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Report

Process mapping in the whitefish supply chain – analysis of information and material flow

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iProcess – WP4 Information Management

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Report

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ABSTRACT
The objective of WP4 in iProcess project is to develop information management strategies to support decision making by the food industry making them more profitable and resource efficient. This report presents the results from process mapping conducted in the whitefish industry to analyse the flow of information and material between the fishing vessels and processors. Process maps are developed for a whitefish processor, a seagoing vessel and a coastal vessel using the Event-based Process Modelling technique. This study provides several insights that are of great relevance for the industry. The most important findings are the lack of information exchange related to quality of fish between the fishing vessels and the processors as well as the lack of raw material inventory transparency between the processing plant locations for the same company. The results from this study will be used to develop data capture and information exchange strategies for the whitefish supply chain.

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1 Introduction

Information sharing is one of the main supply chain strategies for reducing uncertainty[1]. Information sharing plays a central role in supply chain collaboration and is vital for supply chain efficiency. Management of food supply chains are particularly complex due to an intrinsic focus on product quality[2]. Various motivation factors for supply chain information sharing are mentioned in the literature and include legislative requirements, efficient product recalls, optimization of business processes and product differentiation[3].

In recent years, several studies have been conducted on the value of information sharing in supply chains and its impact on supply chain performance. Sahin and Robinson (2005) studied the impact of information sharing and physical flow coordination in a make-to-order supply chain and found that information sharing reduces costs and the main economic benefit comes from coordinated decision-making[4]. Information systems in marketing are often well connected to the processing information systems or at least to the product inventory. However, when it comes to displaying marketing information from the other parts of the value chain, no such system is available in the seafood industry[5].

Information sharing and coordination between the buyer and vendor in the supply chain have been considered as useful strategies to remedy the so-called bullwhip effect and to improve supply chain performance. The debate is not about whether or not production information should be shared in the supply chain, but about how to share the right information at the right time in the right format by the right people under the right environment to maximize the mutual benefits of the supply chain as a whole as well as the individual business players.[6]

iProcess is a Research-driven project funded by the Research Council of Norway and is a joint effort between research institutes, food processing industry, and solution providers to enable increased raw material utilization and profitability for the Norwegian food industry. The objective of WP4 in iProcess is to develop information management strategies to support decision making by the food industry making them more profitable and resource efficient. Two industry cases are selected in WP4 – the whitefish case and the Cattle hide case. This report presents the results from process mapping conducted in the whitefish industry to analyse the flow of information and material between the fishing vessels and processors.

2 Objectives

The objective of the process mapping task is to describe the flow of information and material between the fishing vessels and the processor and to identify the data management systems that are used by

[1] Chaudhuri, A., Dukovska-Popovsk, I., Damgaard, C.M., Hvolby, H., 2014. Supply Uncertainty in Food Processing Supply Chain: Sources and Coping Strategies. IFIP Advances in Information and Communication Technology, September 2014.
[2] Luning, P.A., Marcelis, W.J., 2006. A techno-managerial approach in food quality management research Trends Food Sci. Technol., 17: pp. 378–385.
[3] Trienekens, J.H., Wognuma, P.M., Beulens, A.J.M., van der Vorst J.G.A.J., 2012. Transparency in complex dynamic food supply chains. *Advanced Engineering Informatics,* 26: 55–65.
[4] Sahin, F., Robinson Jr., E.P., 2005. Information sharing and coordination in make-to-order supply chains. *Journal of Operations Management* 23: 579-598.
[5] Margeirsson, S., Sigurdardottir S., 2010. Advances in the development and use of fish processing equipment. Use of value chain data. *Second International Congress on Seafood Technology on Sustainable, Innovative and Healthy Seafood.* FAO/The University of Alaska, 10-12 May 2010.
[6] Huang, G.Q., Lau, J.S.K., Mak, K.L. , 2003. "The impacts of sharing production information on supply chain dynamics: a review of the literature," International Journal of Production Research, 41(7), 1483-1517.

the different actors in the supply chain and the use of this information in the production planning decisions. The outcome of the process mapping task will form the basis for developing data capture and information exchange strategies in the whitefish supply chain.

3 Case Study

The whitefish chain between the catch and processor was analysed. Whitefish supply chains are complex in nature due to high supply uncertainty and rapid quality deterioration due to handling and temperature variations. In Norway, catch volumes for whitefish including cod, saithe and haddock amounted to 721 525 tonnes in 2014. This included 473 478 tonnes of cod with a value of approximately 520 million Euros[7]. Most wild cod is exported as lower-value products preserved in salted, dried, and frozen forms[8]. In-season whitefish processors typically buy from coastal vessels that deliver fresh fish and buy from sea-going vessels that deliver frozen fish. Figure 1 shows the typical whitefish chain from catch to the processor.

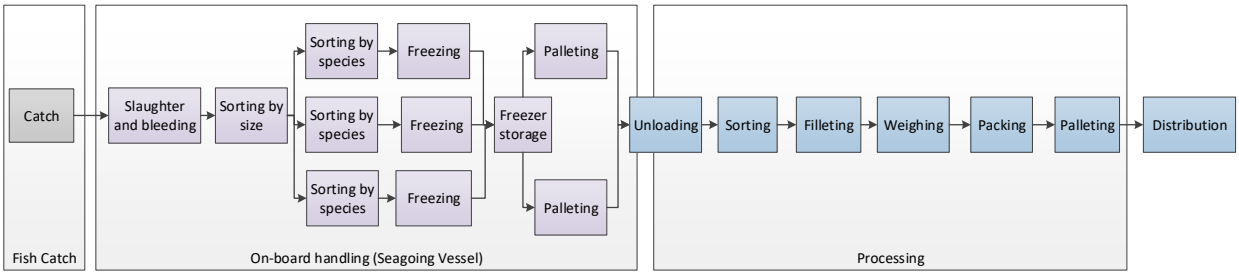


Figure 1. A typical whitefish chain from catch to processor

The first step in developing the information exchange strategies for whitefish supply chain is to develop the AS-IS model for material and information flows as well as the actors involved. This was done through semi-structured interviews and plant visits.

The following actors in a whitefish chain were interviewed in this study:

1. A large whitefish processor *(Processor)*
2. A fishing company using deep-sea trawlers *(Seagoing vessel)*
3. A coastal fishing vessel using long lines and gill nets *(Coastal vessel)*

The *processor* interviewed comprises of a large sourcing network purchasing fresh fish directly from fishermen with a total of 14 sourcing stations along the coast of Northern Norway. Their customers are leading retailing chains, foodservice providers and industrial clients in Europe, USA and Asia. In season, the company buys fish from local vessels while in off-season, they buy fish from a trawler company in Norway. In off-season, fish needs to be transported between company locations to meet production goals.

The *Seagoing vessel* in this study is one of the largest fishing companies in Norway that delivers frozen whitefish to processors all over the world. The company uses deep-sea trawlers for catching fish.

[7] https://www.ssb.no/en/jord-skog-jakt-og-fiskeri/statistikker/fiskeri
[8] Trondsen, 2012. Value chains, business conventions, and market adaptation: A comparative analysis of Norwegian and Icelandic fish exports. *The Canadian Geographer / Le G´eographe canadien* 2012, 56(4): 459–473

The *Coastal vessel* interviewed uses long lines and gill nets to catch fish. The company sells both fresh and frozen whitefish to buyers in Norway either through auctions or through direct contacts.

4 Methodology

In this study, the Event-driven Process Chains (EPC) technique is used to develop as AS-IS model of the whitefish processing chain depicting the current material and information flow practices. EPC is a process modelling technique used for modelling, analysing and redesigning business processes. The language is used to describe processes at the level of their business logic and to be easy to understand and use by end users. In addition, the same EPC models can be used for the requirements definition of an information system.

An EPC consists of the following elements:

- Functions: the basic building blocks are functions. A function corresponds to an activity (task and process step), which needs to be executed.
- Events: events describe the situation before and/or after a function is executed. Functions are linked by events. An event may correspond to the post-condition of one function and act as a pre-condition of another function.
- Control flows: A control flow connects functions, process paths or logical connectors creating a sequence and interdependencies.
- Logical connectors: connectors can be used to connect activities and events. In this way, the control flow is specified and they can be used to split the control flow from to two or more flows or to combine two or more flows into one control flow. There are three types of connectors: Λ (and), XOR (exclusive or) and V (or).
- Organization unit: Organization unit is used to describe which organization is responsible for a specific function.
- Information: Information refers to information, material or resources connected to a function.
- Information flow: Information flows show the connection between functions and input or output data.

The various EPC elements are described in Figure 2.

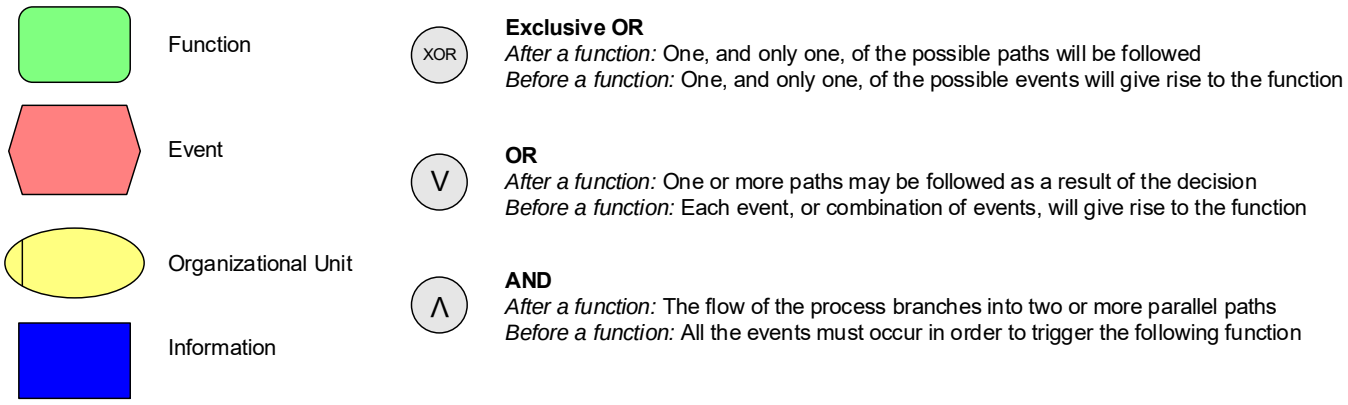


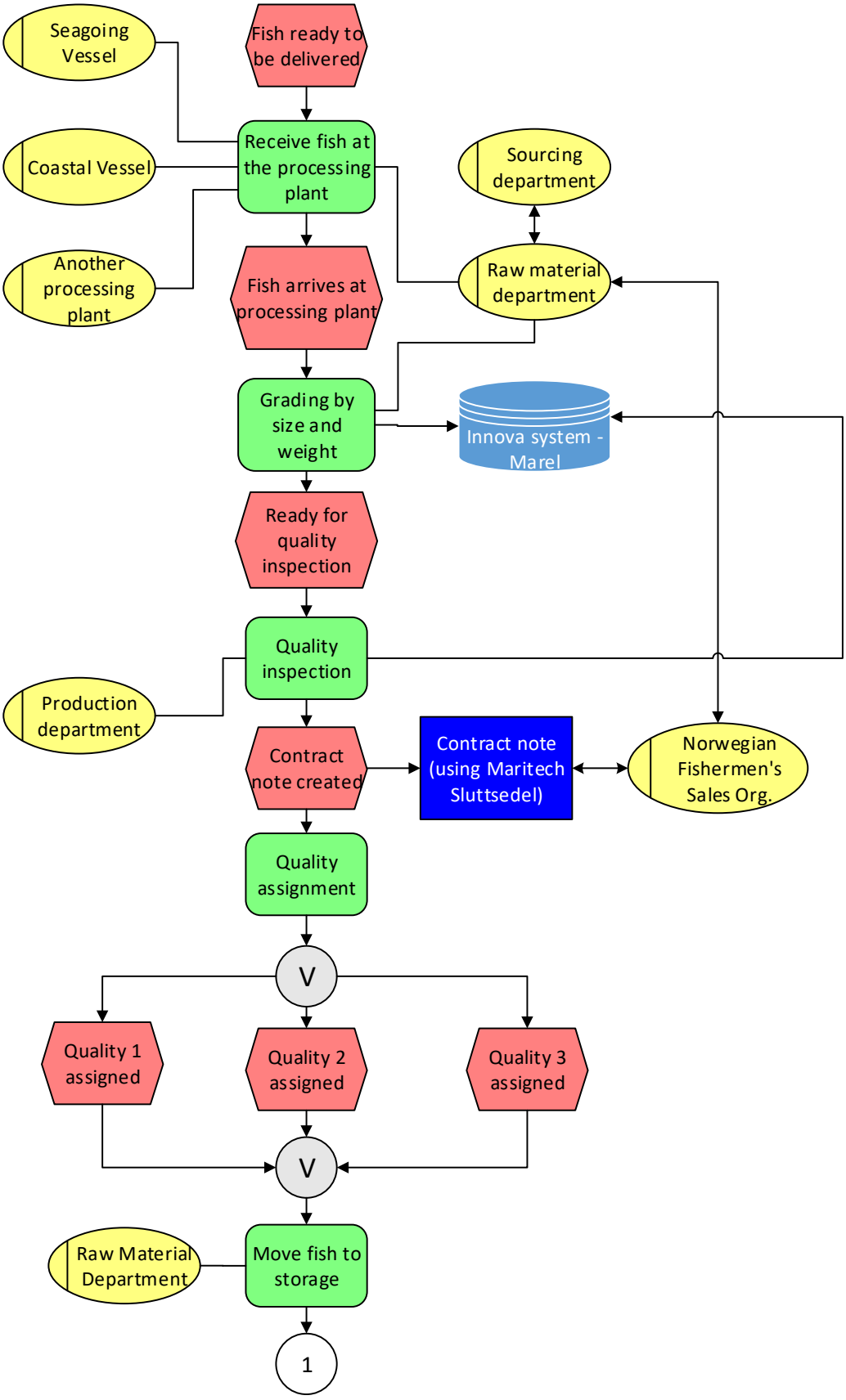
Figure 2. Elements of the Event-driven Process Chains

Microsoft Visio 2013 software was used to develop the EPC models for the whitefish *processor, seagoing vessel* and the *coastal vessel.*

5 EPC models

5.1 Flow of information and material at the *processor*

Figure 3 shows the flow of information and material at the *processor*. The first step in the supply chain is the catching process which is described in Figures 5 and 6. The first function at the *Processor* is to "*Receive fish at the processing plant".* In-season, the fish is mostly delivered by *Coastal Vessels* (fresh on the same day) while in off-season, the fish is delivered (mostly frozen) either by *Seagoing vessels* or transported from another processing plant of the same company. The Raw material department buys from the Sourcing department. Fish is graded by size and a contract note is created using the information from grading. This information is communicated to the Norwegian Fishermen's Sales Organization that communicates the catch information to Catch Certificate SA for issuing the catch certificate (shown in Figure 4). Various data management systems are used by the *Processor* and their details are provided in Table 1. Table 2 lists the data elements linked to different events in the Processing stage and their relevance.


Seagoing Vessel
Fish ready to be delivered
Coastal Vessel
Receive fish at the processing plant
Sourcing department
Another processing plant
Fish arrives at processing plant
Raw material department
Grading by size and weight
Innova system - Marel
Ready for quality inspection
Quality inspection
Production department
Contract note created
Contract note (using Maritech Sluttsedel)
Norwegian Fishermen's Sales Org.
Quality assignment
V
Quality 1 assigned
Quality 2 assigned
Quality 3 assigned
V
Raw Material Department
Move fish to storage
1

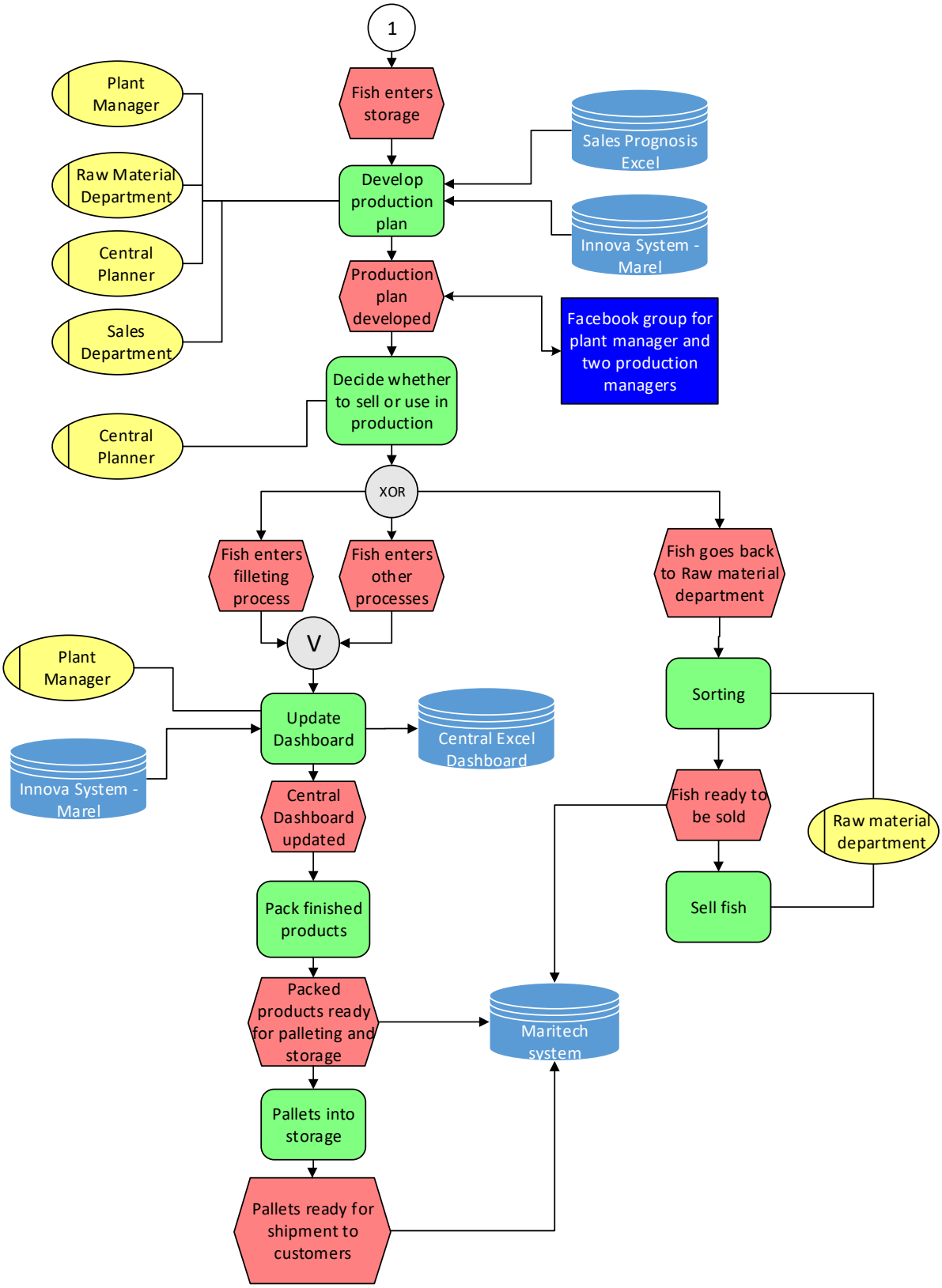


Figure 3. Information and material flow at the processor[9]

[9] This figure is valid for seagoing vessels and coastal vessels with the only exception that when buying from coastal vessels in season, heading and gutting is done by the processor as the coastal vessels deliver whole fish.

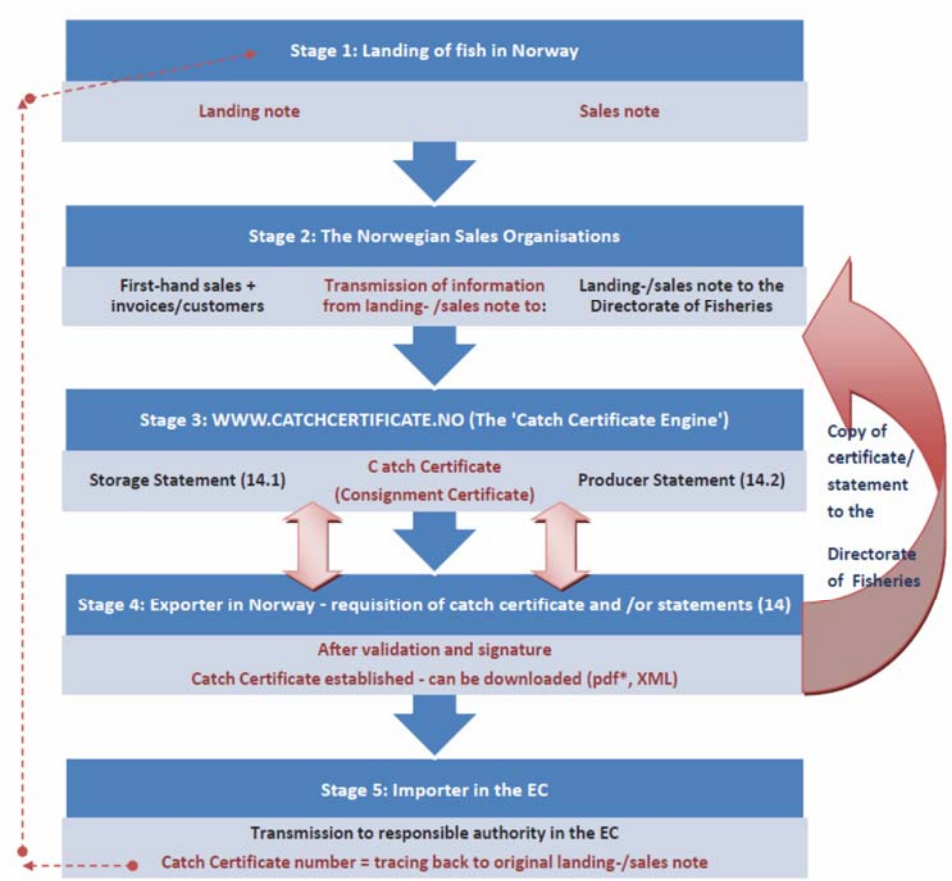


Figure 4. Information exchange between the Norwegian Sales Organization and Catch Certificate SA[10]

Table 1. Data management systems in use

Data management system	Application type	Purpose of use
Marel Innova[11]	Food processing software	Production control. All machines in the production line are connected to Marel system.
Maritech[12]	ERP system	Used for finished products inventory management
Central Dashboard	Excel	Managed by the Controller, it contains plans for all processing plants including raw material volumes (monthly and daily levels), yield by species, salary/kg/day, utilization of cutting line (kg/hour). Weekly reports are also generated through this dashboard. How much fish is sent into production is recorded in the dashboard
Sales Prognosis	Excel	Used by the sales department, central planner and the plant managers to develop the production plans
Facebook group	Closed group for internal plant level communication	Used by plant manager and two production managers to communicate production plans and any deviations

[10] https://www.regjeringen.no/globalassets/upload/fkd/vedlegg/diverse/2009/fangstsertifikat/09-12-17-flow-catch-certificate-200800408.pdf
[11] http://marel.com/innova
[12] http://www.maritech.no

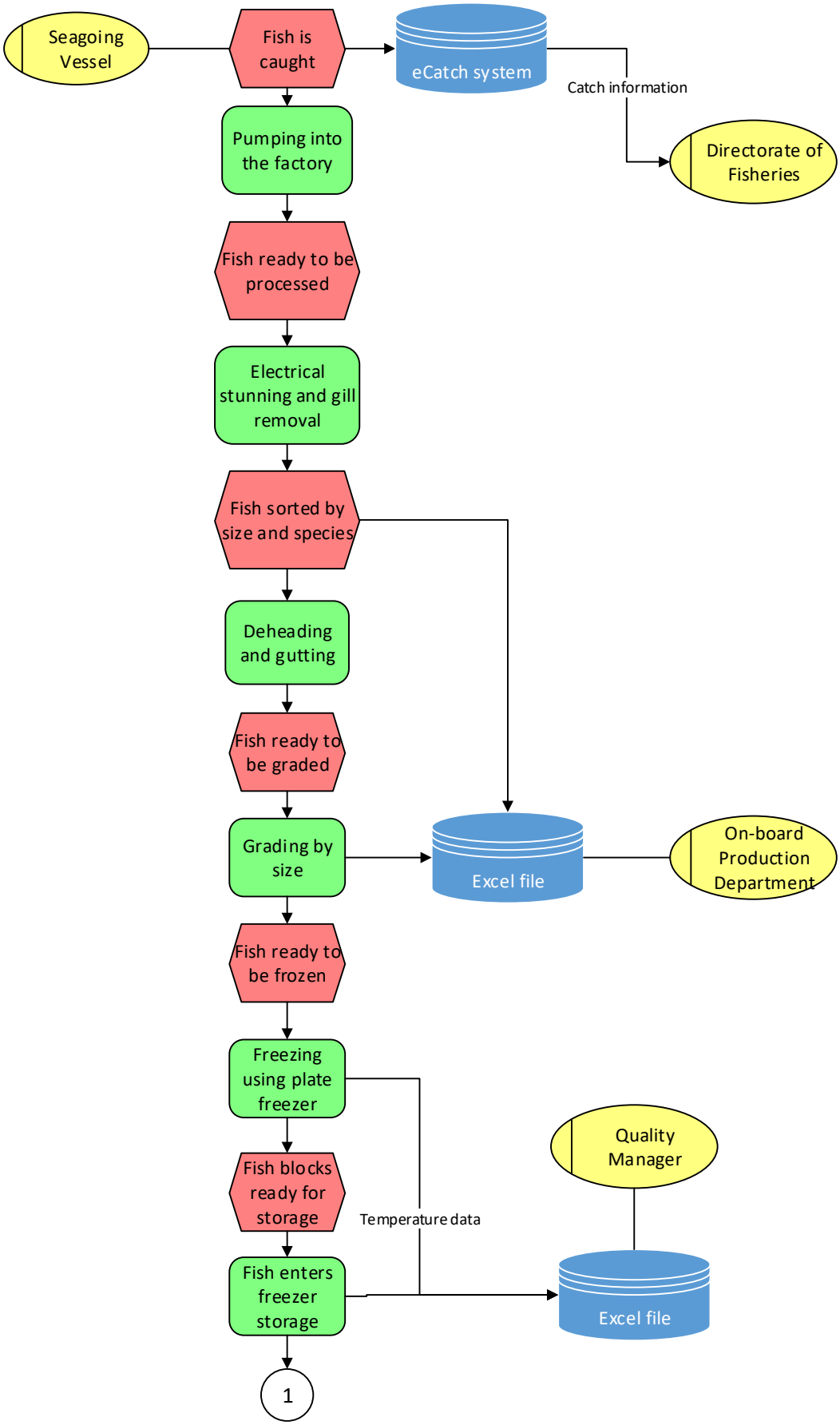
Table 2. Data elements linked to key events

Event	Linked data elements	System used	Relevance of data
Contract note created	Vessel ID, Vessel name, Fishing company name, Catch date, Catch area, Catch method, Landing date, Catch description (species, fresh/frozen, weight, size), Price	Norwegian Fishermen's Sales Organization	Used to create catch certificate and to pay the fishermen
Quality assigned	Batch ID, Date, Quality grade	Marel Innova	Used in production planning decisions
Central dashboard updated	Production data	Excel based central dashboard	Used for monitoring production
Packed products ready for palleting and storage	GTIN, Species, Catch area, Lot number, Size, Treatment, Quality, Preservation (fresh/frozen), Packing date, Best before date, Net weight, Box number, Pallet number, Catch method	Maritech	Used for communication to the buyers of finished products
Pallets ready for shipment to customers	SSCC, Pallet number, Order number, Species, Treatment, Size, Number of boxes, Weight per box	Maritech	Used for communication to the buyers of finished products and billing

5.2 Flow of material and information at *Seagoing Vessel*

Figure 5 shows the flow of information and material at the *Seagoing vessel*. The *Seagoing vessels* deliver frozen fish to land (processors/exporters). The vessel interviewed for this study uses the trawling method for catching whitefish. The company uses the eCatch[13] system on-board the fishing vessel for recording catch information and communicating it to the Norwegian and EU authorities (for export products). The eCatch system is accessible by the Sales department and the office in Norway. The company has direct contacts with buyers or can sell through auctions. Daily production reports are used to manage the on-board operations. The company also sells to buyers in Poland and China. Transportation to Poland takes 3-5 days while to China it takes 5-6 weeks.

[13] https://ecatch.no/


Seagoing Vessel
Fish is caught
eCatch system
Catch information
Directorate of Fisheries
Pumping into the factory
Fish ready to be processed
Electrical stunning and gill removal
Fish sorted by size and species
Deheading and gutting
Fish ready to be graded
Grading by size
Excel file
On-board Production Department
Fish ready to be frozen
Freezing using plate freezer
Quality Manager
Fish blocks ready for storage
Temperature data
Fish enters freezer storage
Excel file
1

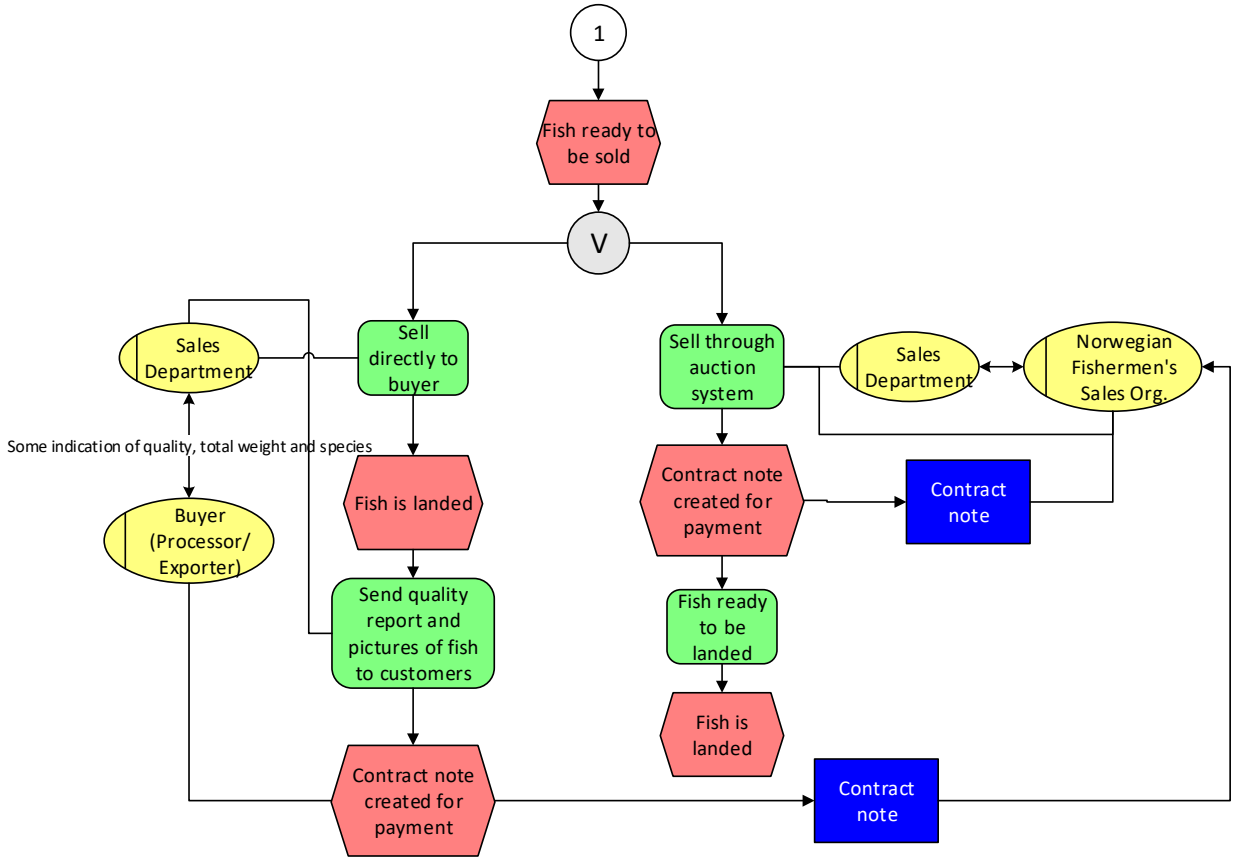


Figure 5. Information and material flow at the seagoing vessel

Table 3. Data management systems in use

Data management system	Application type	Purpose of use
eCatch	Electronic logbook, electronic reporting system and information system	Record catch information and communication to the Norwegian authorities (Norwegian Fishermen's Sales Organization)
Classification	Excel	Excel form used for allocation of catch into species and quality classes

Table 4. Data elements linked to key events

Event	Linked data elements	System used	Relevance of data
Catch	Vessel name, Trawling time, Species, Total weight, Catch area, Product condition, Trawling position (start and end)	eCatch	This information is provided to the Directorate of Fisheries. This information is also communicated to the Sales department on land.
Grading by size	Catch date, Percentage of catch in different grades	Excel	Used in the on-board production planning
Sorting by species	Catch date, Percentage of catch in different species	Excel	Used in production planning decisions
Freezing	Freezing duration, Temperature in Tank, Temperature of fish	Manual	Quality control

Freezer storage	Ambient temperature	Manual	Quality control

5.3 Flow of material and information at *Coastal Vessel*

Figure 6 shows the flow of information and material at the *Coastal vessel*. The *Coastal vessels* operate in season and deliver fresh fish to the land (processors/exporters). Some *Coastal vessels* have small on-board freezers that can be used to freeze fish before delivering it on land. The company interviewed in this study catches fish using long lines and gill nets and has an on-board freezer. Similar to the *Seagoing vessel*, the company uses the eCatch system on-board the fishing vessel for recording catch information and communicating it to the Norwegian and EU authorities (for export products). Fish is either stored fresh on-board for a couple of days if it is caught close to the buyers. Otherwise the fish is stored frozen for several weeks before delivering to the buyers. The company has direct contacts with buyers or can sell through auctions. Fresh fish can be sold directly to the buyers or in an auction while frozen fish is sold only by auction through the Norwegian Fishermen's Sales Organization. Fish is sorted into different sizes and species and are priced accordingly on landing.

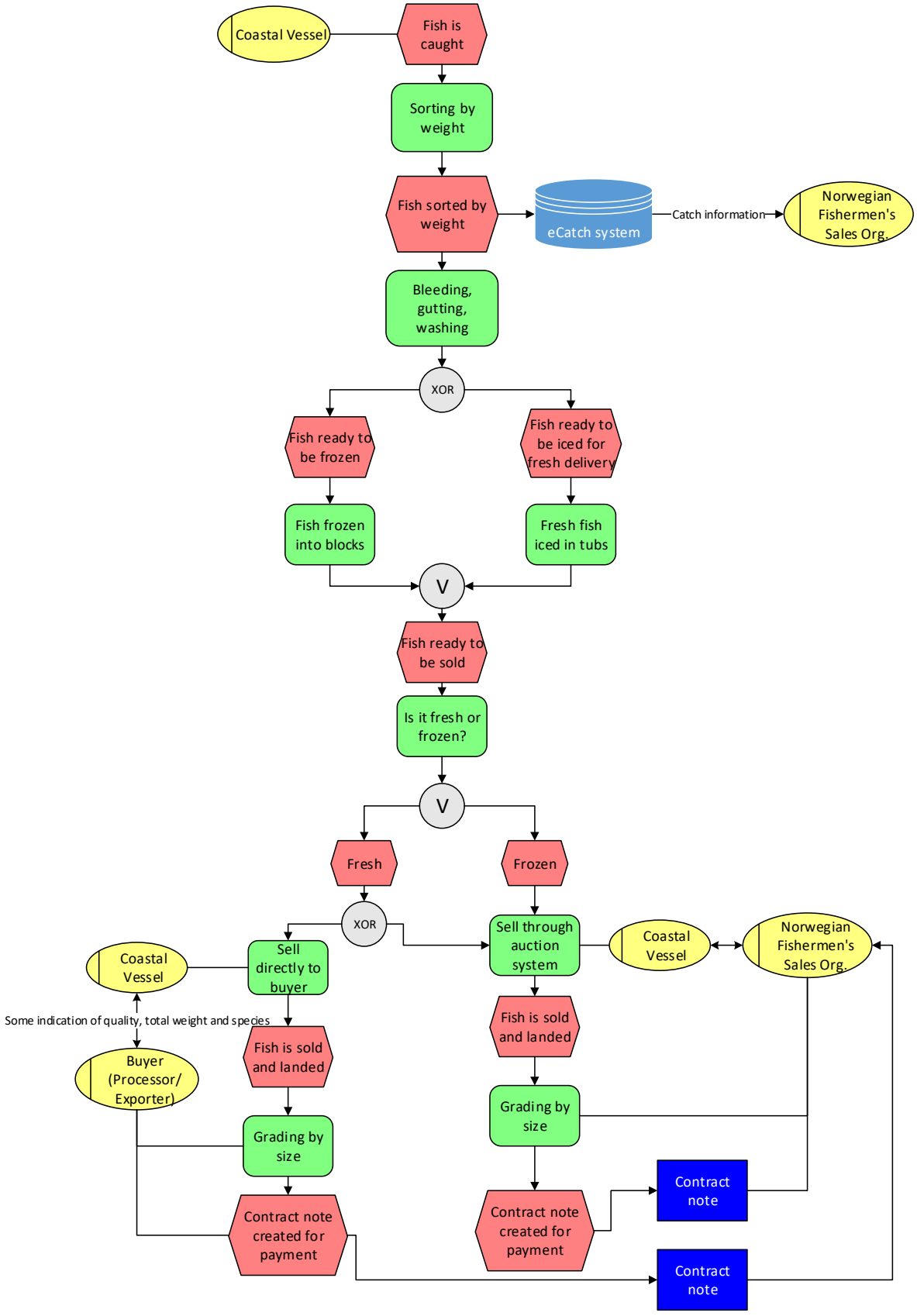


Figure 6. Information and material flow at the Coastal vessel

Table 5. Data management systems in use

Data management system	Application type	Purpose of use
eCatch	Electronic logbook, electronic reporting system and information system	Record catch information and communication to the Norwegian authorities (Norwegian Fishermen's Sales Organization)

Table 6. Data elements linked to different events

Event	Linked data elements	System used	Relevance of data
Fish is caught	Catch date, catch method, catch area, species, weight	eCatch	Used for communicating to the authorities and creating catch certificate
Fish sorted by weight	Weight group, weight, catch date	Manual	Used for communicating to the authorities
Contract note created (frozen and fresh)	Vessel ID, Vessel name, Fishing company name, Catch date, Catch area, Catch method, Landing date, Catch description (species, fresh/frozen, weight, size), Price	Norwegian Fishermen's Sales Organization	Used to create catch certificate and to pay the fisherman

6 Key Findings

6.1 Processor

As described in the previous sections, there are several data management systems in use by the processor. The Marel Innova system is used for production control and all machines in the production line are connected to the Marel system. An Excel based sales prognosis is used by the sales department and the central planner to develop production plans. The Central dashboard is used to record the production data from the time the raw material enters production. Maritech is the ERP system used for the finished goods inventory and customer billing. The following are the key findings related to information and material flow at the processor:

1. The Marel Innova and Maritech systems are not integrated.
2. Raw material inventory is not registered in a centralized system but only the *Raw Material Department* has an overview of how much is available at a given location. Each plant needs to store at least their three days requirement of the raw material. During off-season, raw material often needs to be transported between plant locations to keep the production running.
3. The grading information is sometimes used in production planning to determine which filleting machine to use.
4. The processor does not receive any quality information from the fishing vessel but only get an indication of total weight and estimated quality.
5. The decision of whether to sell the fish or put it in production is taken by the Central Planner based on the quality grade.

6.2 Seagoing vessel

eCatch is the primary system that is used on-board to record the catch data and communicate it to the Directorate of Fisheries. The following are the key findings related to information and material flow:

1. Catch date is the unique ID and there is no mixing of different catches on board.
2. The crew gets a quality report for each catch.
3. The sales office has access to the on-board production data and the eCatch system.
4. Upon landing, the quality report and pictures of fish are sent to the customers.
5. The company does not get a higher price for premium quality.
6. After landing, delays in transportation can occur and poor temperature management can affect the quality of fish.
7. Buyers in UK (haddock) are interested in additional product information such as exact catch location and handling practices.

6.3 Coastal vessel

Like the *Seagoing vessel*, eCatch is the primary system that is used on-board to record the catch data and communicate it to the authorities. The following are the key findings related to information and material flow:

1. Fish is not graded for quality on-board. However, the company is working continuously to have good handling practices on-board. Quality also depends on where the fish is caught. Most buyers can follow the vessel and see where it is and where the vessel has been fishing to know whether the quality is good or not based on previous experience.
2. Weight of individual fish are not recorded on-board
3. Currently, most buyers do not ask for additional catch or quality information but there is an increasing interest in knowing about the catch, handling methods and environmental factors such as fuel use and handling of by-catch.

7 Recommendations

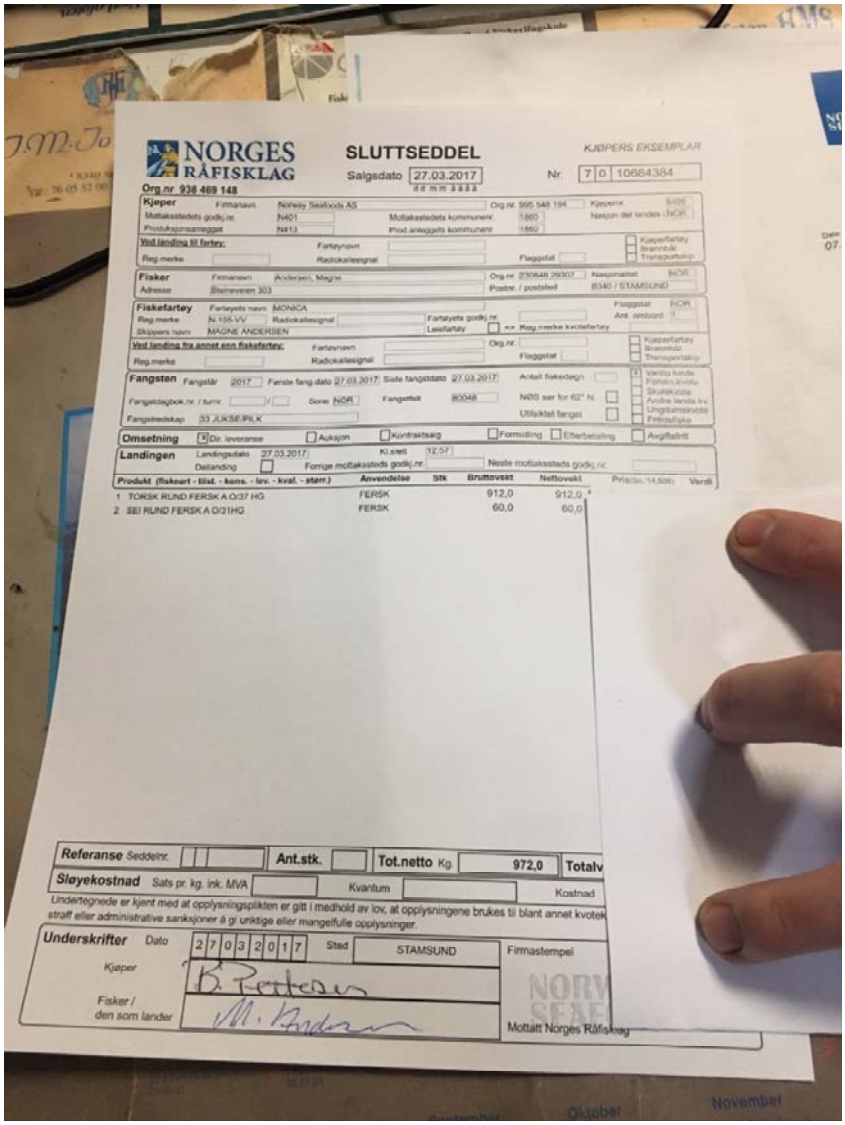
The process mapping in the whitefish supply chain provides a number of insights that are of great relevance for the industry. The most important finding is the lack of information exchange between the fishing vessels and the processors. In case of Seagoing vessels, the company interviewed in this study sent the quality report and pictures of fish to the customers. It would be relevant to install a control station on-board with a camera to take pictures as the fish goes through the production line and in combination with the temperature of fish during handling and storage can generate a quality report that can be used internally by the company for production optimization and for communication to the customers. The quality report can be linked to the Catch date which is used as the Unique ID and this information can be useful for tracking the quality linked to catch area, season and catch method.

From the processors perspective, if they have the quality information in advance, it is easier to determine what proportion of the catch can be used for fillet production which is their main business and what proportion should go for other products or should be sold without further processing. For the processor interviewed in this project, the raw material inventory status for different plant locations is not available, making coordination between locations very time consuming and inefficient. A real-

time raw material inventory system could be developed by tagging the tubs used to store the raw material which in turn would provide a transparent system for all locations and allow for efficient coordination. The information about quantity, grade and quality could also be linked to each tub.

A Appendix

Example of a Contract Note (Sluttsedel)



NORGES RÅFISKLAG

SLUTTSEDDEL

KJØPERS EKSEMPLAR

Salgsdato 27.03.2017 (d d m m å å å å)

Nr. 7 0 10684384

Org.nr. 938 469 148

Kjøper Firmanavn Norway Seafoods AS Org.nr. 995 548 194 Kjøpernr. 5495

Mottakestedets godkj.nr. N401 Mottakestedets kommunenr 1860 Nasjon det landes i NOR

Prod.anleggets godkj.nr. N413 Prod.anleggets kommunenr 1860

Ved landing til fartøy: Fartøynavn Flaggstat

Reg.merke Radiokallesignal

Fisker Firmanavn Andersen, Magne Org.nr. 270648 29307 Nasjonalitet NOR

Adresse Bleireveien 303 Postnr. / poststed 8340 / STAMSUND

Fiskefartøy Fartøyets navn MONICA Flaggstat NOR

Reg.merke N-155-VV Radiokallesignal Fartøyets godkj.nr. Ant. ombord 1

Skippers navn MAGNE ANDERSEN Leiefartøy Reg.merke kvotefartøy

Ved landing fra annet enn fiskefartøy: Fartøynavn Org.nr.

Reg.merke Radiokallesignal Flaggstat

Fangsten Fangstår 2017 Første fang.dato 27.03.2017 Siste fangstdato 27.03.2017 Antall fiskedøgn

Fangstdagbok.nr. / turnr. / Gone NOR Fangstfelt 80048 N05 sør for 62° N

Fangstredskap 33 JUKSE/PILK Ulovlig fangst

Omsetning Dir. leveranse Auksjon Kontraktsalg Formidling Etterbetaling Avgiftsfritt

Landingen Landingsdato 27.03.2017 Kl.slett 12:57

Deilanding Forrige mottakestedets godkj.nr. Neste mottakestedets godkj.nr.

Produkt (fiskeart - tilst. - kons. - lev. - kval. - størr.)	Anvendelse	Stk	Bruttovekt	Nettovekt	Pris(Bto./Nto.)	Verdi
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2 SEI RUND FERSK A O/21HG	FERSK		60,0	60,0		

Referanse Seddelnr. Ant.stk. Tot.netto Kg. 972,0 Totalv

Sløyekostnad Sats pr. kg. ink. MVA Kvantum Kostnad

Undertegnede er kjent med at opplysningsplikten er gitt i medhold av lov, at opplysningene brukes til blant annet kvotek straff eller administrative sanksjoner å gi uriktige eller mangelfulle opplysninger.

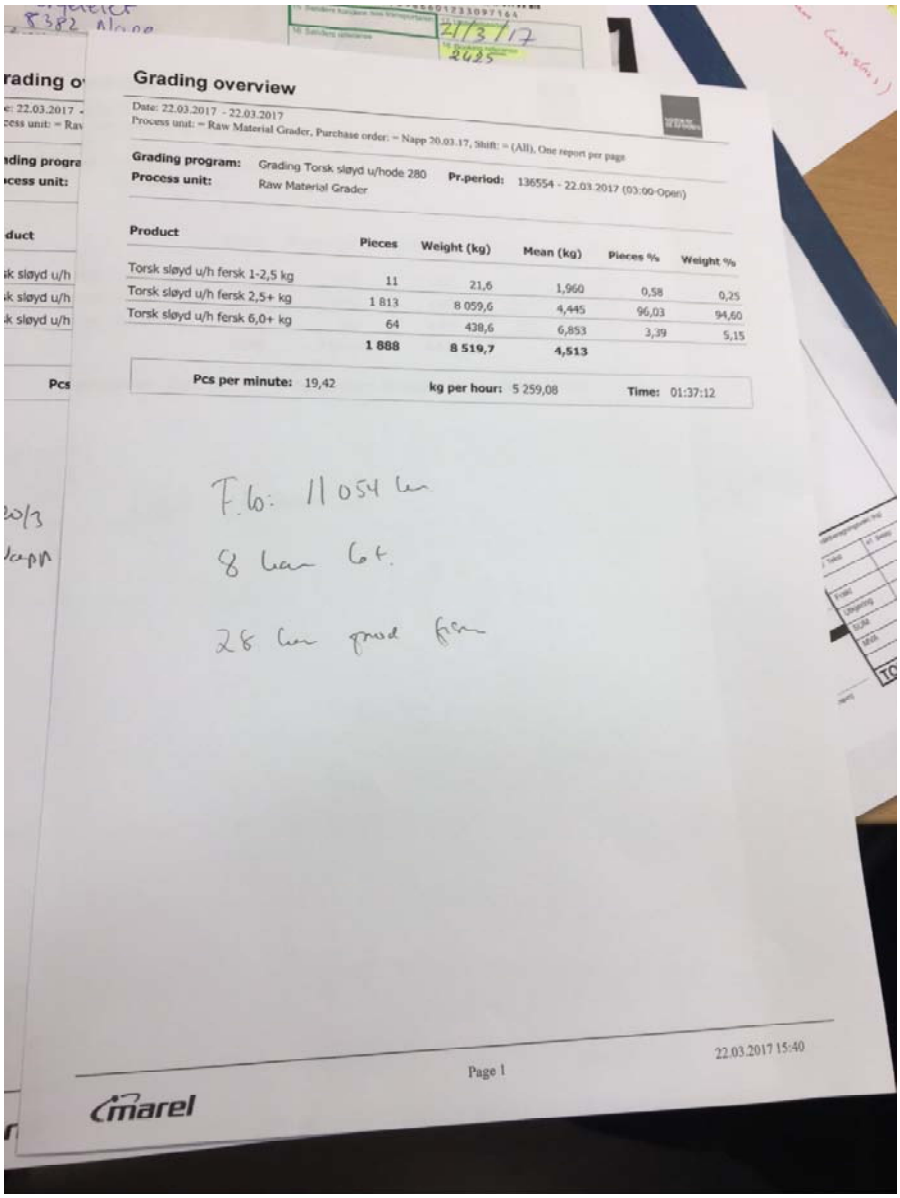
Underskrifter Dato 2 7 0 3 2 0 1 7 Sted STAMSUND Firmastempel

Kjøper

Fisker / den som lander

Mottatt Norges Råfisklag

Example of Grading Report from Marel



Grading overview

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Process unit: = Raw Material Grader, Purchase order: = Napp 20.03.17, Shift: = (All), One report per page

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Process unit: Raw Material Grader

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Torsk sløyd u/h fersk 2,5+ kg	1 813	8 059,6	4,445	96,03	94,60
Torsk sløyd u/h fersk 6,0+ kg	64	438,6	6,853	3,39	5,15
	1 888	**8 519,7**	**4,513**		

Pcs per minute: 19,42 **kg per hour:** 5 259,08 **Time:** 01:37:12

F.lo: 11 054 kr
8 kar Lt.
28 kar grad fisk

Page 1 22.03.2017 15:40

marel

Box label

Pallet Label

Example: Tracking of Contract Note

NORGES RÅFISKLAG

SALG AV FANGST | PRIS OG STATISTIKK | TJENESTER | OM OSS

Fisknytt | Statistikkbank | Minstepris | Ferskfiskordningen

Sporing seddelstatus

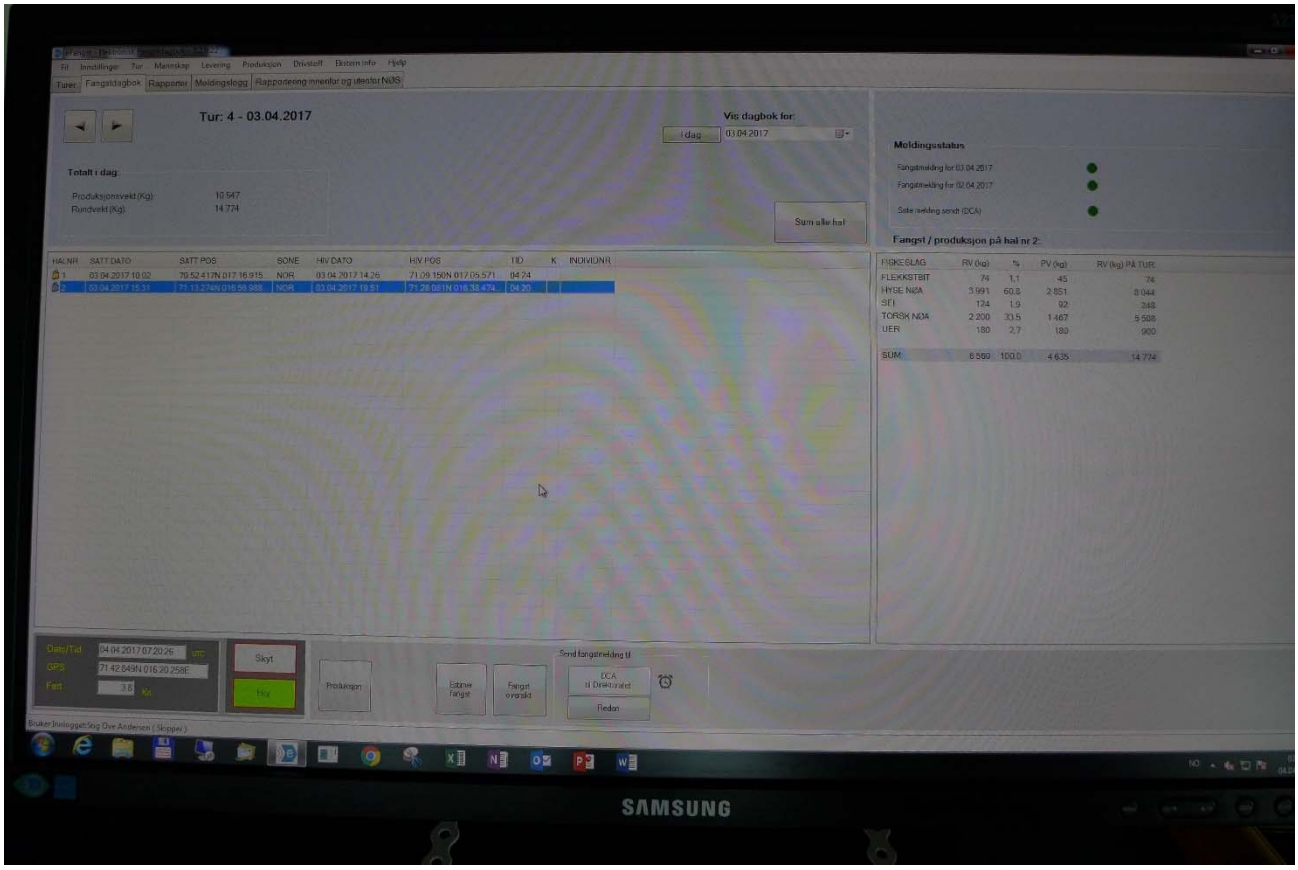
SEDDEL	TIDSPUNKT	TEKST	RESULTAT
70-10684384	27.03.2017 12:58	Seddel registrert i Råfisklagets seddelsystem (fangstdato 27-MAR-17 NOR)	Godkjent
	27.03.2017 13:02	Sendt til CatchCertificate	OK

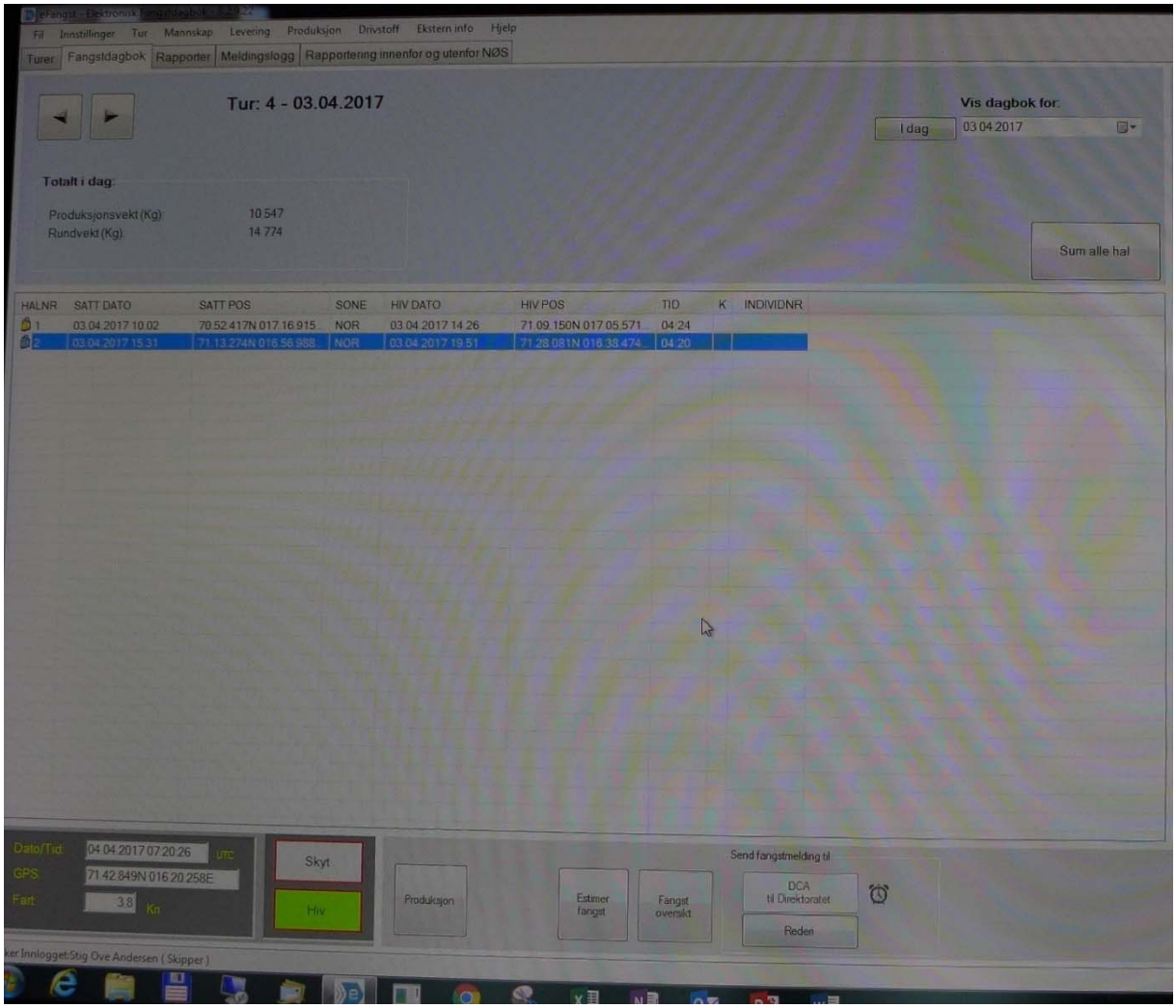
Oversikten over viser seddel dersom den er innsendt av kjøper og registrert hos Råfisklaget.

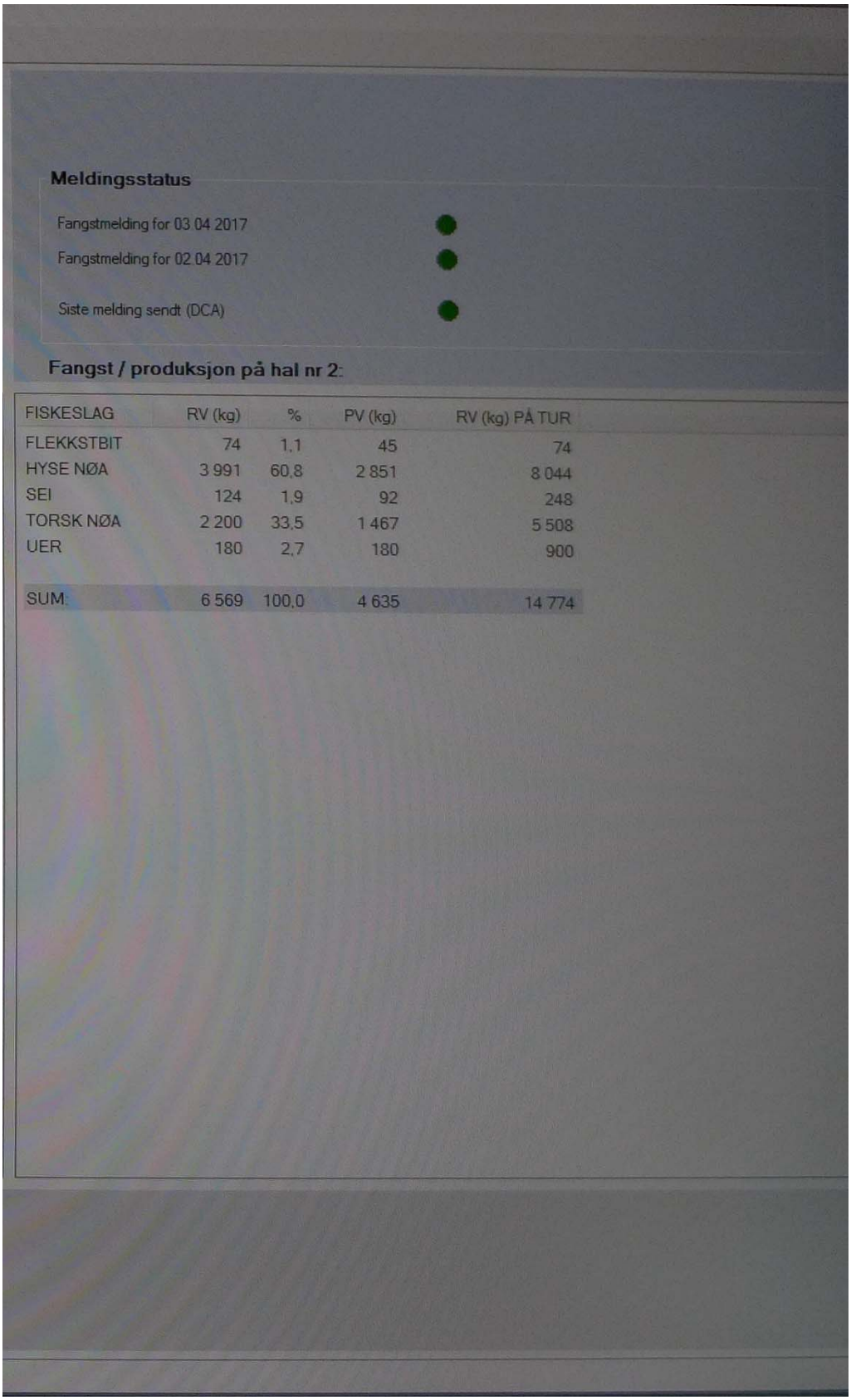
Før seddel kan sendes til Catchcertificate må den framkomme som:
Seddel registrert i Råfisklagets seddelsystem og med status Godkjent.

Fangstsertifikat kan kun utstedes på basis av sedler fra og med 2010 på norske fartøy.

Screenshot of the eCatch system




Fil Innstillinger Tur Mannskap Levering Produksjon Drivstoff Ekstern info Hjelp
Turer Fangstdagbok Rapporter Meldingslogg Rapportering innenfor og utenfor NØS
Tur: 4 - 03.04.2017
Vis dagbok for:
I dag
03.04.2017
Totalt i dag:
Produksjonsvekt (Kg) 10 547
Rundvekt (Kg) 14 774
Sum alle hal
HALNR SATT DATO SATT POS SONE HIV DATO HIV POS TID K INDIVIDNR
1 03.04.2017 10:02 70 52.417N 017 16.915 NOR 03.04.2017 14:26 71 09.150N 017 05.571 04:24
2 03.04.2017 15:31 71 13.274N 016 56.988 NOR 03.04.2017 19:51 71 28.081N 016 38.474 04:20
Dato/Tid: 04.04.2017 07:20:26 UTC
GPS: 71 42.849N 016 20.258E
Fart: 3.8 Kn
Skyt
Hiv
Produksjon
Estimer fangst
Fangst oversikt
Send fangstmelding til
DCA til Direktoratet
Reden
Innlogget:Stig Ove Andersen (Skipper)



Meldingsstatus

Fangstmelding for 03 04 2017

Fangstmelding for 02 04 2017

Siste melding sendt (DCA)

Fangst / produksjon på hal nr 2:

FISKESLAG	RV (kg)	%	PV (kg)	RV (kg) PÅ TUR
FLEKKSTBIT	74	1,1	45	74
HYSE NØA	3 991	60,8	2 851	8 044
SEI	124	1,9	92	248
TORSK NØA	2 200	33,5	1 467	5 508
UER	180	2,7	180	900
SUM	6 569	100,0	4 635	14 774

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