 9086860052 Wageningen Academic Publishers.
- Olsen, (Submitted). "*Analysis of traceability in food supply chains, standard method*", Journal of supply chain management.
- Randrup, M., Storøy, J., Lievonen, S., Margeirsson, S., Árnason, S.V., í Ólavsstovu, D., Møller, S.F., & Frederiksen, M. (Submitted, 2007). Simulated recalls of fish products in five Nordic countries. Food Control.

3.3 Annual reports

- Annual report for IFSAT, 2004
- Annual report for IFSAT, 2005
- Annual report for IFSAT, 2006



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Nordic Innovation Centre

Nordic Innovation Centre

The Nordic Innovation Centre initiates and finances activities that enhance innovation collaboration and develop and maintain a smoothly functioning market in the Nordic region.

The Centre works primarily with small and medium-sized companies (SMEs) in the Nordic countries. Other important partners are those most closely involved with innovation and market surveillance, such as industrial organisations and interest groups, research institutions and public authorities.

The Nordic Innovation Centre is an institution under the Nordic Council of Ministers. Its secretariat is in Oslo.

For more information: www.nordicinnovation.net