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New technology for the Nordic fishing fleet

Proceedings from a workshop on fishing gear and effective catch handling held in Reykjavik October 1st and 2nd 2013

Jónas R. Viðarsson
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Hanne Digre
Ulrik Jes Hansen
Leon Smith

Vinnsla, virðisaukning og eldi

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Report summary

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Titill / Title	**New technology for the Nordic fishing fleet** Proceedings from a workshop on fishing gear and effective catch handling held in Reykjavik October 1st and 2nd 2013		
Höfundar / Authors	Jónas R. Viðarsson[1], Ida Grong Aursand[2], Hanne Digre[2], Ulrik Jes Hansen[3] and Leon Smith[4]		
Skýrsla / Report no.	01-14	*Útgáfudagur / Date:*	January 2014
Verknr. / Project no.	(77)-2013		
Styrktaraðilar /Funding:	AG-fisk (*The Nordic Working group for fisheries co-operation*)		
Ágrip á íslensku:	Í þessari skýrslu eru birtar þær kynningar sem haldnar voru á Norrænum vinnufundi um veiðarfæri og aflameðferð, sem haldin var í Reykjavík í október 2013. Skýrslan inniheldur einnig nokkrar helstu niðurstöður fundarins og tillögur þátttakenda varðandi mögulega eftirfylgni. Kynningarnar sem birtar eru í skýrslunni, ásamt upptökum af öllum framsögum og ýmsu öðru efni er snýr að umfjöllunarefninu, má nálgast á vefsíðunni www.fishinggearnetwork.net, en þeirri síðu verður haldið við a.m.k. út árið 2015.		
Lykilorð á íslensku:	*Veiðarfærarannsóknir, aflameðferð, veiðar, vinnsla*		
Summary in English:	In this report are published presentations given at a Nordic workshop held in Reykjavik on various aspects of research and development on fishing gear and effective catch handling. The report also accounts for the main outputs from the workshop in regards to possible follow-ups. All of the proceedings, including the content of this report and video recordings of all presentations are available at the project's web-page www.fishinggearnetwork.net which will be maintained at least until the end of year 2015.		
English keywords:	*Fishing gear research, catch handling, fishing, processing*		

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Working Group for Fisheries Co-operation (AG-Fisk)

[1] Matís, Iceland
[2] Sintef, Norway
[3] Catch-fish, Denmark
[4] Havstovan, Faroe Islands

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1 Introduction

The workshop "New technology for the Nordic fishing fleet" held in Reykjavik, Iceland on October 1st and 2nd 2013 was a result of co-operation between Icelandic, Faroese and Norwegian scientific institutions. The idea behind the workshop was to bring together researchers, industry and those servicing the sector in one form or another to share information, knowledge and their views on various challenges facing the sector in regards to fishing gear development and effective catch handling issues.

In order to ensure that viewpoints of a wider range of audience would be taken into account when identifying the main focal points of the workshop and to suggest the most relevant presenters, a steering group was formed around the preparation of the workshop.

The steering group consisted of the following persons.

- Jónas R. Viðarsson – Matís, Iceland
- Hanne Digre – Sintef, Norway
- Ida Grong Aursand – Sintef, Norway
- Sigurjón Arason – Matís, Iceland (also on the board of AG-fisk)
- Leon Smith – Havstovan, Faroe Islands (also on the board of AG-fisk)
- Staffan Larson – Swedish cod fishermen's producer organisation, Sweden
- Haraldur Einarsson – Icelandic Marine Research Institute, Iceland

With such a diverse topic to address as fishing gear development and effective catch handling, the steering group was forced to choose only a small part of the topics and presenters that they would have liked to include. The presentations are though only a part of the output from the workshop, as the main objective of the project was to initiate networking within the sector and facilitate possible future co-operation. The steering group believes that the objectives have been reached. First steps have been taken in order to initiate co-operative projects among some of the participants, knowledge transfer and networking has been facilitated and important challenges identified.

The steering group would like to thank AG-fisk for making this workshop a reality.

2 Summary

This chapter contains a short summary of some main points and conclusions from the workshop. The intention is not to give exact minutes from the workshop's proceedings, but rather to highlight some interesting issues raised and feedback from participants. The slides presented during the lectures are presented in chapter 5 and recordings from the actual presentations are available at www.fishinggearnetwork.net.

The workshop agenda was broken up into four thematic sessions and the summation below will therefore be divided into corresponding sub-chapters and then finally the overall conclusions.

2.1 Selectiveness of fishing gear

There were five presentations given in a session devoted to selectiveness of fishing gear. Each contributing input for discussions on variety of issues related to improved selectiveness of fishing gear.

Jan Montin from X-chain systems in Sweden introduced a work he has been involved in with designing and testing of a new ecological selective and cost efficient cod trawl. The trawl has been tested in the Baltic Sea and the results are very promising, as they give opportunity for reducing bottom impacts, better fuel efficiency, better selectiveness and higher catch efficiency. A discard ban is to be imposed for the Baltic in 2015 and the STOP is confident that this trawl will contribute significantly to achieving those goals.

Eduardo Grimaldo from Sintef presented his research on selection in mid-water trawl fisheries for cod. He compared selectiveness and efficiency when using different types of selectivity measures, such as exit window panels, T90 cod-end and sorting grids. The results of his research highlight that application of sorting grids can have severe effects on water flow in the trawl, the selectiveness can be highly variable depending on catch rate and information given by catch sensors can be unreliable when the path of the catch is interrupted with a sorting grid. Dr. Grimaldo concluded therefore that application of exit window panels and T90 cod-ends were better suited to improve selectiveness in trawl fisheries, but also pointed out that a new four-panel grid has been designed that has several advantages over the existing two-panel grids.

Sigmar Guðbjörnsson from Star-Oddi introduced his work on designing the fish selector. The fish selector is a device that uses computer vision to identify and select fish inside a bottom trawl. The fish selector can then divert the catch either into the cod end or through an escape panel, based on how the device has been programmed i.e. what species and sizes are to be kept or released. Sigma's presentation gained considerable attention amongst the workshop participants, but the main obstacle in further development and marketing of the fish selector is affected by little demand for the product from Icelandic fishing companies and lack of available funding for further research and development from authorities. The Icelandic fishing companies are not too worried about by-catch, as it is not really a problem in Icelandic fisheries. The fishing companies are also hesitant in putting an 80 kg device onto a trawl, due to possible accidents when working with it in bad weather conditions.

It should be mentioned here that the fish selector was awarded the innovation reward at the Icelandic fisheries conference held in Reykjavík on November 21st and 22nd 2013. The reward suggests that the Icelandic fishing sector is interested in the potentials that the fish selector can potentially provide and the hope is that the device will be available in the future as a fully functional product.

Discussions at the workshop amongst participants were unanimous that the fish selector was an exciting initiative and that if it would be finished and marketed, there would be opportunities in marketing it in Europe. The European fishing sector is looking for alternatives to increase selectiveness of fishing gear, particularly to be able to meet new regulations connected to the reform of the CFP (Common Fisheries Policy), which has imposed a discard ban that is to take effect in the next few years.

Haraldur Árnason from Hampiðjan introduced the Dynex warp and its use in fishing. The Dynex warp has been in use in fisheries for many years now and has proven to reduce drag, safe fuel and have longer lifespan than the conventional steel wires. The Dynex warps are therefore cost efficient and environmentally friendly alternative.

Haraldur Einarsson from the Icelandic Marine Research Institute introduced his research on whether the design or the size of the trawl was affecting the cod-end selectivity in bottom trawl fisheries. His main results indicate that circumference within the trawl has a significant effect on selectivity and the design of the trawl is therefore just as important, or even more important, than using grids or T90 cod-end.

After the five presentations in this session had been presented, where workshop participants were given opportunity to ask questions, give comments and discuss further; the workshop participants were divided into six working groups, to discuss the thematic topic and come with some overall feedback. Each working group was afterwards asked to present their main findings and the outcome was then discussed in a plenary discussion.

The most commonly mentioned inputs were as follows:

- Increasing selectivity usually results in reduction of catch, which reduces profitability. This is why companies are generally reluctant in using tools that effect selectivity. In Nordic fisheries there are not many by-catch that can truly be classified as “unwanted”.
- Some gear that is intended to increase selectivity causes damage to the catch.
- R&D on selectiveness is expensive and funding for such initiatives is difficult.
- Regulations can be hindering, so there is often a need to simplify rules in order to be able to apply selective fishing gear as preferred by the fishing companies.
- Energy cost will automatically drive fishermen to change or develop gear so it will select the right catch with as low cost as possible.
- The discard ban in the CFP is likely to strengthen R&D in this field.

2.2 Environmental impacts of fishing gear

There were four presentations given in a session devoted to environmental impacts of fishing gear. Each contributing input for discussions on variety of issues related to the subject.

Staffan Larson from the Swedish cod fishermen's producer organisation (STPO) presented gear development from the industry perspective. Much of his presentation was on issues related to market demands for sustainable fisheries and changes in regulation i.e. reform of the CFP. Sweden is as part of the EU obligated to follow rules and regulations in the CFP and the pending discard ban has therefore motivated the STPO to award considerable attention to R&D in recent years. Swedish consumers are also very environmentally aware, which is why Swedish fishermen and producers have given eco-labels and other such initiatives great attention. Staffan concluded that Eco-labels should be looked at as opportunity for fishermen and there was no use in resist using eco-labels. They are demanded by the market and you have to meet the demands of the market.

Antonello Sala from CNR-ISMAR in Italy discussed fuel efficiency and fisheries' carbon footprint reduction. He has been working on profiling fuel use in the Italian fleet for many years and gave a good overview of fuel efficiency and how it can be reduced. Fuel prices have been rising and that is why fuel efficiency is not only an environmental issue, but also a cost issue. Having a good overview of fuel use and having equipment that gives opportunity to save fuel can have significant impact on fuel cost and the rate of return when buying fuel saving equipment can often be very short.

Ulrik Jes Hansen from Catch-fish in Denmark presented work that has been done on redesigning trawls and raising trawl doors so that they do not contact the seabed, in order to reduce fuel cost and environmental impact. He demonstrated that by using best available technology, including for example Dynema warps and Dynema trawls, T90, flymeshes, side panels and raised trawl doors it is possible to increase profitability in certain fisheries by up to 48% and that payback time in equipment can be measured in just few weeks.

Halla Jónsdóttir from Innovation Centre Iceland presented the light trawl, which is a concept she has been developing for some years now, where she uses light beams to heard fish into the trawl. The light trawl is still at a development phase, as the next steps will be awarded to testing the solution. If successful, the light trawl will reduce both fuel cost and environmental impact of demersal trawling.

After the four presentations in this session had been presented, where workshop participants were given opportunity to ask questions, give comments and discuss further; the workshop participants were divided into six working groups, to discuss the thematic topic and come with some overall feedback. Each working group was afterwards asked to present their main findings and the outcome was then discussed in a plenary discussion.

The most commonly mentioned inputs were as follows:

- Fuel cost has increased dramatically and that is the main driver in trying to increase fuel efficiency; rather than environmental concerns.
- The aim should be to the more valuable catch with the same amount of fuel.
- The fisheries industry representatives at the workshop commented that they have put a lot of effort into improving fuel efficiency. It has often returned good results, but not nearly the same kind of results as demonstrated in the Danish and Italian research.
- It should be kept in mind that 30% of the energy goes into processing on-board processing vessels, so there are opportunities to improve fuel efficiency in more categories than towing the gear.

2.3 Improving fishing gear to minimize cost and improve quality

There were four presentations given in a session devoted to Improving fishing gear to minimize cost and improve quality. Each contributing input for discussions on variety of issues related to the subject.

Kristjan Zachariassen from Vonin in the Faroe Islands gave a presentation on development on trawl technology, seen from a netmakers view. Netmakers at Vonin have devoted much of their efforts to increasing efficiency, reducing fuel consumption, improving selectivity and reducing bottom impacts. They have also aimed at having their solutions as user friendly as possible. They use simulation software's when designing the gear and then test the prototypes out in flume tanks. Today's gears are equipped with all kinds of equipment that allows the captains to monitor what is happening in the gear, but the equipment can be quite complicated to work with, which is why Vonin has emphasised that everything should be as user friendly as possible.

Daphné Deloof from ILVO in Belgium presented research that has been done in Belgium on effects of fishing gear on quality and how the Sequid device, which ILVO has been involved in developing, can be used to measure quality in an effective manner. The results from the research showed that the Sequid device was able to measure quality with good accuracy i.e. when comparing with TVB-N and QIM measurements. The results also showed that otter trawls give better quality catch then beam trawls and gillnets.

Jónas R. Viðarsson from Matís in Iceland gave a presentation on an ongoing project which is focusing on analysing and comparing coastal fisheries in the North-Atlantic. This is a project that Norwegian, Swedish, Danish, Faroese, Icelandic, Greenlandic and Canadian researchers are involved in. The purpose is to gather all kinds of information on the coastal sectors in these countries and to analyse the data so that fishermen and policy makers can compare the sectors and see if there are potentials to learn from each other.

Arne Tennøy from Mustad longline in Norway gave a presentation on innovative solutions that Mustad have been developing to minimize cost and improve quality. He featured the autoline systems that Mustad have been marketing i.e. the DeepSea system, the Coastal system and the SelectFish system. He also presented the OrcaSaver project and the Seabird Saver project, where they have been working on solutions to repel orcas and seabirds from eating bait and catch from the hooks.

After the four presentations in this session had been presented, where workshop participants were given opportunity to ask questions, give comments and discuss further; the workshop participants were divided into six working groups, to discuss the thematic topic and come with some overall feedback. Each working group was afterwards asked to present their main findings and the outcome was then discussed in a plenary discussion.

The most commonly mentioned inputs were as follows:

- The market is seldom prepared to pay a premium for quality above what is considered good quality i.e. if you have 80% quality you will probably not get higher price for raising the quality to 90%.
- Loyal customers are most important and they want constant quality.
- Captains need to get good information on what is happening in the trawl.
- Opportunities for Nordic producers are in traceability and telling the story behind the product.
- Correct handling, bleeding, chilling, freezing and thawing is a constant struggle that never ends.
- Fishermen should get educated more on proper handling and issues that affect quality.

2.4 Effective catch handling

There were six presentations given in a session devoted to effective catch handling. Each contributing input for discussions on variety of issues related to the subject.

Leif Grimsmo from Sintef presented work that he and his colleagues at Sintef have been working on regarding effective catch handling systems for cod, haddock and saith. They have been researching automatic stunning, bleeding and sorting systems for wild capture fisheries and automatic trimming lines for fillets. As a part of these research Sintef have also been studying electro-stunning of wild captured fish, which if successful will make all handling easier on the handling line. The work that Leif accounted for is still ongoing, but the results may have considerable impact for the Nordic fishing fleet if successful.

Hardi Hansen, which is the chief engineer on-board the Faroese pelagic vessel Finnur Fríði, presented the mackerel pump system that they have been developing. The concept is that by pumping the catch directly into the vessel during hauling will give the best quality catch possible. Finnur Fríði is one of three vessels from the company Varðinn involved in the fishery. Two other vessels tow the pelagic trawl and Finnur Friði follows right behind the cod-end where it pumps that catch on-board. This method has proven to give very good quality, as the fish is alive when coming aboard and is chilled extremely fast in the RSW tanks. When traditional trawling or purse seine methods that catch is all pumped aboard in a very short time, which makes it difficult to chill all the catch as efficiently as with this pumping method. Hardi though had to admit that it has been difficult to get price premiums for the catch, even though the superior quality can be proven.

Ida G. Aursand from Sintef presented research that she has been involved in where new concepts for gentle and effective catch handling and storage of pelagic fish on-board vessels have been explored. They have been developing and testing pumps that use negative pressure instead of blades, water separators with larger drainage area than currently used, cylindrical RSW tanks, automatic cleaning solutions for RSW tanks and automatic fish sampling and single fish weighing. Ida reported how all of these new concepts have been tested and what are the preliminary results, but overall the results are quite promising.

Sæmundur Elíasson from Matís presented researchers and equipment vendors had cooperated with the fishing company HB Grandi when redesigning the processing decks of Grandi's wetfish trawlers. The whole process from the time that fish is hauled aboard until it reaches the cold storage hold was optimised in order to achieve the best quality catch as possible. Three of Grandi's trawlers have now been modified according to the results of this work.

Jónas R. Viðarsson from Matís presented the Norwegian research project CRISP. Tommy Torvanger from Nergård had intended to give a presentation on Crisp, but had to cancel on last minute. Jónas therefore gave a very short overview of the project, but the project aims at developing technology for fish detection, classification and capture process monitoring; designing low-impact and selective fishing gears and finally to improve quality of catch and adding value.

Hans Van De Vis from IMARES in the Netherlands presented his work on electrical stunning and attempted to answer the question if it is a realistic alternative for wild capture fisheries. Electro-stunning is commonly used in aquaculture, but IMARES along with other researchers have been trying to adapt similar solutions for wild capture fisheries. The work is still at a research stage and a lot of challenges that need to be addressed, but if successful electro-stunning could be a realistic alternative for the sector.

After the six presentations in this session had been presented, where workshop participants were given opportunity to ask questions, give comments and discuss further; the workshop participants were divided into six working groups, to discuss the thematic topic and come with some overall feedback. Each working group was afterwards asked to present their main findings and the outcome was then discussed in a plenary discussion.

The most commonly mentioned inputs were as follows:

- Despite of all these innovative research and possible new solutions, the main problems are always the same i.e. coping with large quantity of catch and optimizing bleeding and chilling.

- Improving catch handling has to either reduce cost or increase revenues. It is often difficult to get price premium for "little bit" more quality.
- Quality is a task for the whole value chain. Effective catch handling is just the first stage. Good traceability and effective monitoring is an important factor to ensure that quality is maintained through the value chain.
- Avoiding bottle necks is a big challenge when optimizing on-board handling.

2.5 Wrap up and where do we go from here?

Last topic on the agenda of the workshop was to wrap up the inputs and results from all of the sessions and to explore potentials for future cooperation's. Many of the researchers and industry representatives decided to follow up on some ideas and some business relationships were established. It was also decided to explore possibilities for funding of international research and development projects. Some alternatives were suggested and all of the researchers at the workshop came to agreement to cooperate on exploring these possibilities. The main funding opportunities identified for first round were the following:

- Cost projects (European cooperation in science and technology) http://www.cost.eu/
- Martec-eranet http://www.martec-era.net
- Seas eranet http://www.seas-era.eu/np4/homepage.html
- Susfood eranet https://www.susfood-era.net/
- Nordic innovation – the Nordic Solved programme http://www.nordicinnovation.org/funding/the-nordic-solved-programme/#.UqFyC0Sf6m0.email
- Horizon 2020 SFS 9 call – Towards a gradual elimination of discards in European fisheries http://www.fishinggearnetwork.net/wp-content/uploads/2013/06/SFS-9-call-text.pdf.

Workshop participants were overall satisfied with the outcome of the workshop. State of art research was disseminated, knowledge from industry shared and relationships built for future cooperation. The organizers are confident that future work will be founded on the results of this workshop and it will lead to increased cooperation within the Nordic seafood sector.

3 Agenda

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Working Group for Fisheries Co-operation (AG-Fisk)

New technology for the Nordic fishing fleet

Fishing gear and effective catch handling

Workshop in Reykjavík, October 1st & 2nd 2013

October 1st

8:45	Registration and coffee
9:00	Welcome by Hörður Kristinsson, Research Director of Matís ohf
9:05	Welcome by AG-fisk, Leon Smith from Havstovan & AG
9:10	Welcome and "housekeeping" by Jonas R. Viðarsson, project coordinator

	Session 1: Selectiveness of fishing gear
9:20	**Development of a new ecological selective cod trawl for the Baltic** *Jan Montin from X-Chain System AB and STPO (Sweden)*
9:40	**Selection in the mid-water trawl fisheries for cod** *Dr. Eduardo Grimaldo from Sintef (Norway)*
10:00	**The Fish Selector - using computer vision to select what fish is diverted to the cod-end and what is released** - *Sigmar Guðbjörnsson from Star-Oddi (Iceland)*
10:20	**Dynex Warp and its use in fishing** *Haraldur Árnason from Hampiðjan (Iceland)*
10:40	**Are design or the size of the trawl affecting the cod-end selectivity?** *Haraldur Einarsson from Icelandic MRI (Iceland)*
11:00	Group discussions
11:30	Presentation and plenary discussions
12:15	**Lunch**

	Session 2: Environmental impacts of fishing gear
13:00	**Gear development for an industry driven fishery management – including challenges to develop harvest strategies to meet discard ban and eco-labelling.** *Staffan Larson from STPO (Sweden)*
13:20	**Fuel efficiency and fisheries' carbon footprint reduction** *Antonello Sala from CNR-ISMAR (Italy)*
13:40	**Redesign of trawls and raised doors in demersal trawling gives large reduction in environmental footprint** - *Ulrik Jes Hansen from CATch-Fish (Denmark)*
14:00	**The light trawl (using light to gather fish into trawl)** *Halla Jónsdóttir from Innovation Centre (Iceland)*
14:20	Group discussions
14:45	Presentation and plenary discussions

Working Group for Fisheries Co-operation (AG-Fisk)

	Session 3: Improve fishing gear to minimize cost and improve quality
15:20	**Developments on trawl technology – seen from netmaker's point of view** *Kristjan Zachariassen from Vonin Ltd. (Faroe Islands)*
15:40	**Effects of fishing gear on quality – the Seaquid project** *Daphné Deloof from ILVO (Belgium)*
16:00	**Introduction of the project "Coastal fishing in the N-Atlantic"** *Jónas R. Viðarsson from Matís (Iceland)*
16:20	**Autoline fisheries – investments in efficiency and quality** *Arne Tennøy from Mustad longline (Norway)*
16:40	Group discussions
17:15	Presentation and plenary discussions
18:00	Summing up

20:00 Project dinner at Hereford (see attached document)

October 2nd

	Session 4: Effective catch handling
9:00	**Effective catch handling systems for cod, haddock and Saithe** *Dr. Hanne Digre from SINTEF (Norway)*
9:20	**Pumping catch directly from trawl to vessel during haul. Experience from Faroese Mackerel fisheries** *Hardi Hansen from Varðin (Faroe Islands)*
9:40	**New concept for loading and unloading of pelagic catches based on under- and over-pressure** - *Dr. Ida G Aursand from SINTEF (Norway)*
10:00	**Bleeding technologies: Redesign of processing deck of HB Grandi's demersal wetfish trawlers to improve quality** - *Sæmundur Elíasson from Matís/Torfi Þorsteinsson from HB Grandi (Iceland)*
10:20	**The CRISP project and Nergård's future plans regarding on-board handling and processing** - *Tommy Torvanger from* Nergård AS *(Norway)*
10:40	**Electro stunning: Is it an alternative for wild capture fisheries?** *Hans Van De Vis from IMARES (Netherlands)*
11:00	Group discussions
11:30	Presentation and plenary discussions
12:15	**Lunch**
13:00	Wrap up
13:15	**Industry meets scientists** (participants are given the opportunity to have private meetings among each other)
15:00	**Finish**

Each group discussion will focus on:

- Pointing out the three most important challenges within each thematic area
- How can we solve or contribute to solving these challenges
- Possible project cooperation's and knowledge/technical transfer

4 List of attendees

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Working Group for Fisheries Co-operation (AG-Fisk)

New technology for the Nordic fishing fleet

Fishing gear and effective catch handling

Workshop in Reykjavík, October 1st & 2nd 2013

List of attendees

No.	Name	Company	Country
1	Daphné Deloof	ILVO	Belgium
2	Ulrik Jes Hansen	CATch-Fish	Denmark
3	Hardi Hansen	VARÐIN	Faroe Islands
4	Jóannes Mørkøre	KJ Hydraulik	Faroe Islands
5	Kristjan Zachariassen	VONIN	Faroe Islands
6	Leon Smith	Havstovan	Faroe Islands
7	Rúni Petersen	JT electric	Faroe Islands
8	Sigvald Jacobsen	VONIN	Faroe Islands
9	Andrias Lava Olsen	Royal Greenland	Greenland
10	Arnljótur B. Bergsson	Matís	Iceland
11	Atli Már Jósafatsson	Polar Fishing Gear	Iceland
12	Ásbjörn Jónsson	Matís	Iceland
13	Birkir Agnarsson	Ísfell	Iceland
14	Dagný Helgadóttir	MBA student	Iceland
15	Einar Hreinsson	Icelandic Marine Research Institute	Iceland
16	Friðrik Þór Ingvaldsson	Veiðafæragerð Skinneyjar-Þinganess hf.	Iceland
17	Geir Guðmundsson	Innovation Centre Iceland	Iceland
18	Gunnar Þórðarson	Matís	Iceland
19	Halla Jónsdóttir	Innovation Centre Iceland	Iceland
20	Haraldur Árnason	Hampiðjan	Iceland
21	Haraldur Einarsson	Icelandic Marine Research Institute	Iceland
22	Hörður G. Kristinsson	Matís	Iceland
23	Jón Á Grétarsson	Hampiðjan	Iceland
24	Jón Árnason	Matís	Iceland
25	Jónas R. Viðarsson	Matís	Iceland
26	Jónas Þór Friðriksson	Ísfell	Iceland
27	Kristinn Tómasson	MBA student	Iceland
28	Magnea Karlsdóttir	Matís	Iceland
29	Magnús V. Gíslason	Matís	Iceland
30	Paulina Elzibieta Romotowska	Matís	Iceland
31	Sigmar Guðbjörnsson	Star-Oddi	Iceland
32	Sigurjón Arason	Matís	Iceland

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33	Steindór Gunnarsson	MBA student	Iceland
34	Steindór Sverrisson	HB Grandi	Iceland
35	Svanur Valdimarsson	Polar Fishing Gear	Iceland
36	Sæmundur Elíasson	Matís	Iceland
37	Valdimar Ingi Gunnarsson	Sjávarútvegsþjónustan	Iceland
38	Valur N. Gunnlaugsson	Matís	Iceland
39	Antonello Sala	CNR	Italy
40	Hans Van De Vis	IMARES	Netherlands
41	Arne Tennøy	MUSTAD	Norway
42	Gro Tollefsrud Fjeld	MUSTAD	Norway
43	Ida Aursand	SINTEF	Norway
44	Leif Grimsmo	SINTEF	Norway
45	Bengt Kåmark	Swedish Agency for Marine and Water Mgt.	Sweden
46	Jan Montin	STPO / X-chain System AB	Sweden
47	Nils Olav Borghed	STPO / X-chain System AB	Sweden
48	Staffan Larson	STPO	Sweden

Registered but did not show/cancelled

1	Bjarni Áskelsson	RSF - the Icelandic fish auctions	Iceland
2	Einar Bjargmundsson	HB Grandi	Iceland
3	Guðrún Pálsdóttir	MBA student	Iceland
4	Hafsteinn Ólafsson	Beitir	Iceland
5	Loftur B. Gíslason	HB Grandi	Iceland
6	Torfi Þorsteinsson	HB Grandi	Iceland
7	Þóra Bragadóttir	Beitir	Iceland
8	Hanne Digre	SINTEF	Norway
9	Tommy Torvanger	Nergård	Norway

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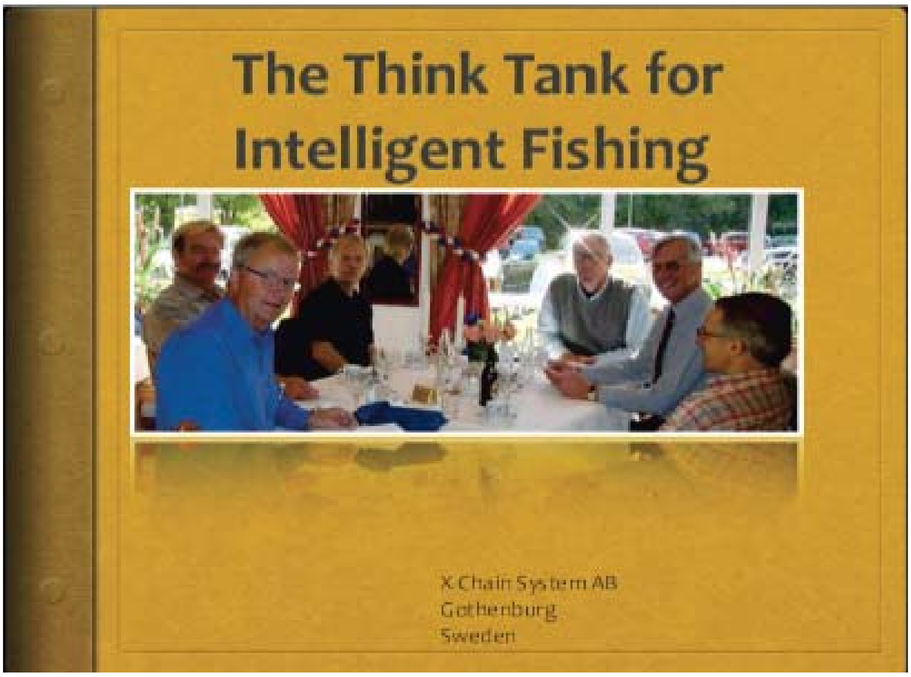
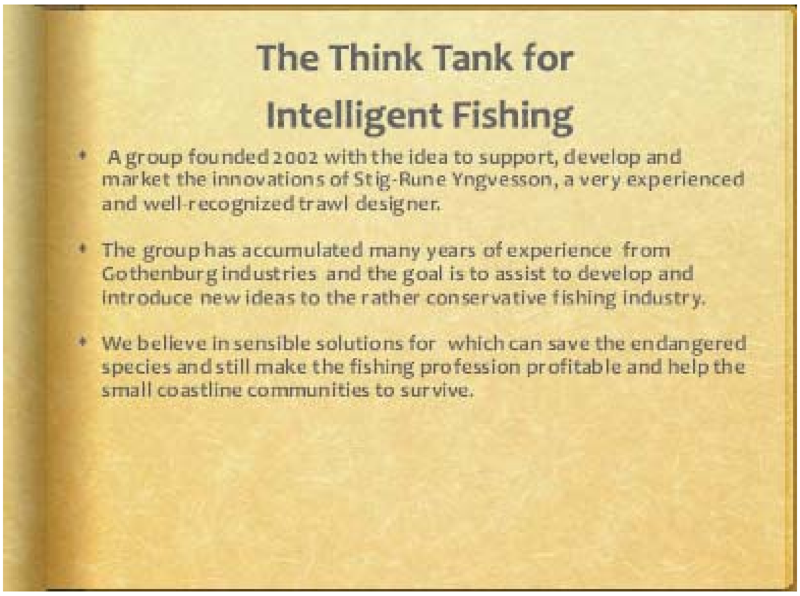
5 Presentations

All of the slides showed during the lectures are presented in this chapter. These slides are also available in higher resolution at the project's web-page www.fishinggearnetwork.net along with recordings of the lectures. The project web-page will be maintained at least until end of year 2015.

5.1 Development of a new ecological selective cod trawl for the Baltic

Presented by Jan Montin from X-chain system AB in Sweden





VISION

The fishery industry shall survive through an Intelligent Fishing approach consisting of well-trained responsible fishermen using selective gears that are efficient, profitable and sustainable taking into account both the survival of the species' and the industry and the supply of healthy food to the consumers

Background of our cod project

- I the Baltic Sea we have since 2002 a mandatory selection system, Bacoma, that did not work very well.
- Alternative solutions have not been promoted.
- The Bacoma system is extremely sensitive to the influence of several factors like i.e. size of catch, weather conditions and the age of the net.
- The profitability of the fishermen is gradually reduced.
- Regulations has been to much focused upon mesh size
- Discard ban is planned to be imposed during 2015

Cod project description

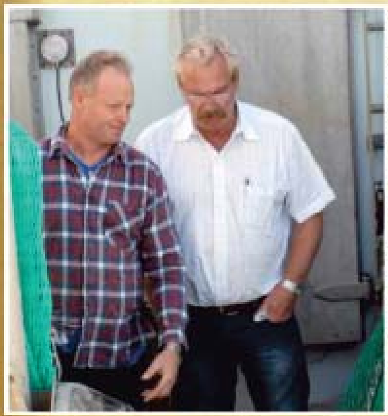
- An EU project initiated by Sweden and funded on 50/50 basis by European Fishery Fund and the Swedish Fund for sea environment.
- The amount funded is 5,3 million SEK.
- Project to be finished by the end of 2014.
- The new trawl ready for distribution and in operation during 2015


Our Project Goals
Qualitative Goals
A more environmental trawl that does not harm the sea bed.
A better fuel efficiency because of less water resistance.
An improved selective capacity in order to minimize bycatch.
A higher catch efficiency with selective gears that are profitable and sustainable.


Our Project Goals
Quantitative Goals
The bycatch reduced by half
The catch efficiency doubled


How to achieve the goals
Exploiting and developing the accumulated experiences and new ideas
Teamwork approach with fishermen, organisations and supported by governmental funding

The listening inventor



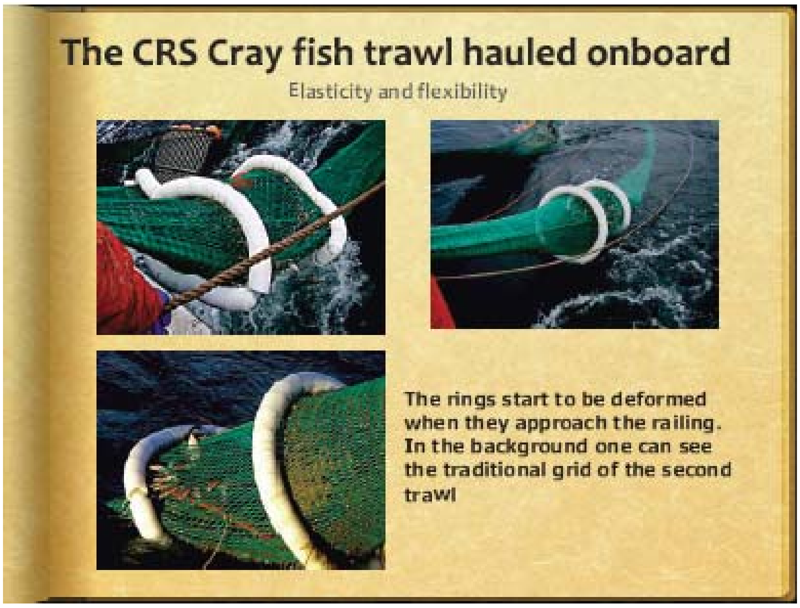
Stig-Rune Yngvesson, has great insights in the needs of a modern trawler and is a great listener to the fishermen .

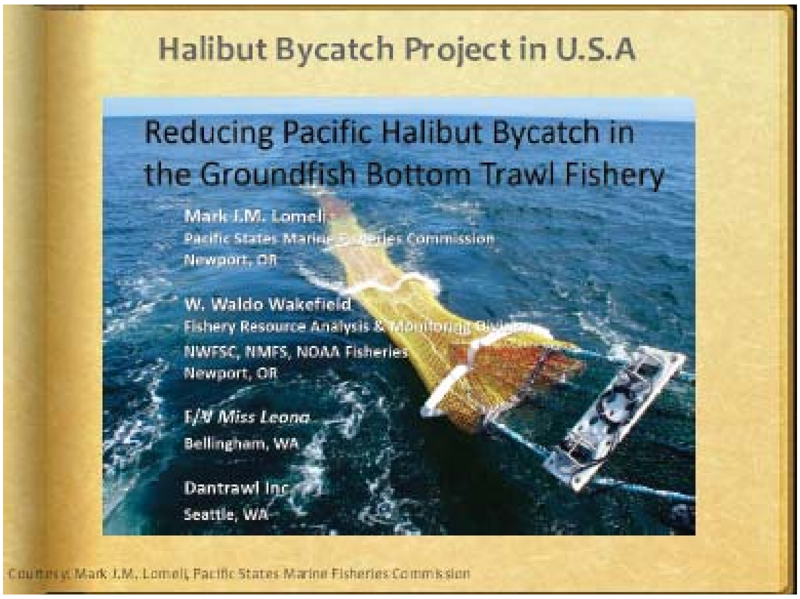
Following up the success of the trawl concepts Exit Window and Conquest he now presents another break-through in creative thinking, the CRS, (Circular Ring System), the result of careful research in his position as the chief designer of Dantrawl Inc. of Seattle

The innovator..

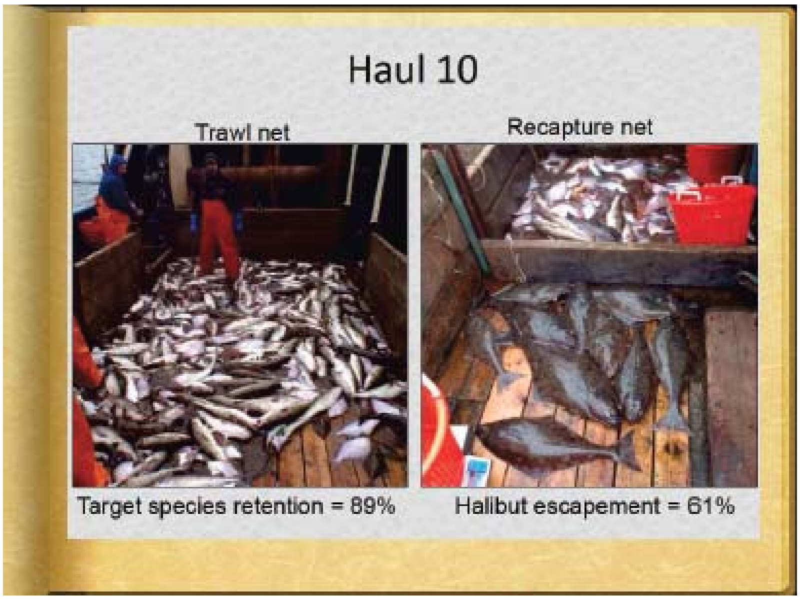
adjusting the CRS Crayfish Trawl..

Flume Tank Testing

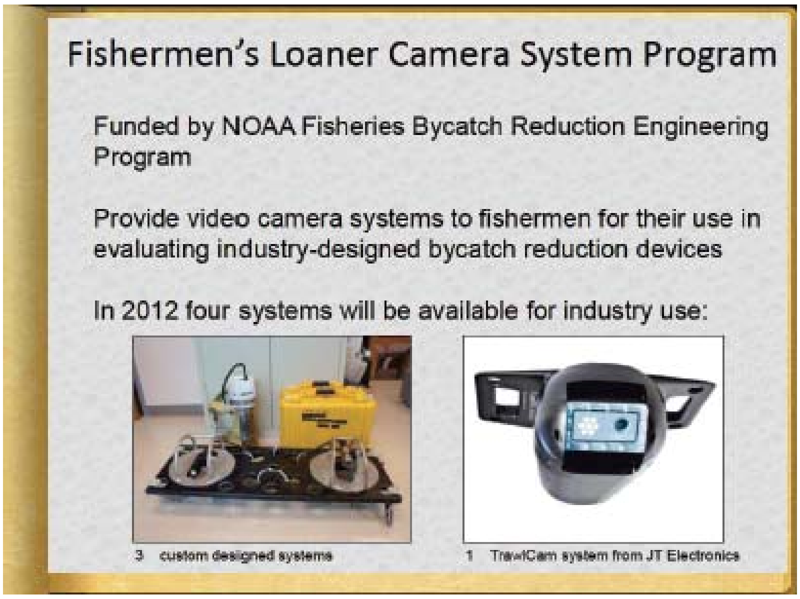

The CRS Cray fish trawl hauled onboard
Elasticity and flexibility
The rings start to be deformed when they approach the railing. In the background one can see the traditional grid of the second trawl


Halibut Bycatch Project in U.S.A
Reducing Pacific Halibut Bycatch in the Groundfish Bottom Trawl Fishery
Mark J.M. Lomeli
Pacific States Marine Fisheries Commission
Newport, OR
W. Waldo Wakefield
Fishery Resource Analysis & Monitoring Division
NWFSC, NMFS, NOAA Fisheries
Newport, OR
F/V Miss Leona
Bellingham, WA
Dantrawl Inc.
Seattle, WA
Courtesy: Mark J.M. Lomeli, Pacific States Marine Fisheries Commission


The CRS trawl in the workshop of Dantrawl Inc. Seattle


Haul 10
Trawl net
Recapture net
Target species retention = 89%
Halibut escapement = 61%


Fishermen's Loaner Camera System Program
http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm
Courtesy: Mark J.M. Lomeli, Pacific States Marine Fisheries Commission

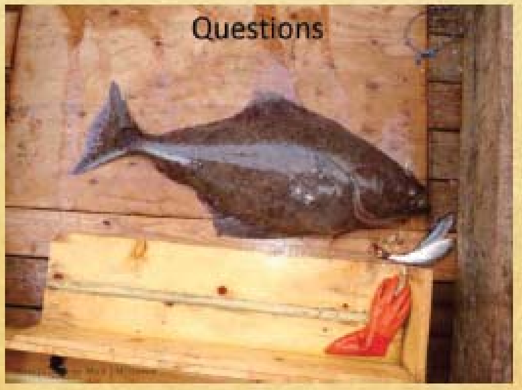

Fishermen's Loaner Camera System Program
Funded by NOAA Fisheries Bycatch Reduction Engineering Program
Provide video camera systems to fishermen for their use in evaluating industry-designed bycatch reduction devices
In 2012 four systems will be available for industry use:
3 custom designed systems
1 TrawlCam system from JT Electronics

Could loaner cameras be made available also here to our projects?

Threats, problems and opportunities

- The difficult financial situation for Swedish fishermen makes it tough for them to develop their gears without outside funding. The aging population of fishermen and the low interest from the young make the future dark.
- Difficult to protect innovations and immaterial rights. Patents are complicated to register and expensive to maintain. Copy cats are everywhere picking ideas.
- Swedish Government allocate 38 million SEK in coming budget for development of selective gears and EU contributes with the equal amount whichs brightens the situation a lot.
- List to be further developed during this workshop…

Thanks for listening



5.2 Selection in mid-water trawl fisheries for cod

Author Dr. Eduardo Grimaldo from Sintef in Norway

"New technology for the Nordic fishing fleet: Fishing gear and effective catch handling"
Reykjavik, Iceland,
October 1st & 2nd 2013.

Selectivity in mid-water trawls for cod

SINTEF Teknologi for et bedre samfunn 1

Background

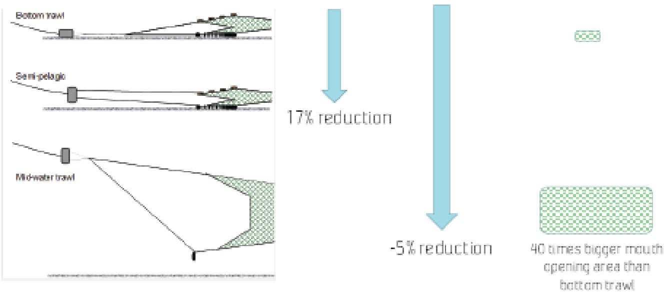
- Mid-water trawling reduces impact on the seabed and associated fauna.
- Requires less energy than bottom trawling, with consequent reduction in fuel costs and NOx emissions.
- Opens the possibility of trawlers to combine bottom and pelagic trawls.

SINTEF Teknologi for et bedre samfunn 2

Energy consumption comparison

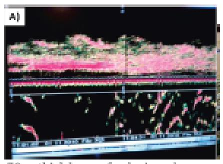
We compared energy consumption (kW) of trawling with three trawl setups, each in and out a fjord, at the same depth and towing speed:

- Bottom trawl with 9m² bottom trawl doors
- Bottom trawl with 6.5m² semi-pelagic trawl doors
- Mid-water trawl with 6.5m² semi-pelagic trawl doors



Challenges regarding selectivity

Size selectivity at extremely high catch rates (> 20 ton/hour):
Mandatory sorting grids, originally designed for bottom trawling, have capacity problems when fishing with pelagic trawls at extremely high catch rates.



70 m thick layer of pelagic cod

Control of catch size:
The risk of taken excessively big catches can potentially lead to reduced quality of the catch and also be associated with handing problems and other H.S.E related problems.

54 tonn cod taken in 8 min tow

Selectivity experiments

Objectives:

Development of a selection system based on flexible web panels (Exit Windows or T90), which has significantly greater capacity than the current sorting grid systems,

The selection systems were :

A codend with 130 mm lateral Exit Window panels
A 135 mm T90 codend
A 55 mm sorting grid (Sort-V type)

6 cruises, 112 hauls with selectivity data

- F/F "Jan Mayen" (march–april 2010)
- M/T "Atlantic Star" (october 2010)
- F/F "Helmer Hansen" (may 2011)
- M/T "Ramoen" (october 2011)
- F/F "Helmer Hansen" (april 2012)
- M/T "Arctic Swan" (october 2012)

- 55 mm grid
- 130 mm EW
- 135 mm T90 codend

Results:

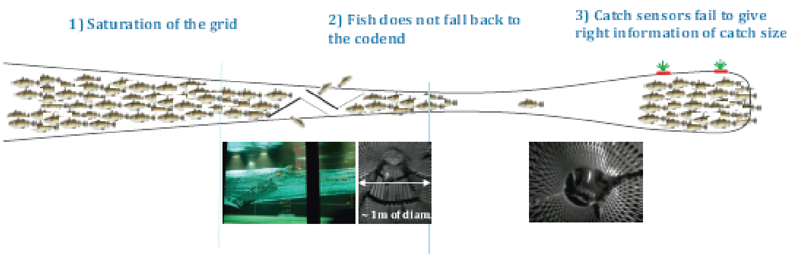
- Exit Windows and T90 showed god and stable selection even with very high catch rates.

Sekk	Parameter		p	p-verdi	95% konfidensintervall grenser (øvre)	grenser (nedre)	Mellom-hal variasjon (cm)
T90 sekk	L50	54.0	0.52	2.2397	45.5	62.5	14.2
	SR	7.8		1.2649	5.7	9.9	4.7
Sekk med E.W.	L50	56.2	0.58	1.6577	50.2	62.3	7.1
	SR	9.9		1.2649	5.7	14.3	5.3

- EW and T90 codend catched less than 2% undersized fish in areas with 16% undersized fish

Norwegian Directorate of Fisheries:
"Not accepted as technical measure for size selectivity in trawls"

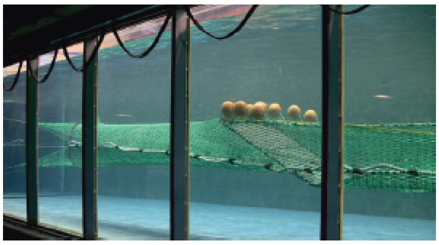
Problems with the sorting grid



Norwegian Directorate of Fisheries:
"Sorting grids are and will be the technical measure for size selectivity in trawls"

Further development of grid sections:

We assessed the water flow of sorting grid sections in the flume tank in Hirtshals, Denmark (juni 2013)

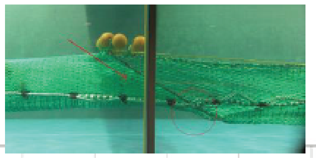


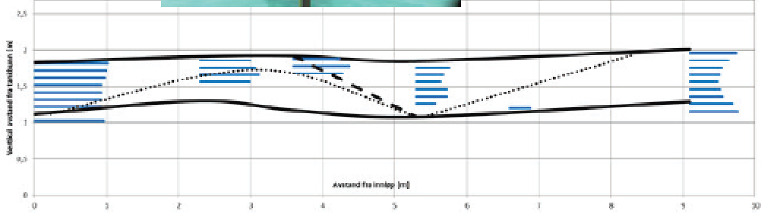
Measurements of water flow were performed in full scale

SINTEF Teknologi for et bedre samfunn 9

2-panel sorting grid (sort-V) with lifting panel

Lifting panel blocked all the section

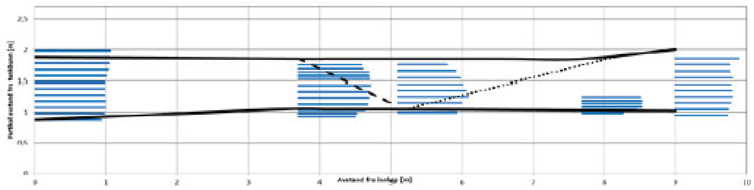




Blue lines indicate the water flow speed reductions. 1 square is equivalent to 0,95 m/s.

SINTEF Teknologi for et bedre samfunn 10

4-panel sorting grid (sort-V) without lifting panel



Blue lines indicate the water flow speed reductions. 1 square is equivalent to 0,95 m/s.

A 4-panel single grid section without lifting panel, has:

- **Larger cross-sectional area,**
- **Better stability.**
- **Better water flow**

SINTEF Teknologi for et bedre samfunn 11

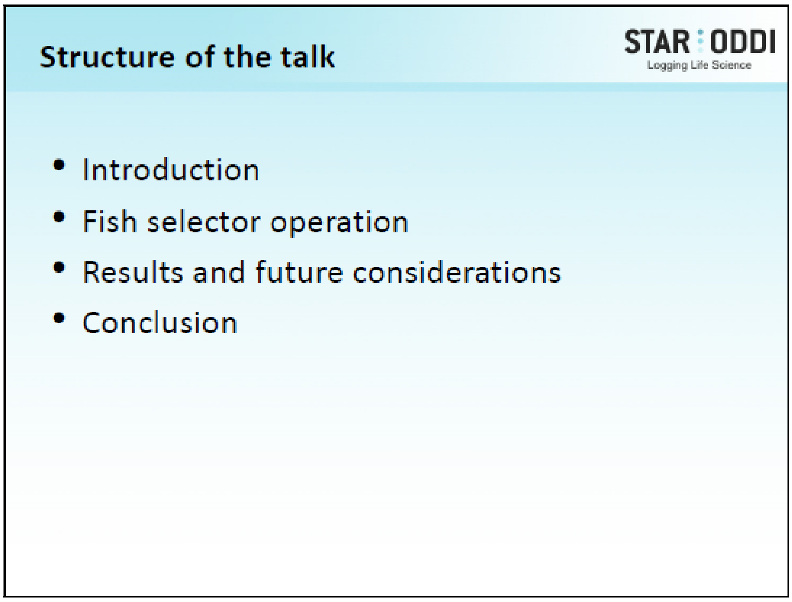
4-panel sorting grid (sort-V) without lifting panel

Full scale experiments with this type of grid section are planned to be performed in October 2013 on board M/T Ramoen

Thank you for your attention!

5.3 The Fish selector

Presented by Sigmar Guðbjörnsson from Star-Oddi in Iceland



Introduction

STAR ODDI
Logging Life Science

Our intentions with Fish Selector are:

- Equipment that is pre-programmed to automatically sort fish underwater by certain size and specie.
- Unwanted fish are automatically bypassed and swim away.
- Reduced discard of fish?
- Counting/measuring of caught fish and bypassed fish.
- Helps skipper with deciding fishing grounds.
- Increase value of the catches.
- Improved use of quotas.

Fish Selector operation 1/2:

STAR ODDI
Logging Life Science

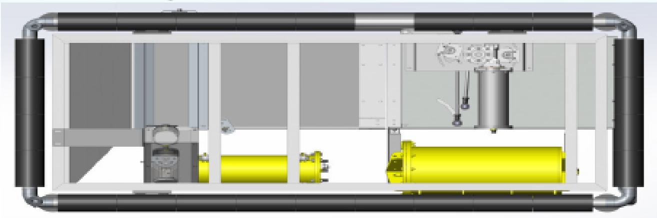
Operation steps:

- Fish Selector is placed at the cod end of the trawl.
- Fish Selector scans the fish as it slides passed the scanner. Measuring the size of the fish (3D) and identifying the specie.
  - It is however not always necessary to identify the specie where size is the main parameter.

Fish Selector operation 2/2:

STAR ODDI
Logging Life Science

- The equipment is around 2 meters in length, the main reason for the length is:
  - We need a length of 65 cm to scan in the fish.
  - It takes a short time for our computer to make a decision whether to throw out the fish; the time gap while decision is made equals approx. 5 cm movement of the fish in the Fish Selector.
  - After the fish has been scanned, the fish goes passed the release grid that's 60 cm of the length.
- For the scanning we have two video cameras.



Results and future considerations 1/3

- The fish selector has been successfully tested and proven, nevertheless there is space for improvements.
- Dialogue with the vessel owners has been on going since the project started. It is difficult to evaluate a product on the drawing board, but after having made the first prototype and tested it, dialogue with the vessel owners changed, which lead to a modified approach of the Fish Selector, where:

Results and future considerations 2/3

- We have suggested design modifications:
- Change the scanning technology, making it less space consuming and more robust.
- Four times volume reduction, going from $3m^3$ to $0,72m^3$.
- Reduce the length of the device by at least 20 cm.
- Weight reduction going from less 300 Kg to less than 100 Kg.

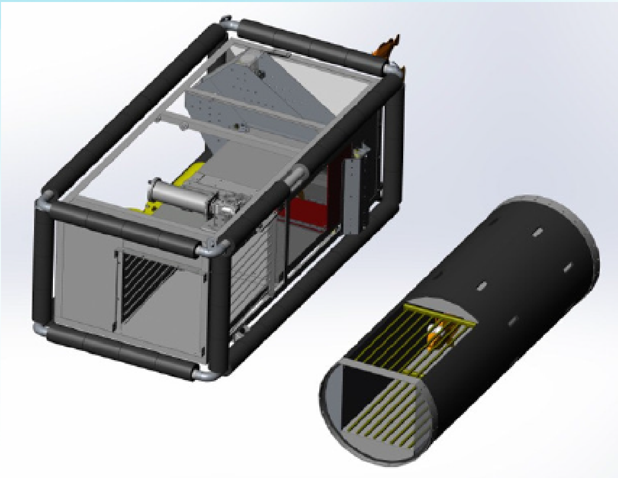
Results and future considerations 3/3

STAR ODDI
Logging Life Science

Modified version of the Fish Selector has received following comments from a vessel owner:

- The device is still much too heavy and bulky to be used on board a vessel.
- Vessel owners like to compare additional equipment on board to a trawl sonar, which is 10 times less volume consuming then the suggested modified Fish Selector, and three times lighter.
- Require better than than 90% of unwanted fish to be sorted out of the trawl, regardless of how the fish enters the cod end.
- Fishermen are still getting well paid for the undersized fish, so why change something that is working?
- Who is going to pay the cost of Fish Selector on board fishing vessels, who is the stakeholder?

STAR ODDI
Logging Life Science



Conclusion

STAR ODDI
Logging Life Science

- Fish Selector has been made and tested, proving that the technology for making such a device is available at Star-Oddi.

How can we bridge the gap:

- We know the purpose of the device, but is it necessary, is it useful and who is going to pay, who is the stakeholder?
- If we can't prove there is a market, we won't make it.

Questions can be directed to:

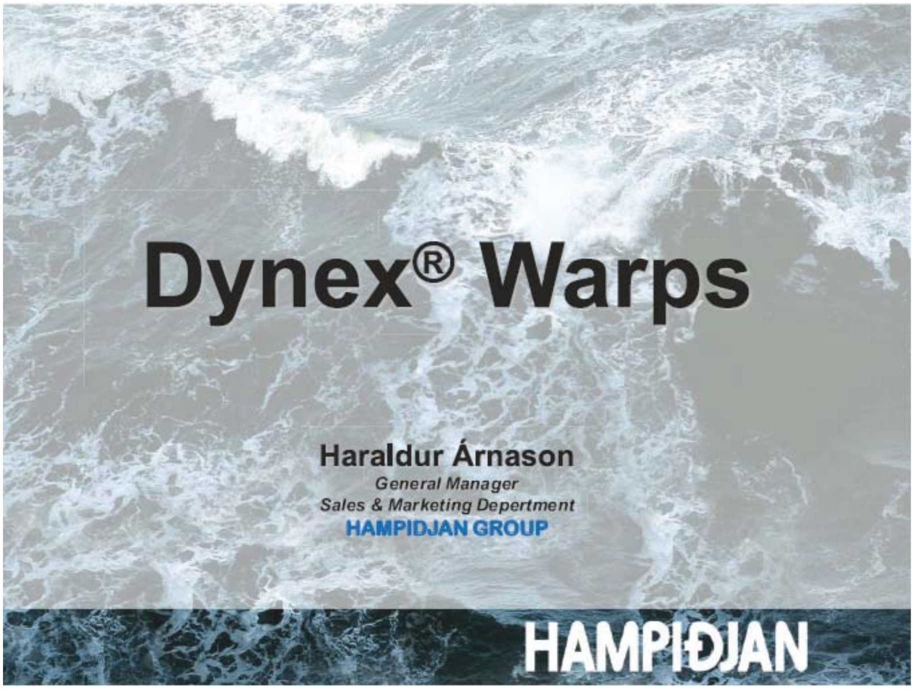
STAR ODDI
Logging Life Science

Sigmar Gudbjornsson
Star-Oddi CEO
sigmar@staroddi.com

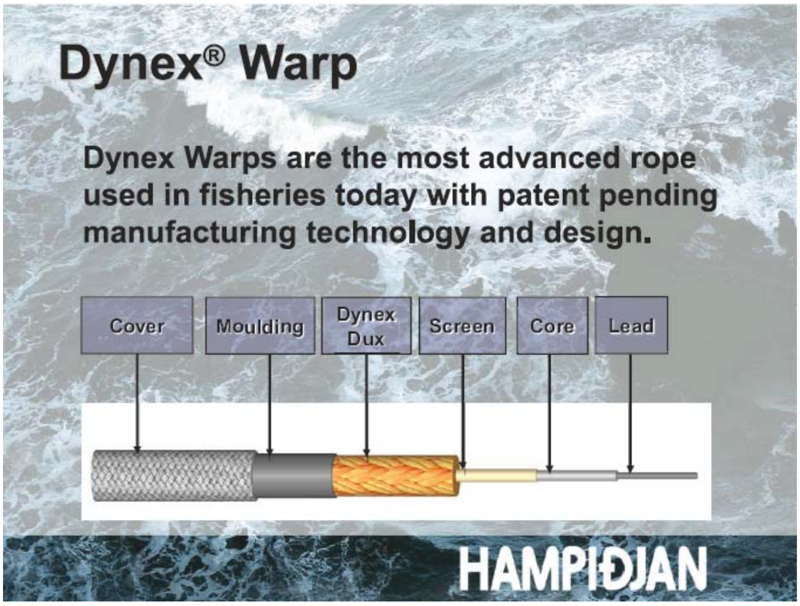
www.staroddi.com
tel +354 533 6060

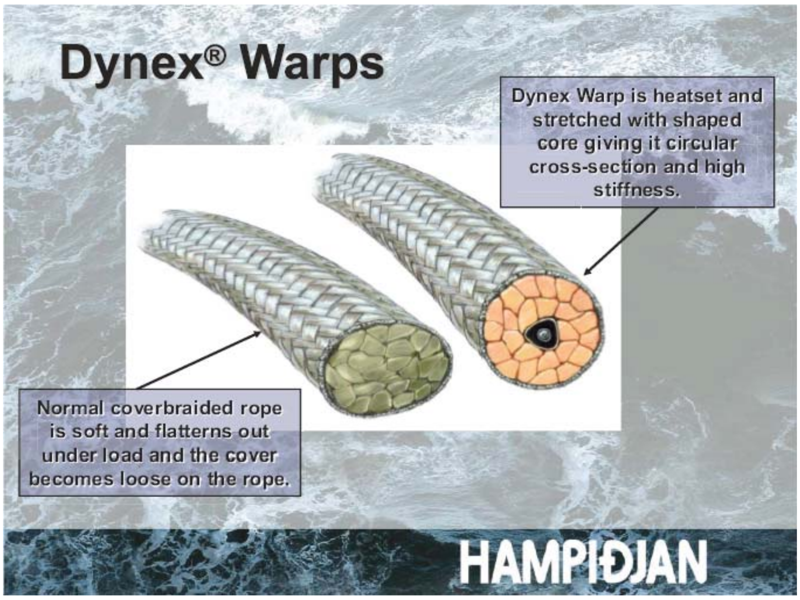
5.4 Dynex warp and its use in fishing

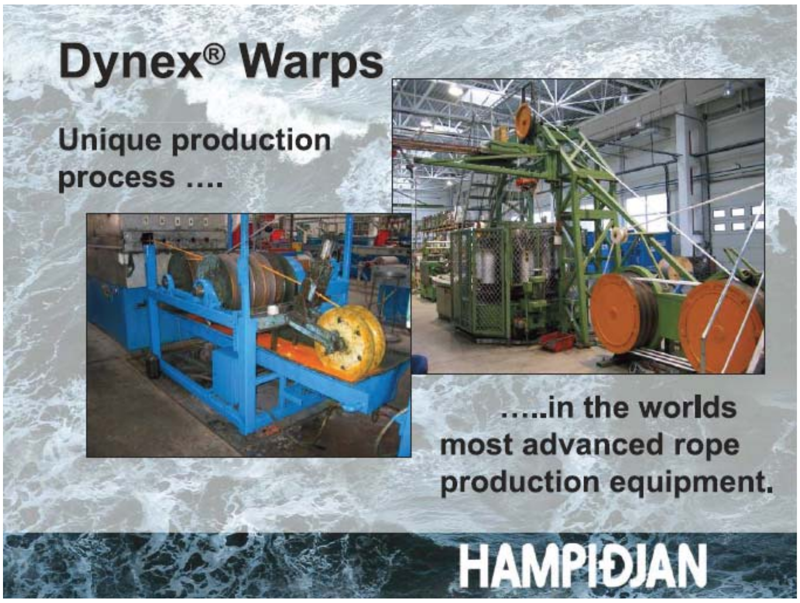
Presented by Haraldur Árnason from Hampiðjan in Iceland

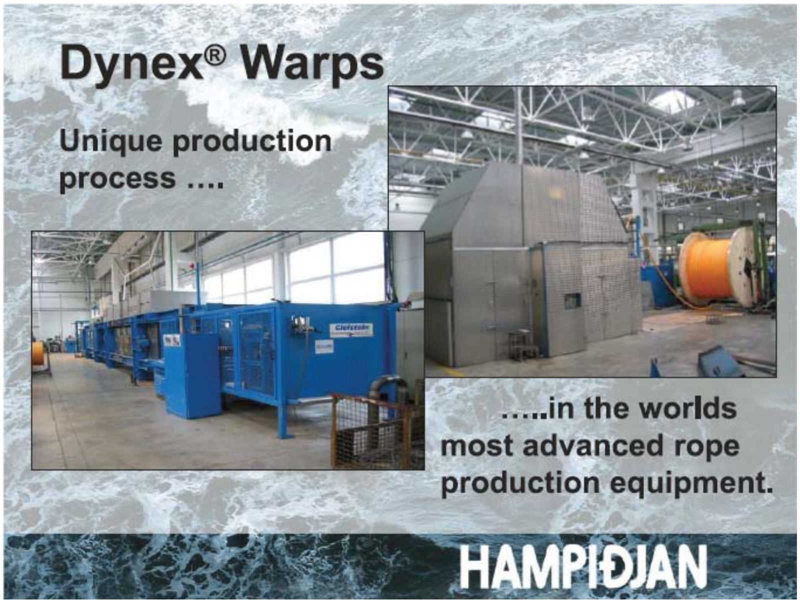


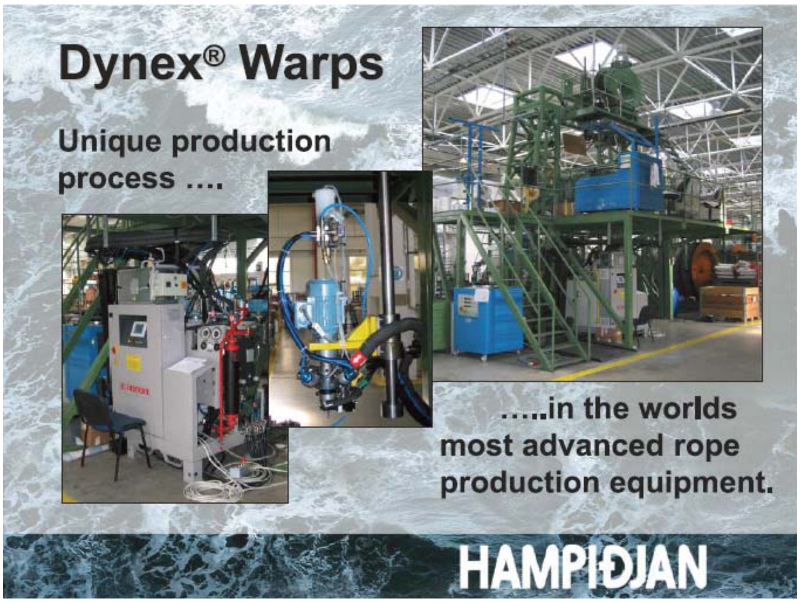

Dynex® Warps
✓ More catch
✓ Oil savings
✓ Increased safety
✓ Less maintenance
✓ Longer lifetime
✓ Close to 100 users to day
HAMPIÐJAN


Dynex® Warp
Dynex Warps are the most advanced rope used in fisheries today with patent pending manufacturing technology and design.
Cover
Moulding
Dynex Dux
Screen
Core
Lead
HAMPIÐJAN


Dynex® Warps
Dynex Warp is heatset and stretched with shaped core giving it circular cross-section and high stiffness.
Normal coverbraided rope is soft and flatterns out under load and the cover becomes loose on the rope.
HAMPIÐJAN


Dynex® Warps
Unique production process ….
…..in the worlds most advanced rope production equipment.
HAMPIÐJAN

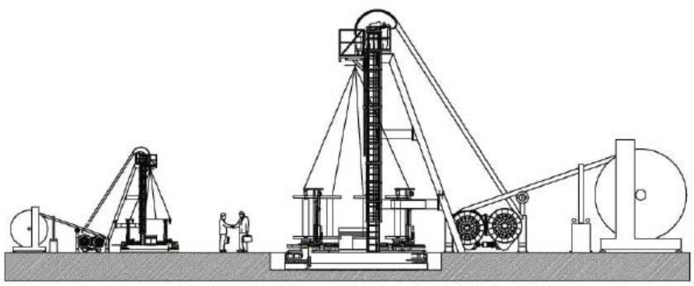

Dynex® Warps
Unique production process ….
…..in the worlds most advanced rope production equipment.
HAMPIÐJAN


Dynex® Warps
Unique production process ….
…..in the worlds most advanced rope production equipment.
HAMPIÐJAN

Herzog 12-2000

HAMPIÐJAN

Herzog 12-660 Herzog 12-2000



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Herzog 12-660 og Herzog 12-2000

Þvermál	Herzog 12-660 Lengd	Herzog 12-2000 Lengd	Slitþol ósplæst
mm	m	m	tonn
40	470	12.900	120
84	100	3.000	456
120	-	1.470	1.127
180	-	670	2.308
204	-	560	2.848

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Dynex® Warps

Type	Steel wire	Dynex Warp
Diameter	40 mm	40 mm
Breaking strength	116 ton	115 ton
Weight in air 2 x 2.500 m	36,0 ton	5,7 ton
Weight in sea 2 x 2.500 m	31,3 ton	0,8 ton
Lifetime	1,5 years	5,0 years

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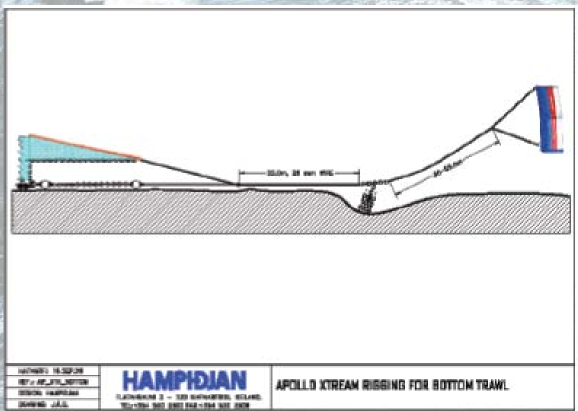
NEW DOOR RIG



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OIL USAGE WITH STANDARD EQUIPMENT

		Hours Sea day	
Oil usage pr/hour with wire	708 litr.	19	13.458
Oil usage - steam	500 litr.	5	2.500
Oil usage ea. day			15.958
Days on sea			330
Total oil consumption liters			5.266.250
Price oil ea. Liter "MDO"		USD	1,15
TOTAL ANNUAL OIL CONSUMPTION		USD	6.056.188

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OIL SAVINGS WITH DYNEX WARPS -11%

		Hours sea day	
Oil usage pr/hour with Dynex	630 litr.	19	11.970
Oil usage - steam	500 litr.	5	2.500
Oil usage ea. day			14.470
Days on sea			330
Total oil consumption liters			4.775.100
Price oil ea. Liter "MDO"			1,15
TOTAL ANNUAL OIL CONSUMPTION		USD	5.491.365
			-6.056.188
ANNUAL SAVINGS		USD	561.823
TOTAL SAVINGS for 4 years		USD	2.247.292

HAMPIÐJAN

OIL SAVINGS WITH DYNEX & NEW DOOR RIG -15,8%

		Hours sea day	
Oil usage pr/hour with Dynex	596 litr.	19	11.324
Oil useage - steam	500 litr.	5	2.500
Oil usage ea. day			13.824
Days on sea			330
Total oil consumption liters			4.561.920
Price oil ea. Liter "MDO"		USD	1,15
TOTAL ANNUAL OIL CONSUMPTION		USD	5.246.208
		USD	-6.056.188
ANNUAL SAVINGS		USD	809.980
TOTAL SAVINGS for 4 years		USD	3.239.920

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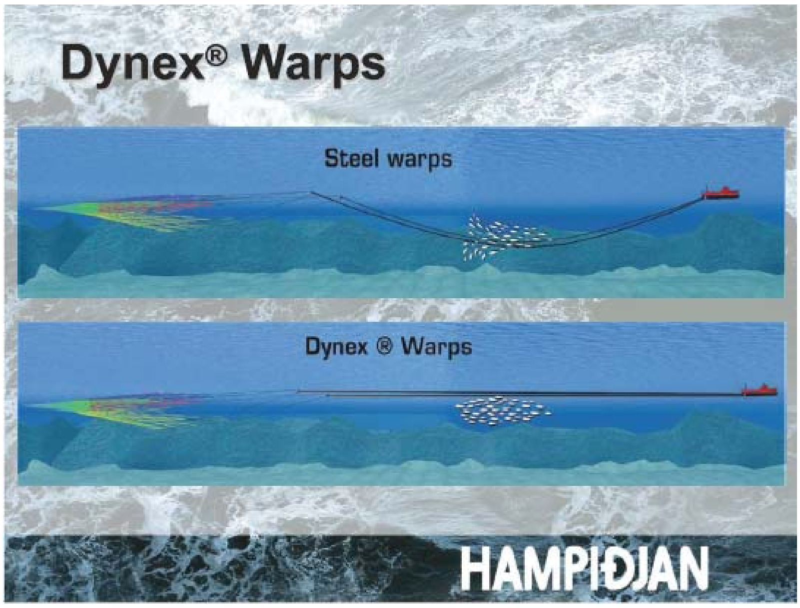
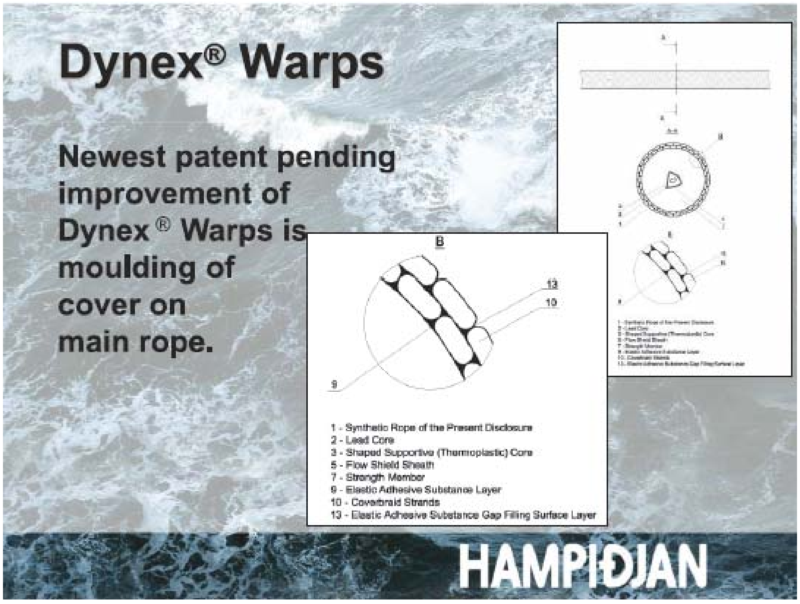
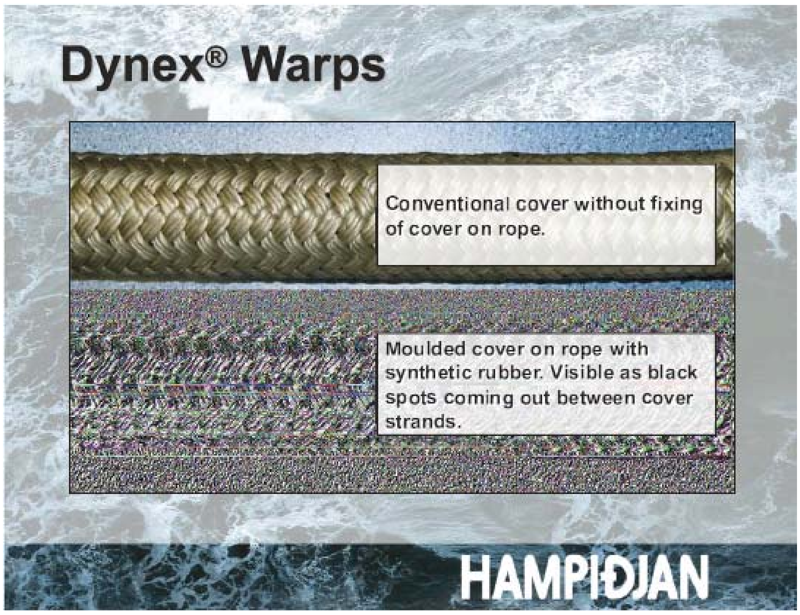
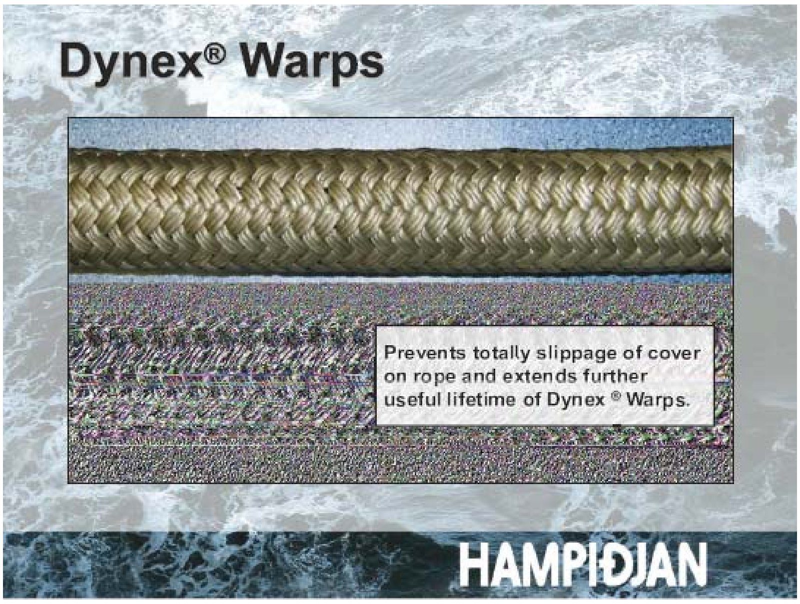

Dynex® Warps
Steel warps
Dynex ® Warps
HAMPIÐJAN

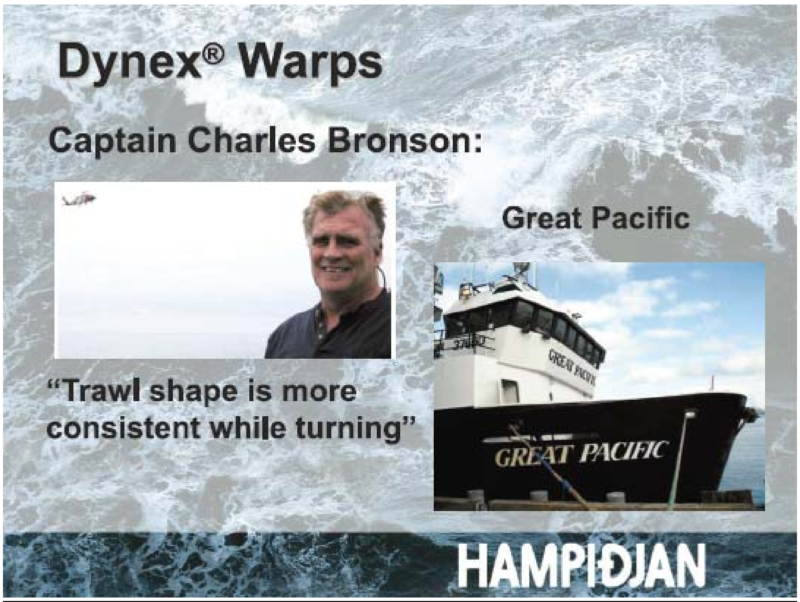

Dynex® Warps
Newest patent pending improvement of Dynex ® Warps is moulding of cover on main rope.
B
13
10
9
1 - Synthetic Rope of the Present Disclosure
2 - Lead Core
3 - Shaped Supportive (Thermoplastic) Core
5 - Flow Shield Sheath
7 - Strength Member
9 - Elastic Adhesive Substance Layer
10 - Coverbraid Strands
13 - Elastic Adhesive Substance Gap Filling Surface Layer
HAMPIÐJAN


Dynex® Warps
Conventional cover without fixing of cover on rope.
Moulded cover on rope with synthetic rubber. Visible as black spots coming out between cover strands.
HAMPIÐJAN


Dynex® Warps
Prevents totally slippage of cover on rope and extends further useful lifetime of Dynex ® Warps.
HAMPIÐJAN


Dynex® Warps
Captain Gudmundur Huginn Gudmundsson:
Huginn VE
"Easy to keep the trawl high in the water"
HAMPIÐJAN


Dynex® Warps
Captain Birgir Thor Sverrisson:
Vestmannaey VE
"I have seen how well this material lasts"
HAMPIÐJAN


Dynex® Warps
Captain Charles Bronson:
Great Pacific
"Trawl shape is more consistent while turning"
GREAT PACIFIC
HAMPIÐJAN

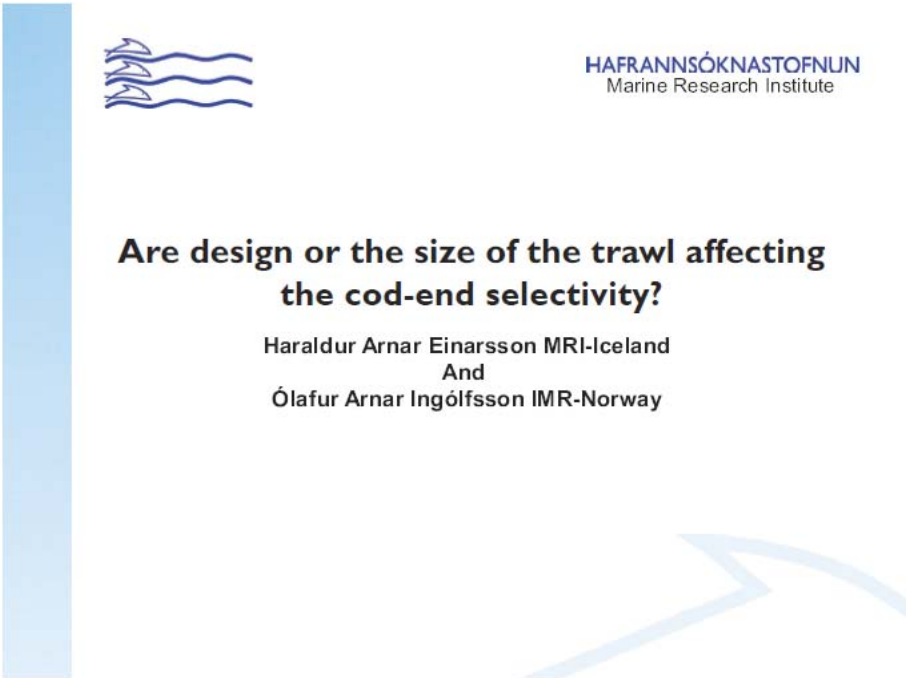

Dynex® Warps
Captains Bogi Jacobsen and Andri Hansen:
Finnur Fridi
"Dynex Warps don't spook the fish"
HAMPIÐJAN

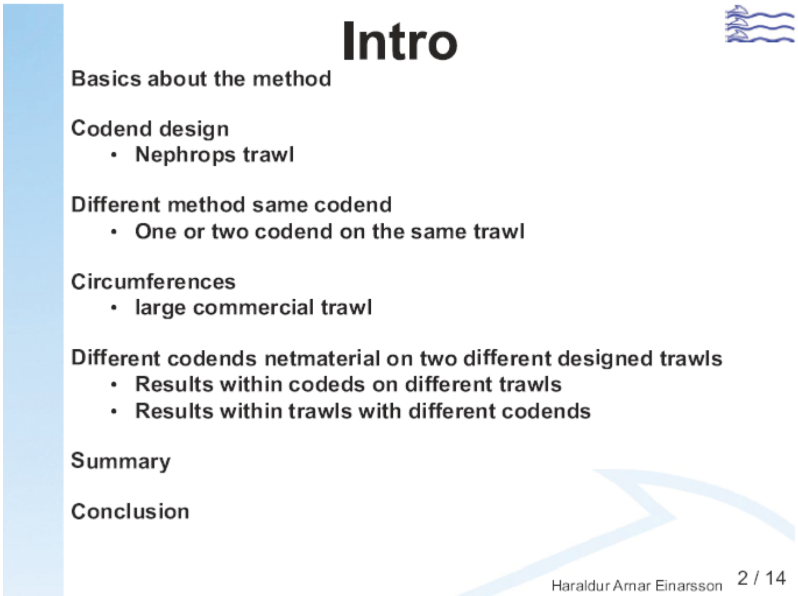

Dynex® Warps
Captain Gudlaugur Jonsson:
Ingunn AK
"Dynex Warps are lighter to tow"
HAMPIÐJAN


FACTS ABOUT NEW DOOR RIG AND USE OF DYNEX WARPS
• Less resistance, less time turning
• 10-15% Fuel savings
• More opening in trawl (Vertical)
• Seldom stuck on bottom
• Less maintenance on doors
• No time in door change
• Easy handle in all condition
• 3,2 x more expensive than wire..
HAMPIÐJAN

5.5 Are design or the size of the trawl affecting the codend selectivity?

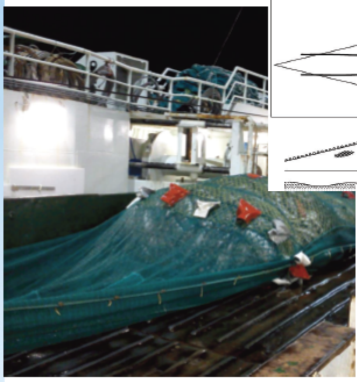
Presented by Haraldur Einarsson from the Marine Research Institute in Iceland

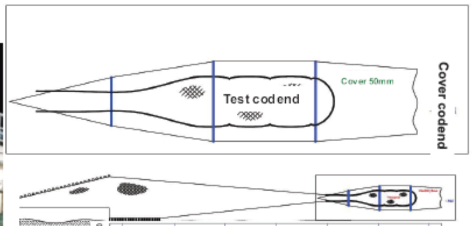


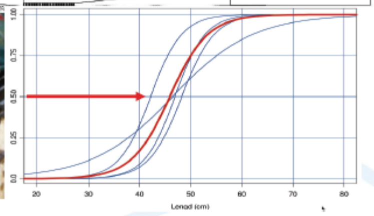


Basics about the method

Cover codend
50mm mesh in the cover with 40 mm meshes in the codend
Small kites lift the net from the codend in test





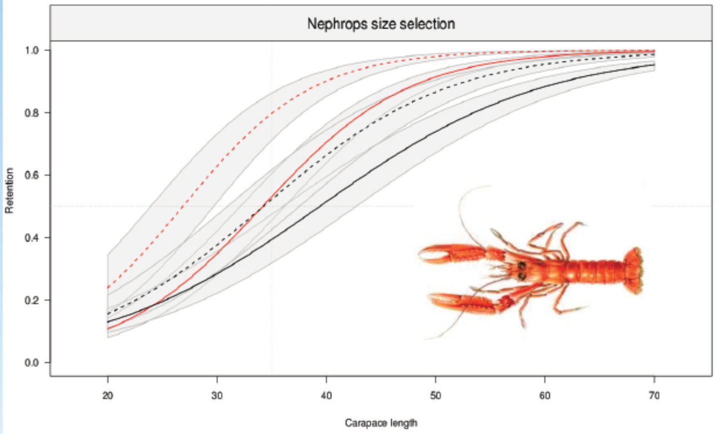


Method

Haraldur Arnar Einarsson 3 / 14

Codend design

Two mesh sizes with two different circumferences each
90mm with 100 (normal) and 134 (wide) meshes around
105mm with 86 (normal) and 114 (wide) meshes around

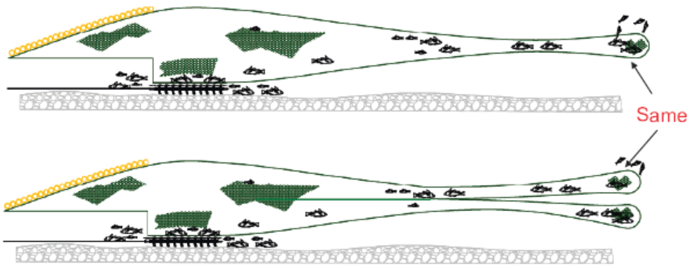


Codend design

Haraldur Arnar Einarsson 4 / 14

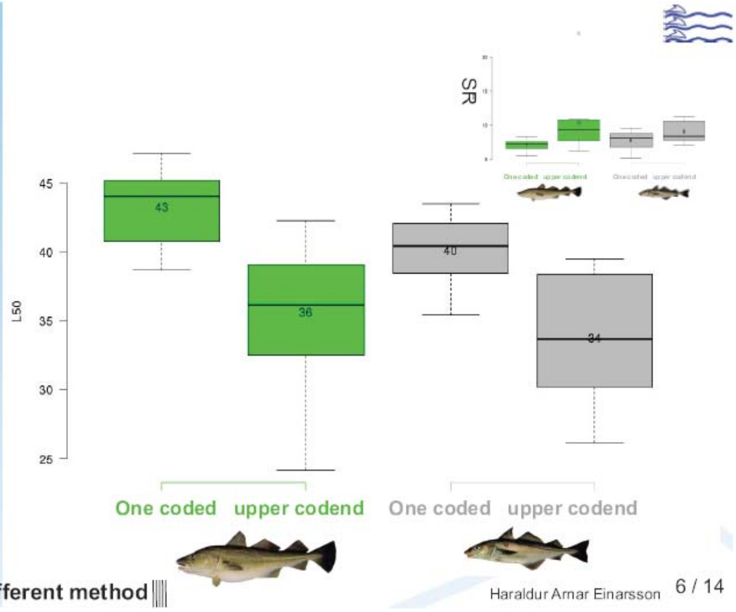
One or two codend on the same trawl

Last year a trial with horizontal divided trawl in comparison with same trawl with one codend
The same codend was measured with cover codend method as single codend and as upper codend at the divided trawl
Mesh size was 135mm (lower codend on the divided one was 155mm)



Different method

Haraldur Arnar Einarsson 5 / 14

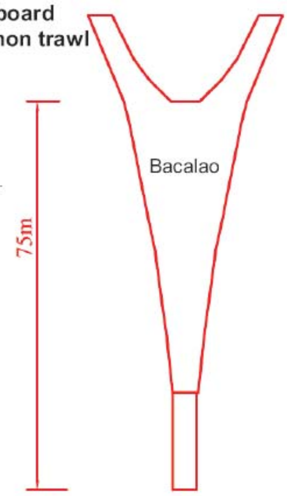


Different method

Haraldur Arnar Einarsson 6 / 14

January 2013:
A selectivity measurements was done on board in a commercial bottom trawler with common trawl

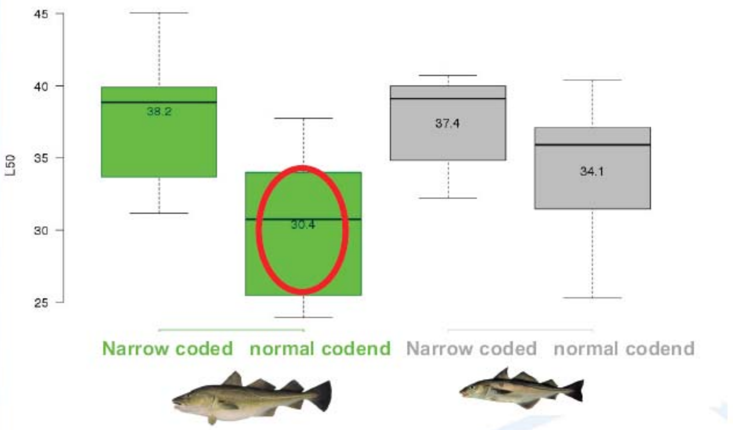
1. T90 in 120mm
2. Normal 135mm (100mesh)
3. Narrow 135mm (60 mesh)



Commercial

Haraldur Arnar Einarsson 7 / 14

Same codend with 135mm meshes but different circumferences

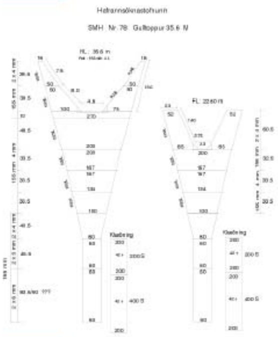


Commercial

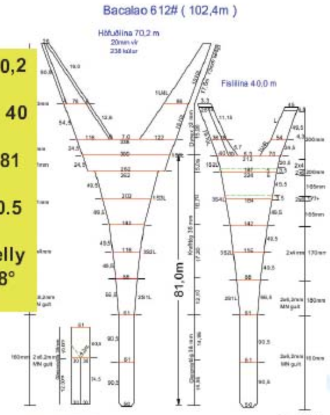
Haraldur Arnar Einarsson 8 / 14

Redesign on six day selectivity survey now in September (1-6 / 9)

Two different trawls, both in size and design
On both trawls two different codends was measured with cover codend

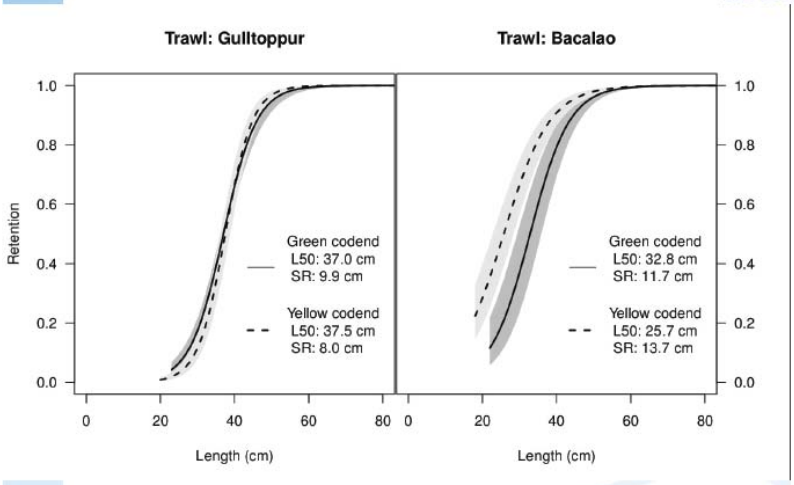


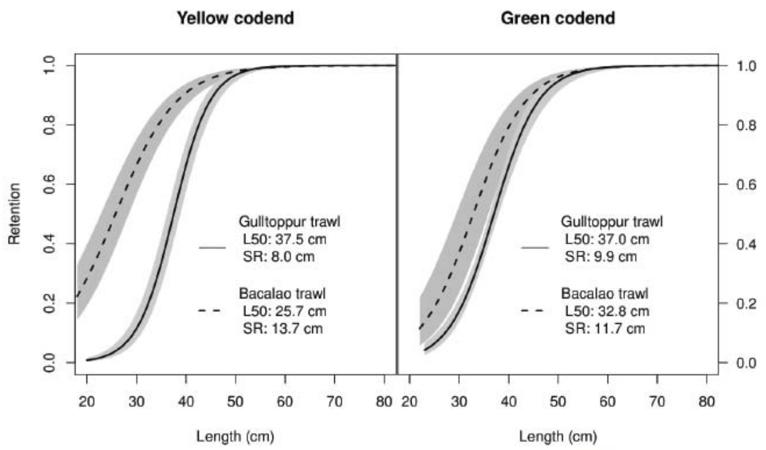
36,6	Headline	70,2
22,6	Fishing-line	40
41	Length	81
45,5	Extension	90.5
Different cut on belly 14°		~8°



Two codends tested

Green codend		Yellow codend
Mesh 135mm	Same circumference Same length	Mesh 135mm
2x6mm PE		2x6,2mm PE
1040 g/100m		1585 g/100m





Summary

- Mesh size is far from be the most important factor for codend selectivity
- Circumference is a strong factor for codend selectivity
  Wider codend reduces L50
  Narrower codend increses L50
- How the codend is used affects selectivity
  - Two codend instead of one
  - Grids in front of the codend....?
- Codend material (twine) affects the selectivity
  But it can vary greatly between the same codend attached
  on different trawl
- Trawl size and/or design has significant effect on codend selectivity

Conclusions

- If laws or regulations are meant for promoting the wanted selectivity from the gear. The whole design of the trawl and codend must be taken into account.
- Results from codend selectivity is only representative for the codend in the trial and the trawl it is attached to.

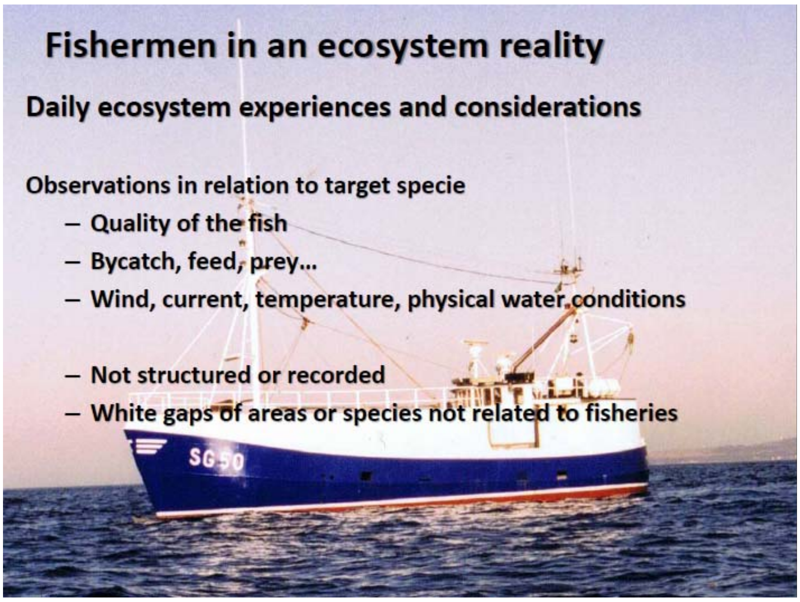
5.6 Gear development for an industry driven fishery management

Presented by Staffan Larson from the Swedish codfishermen producer organisation


Micro management by EU
- Limit the fisheries by regulations
- Partly irrelevant counterproductive (lack of legitimacy)
- Fishermen legally incompetent
CFP process – a door opener
=> regionalization
=> stakeholder involvement
=> stop overfishing by ending discards…
=> long-term planning to replace yearly quota-haggling


Market focus
From biological to product management
- preferences → fishing cod fillets
- part of a supply chain
- improve the precision in the fishingoperation
Winning the consumer confidence
- Develop branding
- Ecolabel – (third party guarantee)


Fishery management for product development – fine tuning the fishing
Industry involvement in management
Shift focused to how fishing best should be conducted
Common vision fishermen <–> scientists
• Data collection > common base
• Develop a concept of fish harvest – Harvest fish produced by nature
Relevant management > legitimacy > compliance

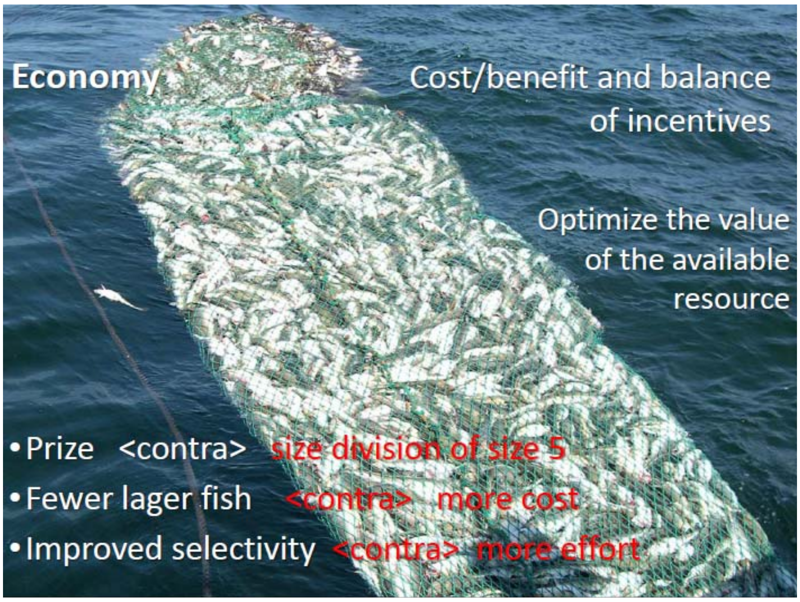

Fishermen in an ecosystem reality
Daily ecosystem experiences and considerations
Observations in relation to target specie
– Quality of the fish
– Bycatch, feed, prey…
– Wind, current, temperature, physical water conditions
– Not structured or recorded
– White gaps of areas or species not related to fisheries
SG 50


Result Based Fishing
• Selective fishing
- focusing on the final result rather than how to regulate
• Making best use of market incentives
• Adapt fishing regulation – minimum standards


Challenges existing and planned regulations
• Technical regulations in force
• Quota allocations
• New control regulation
• Traceability
• Multispecies plan for the Baltic Sea

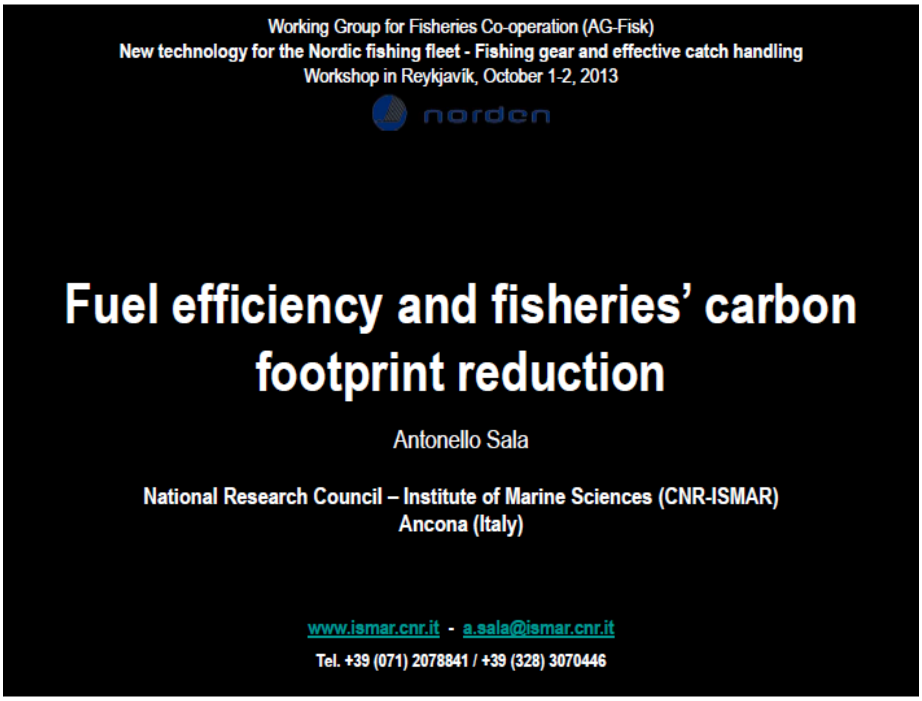

Discard ban – "yes we can"
Shift of paradigm
• Make best use of what we can get
• Adapt fishing pattern to develop future fishery
• size selection - possible
• flounder – complicated challenge
• gear development


Requirements for gear development
• Gear development by industry (PO)
• Evaluation/cooperation by research
• Steep selection curve – minimize catches under minimum landing size
• Efficient catches – minimize energy and bottom contact


Economy
Cost/benefit and balance of incentives
Optimize the value of the available resource
• Prize <contra> size division of size 5
• Fewer lager fish <contra> more cost
• Improved selectivity <contra> more effort

5.7 Fuel efficiency and fisheries' carbon footprint reduction

Presented by Antonello Sala from CNR-ISMAR in Italy



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Rationale: crisis of fishing industry

Main factors affecting fishing industry	Influence on fishing activities
➢ Overfishing ➢ World economic crisis (fishermen do not have any influence in the market)	**Revenue**
➢ Increasing in fuel price ➢ Fishing vessels not efficient usually because of outdated technology	**Costs**

Profitability Index

$$I = \frac{Revenue}{Costs}$$

Management costs:

Fuel	**55%**
Crew	30%
Maintenance	10%
Other	5%

✓ European Commission restrictions related to the actual overfishing;
✓ impossible to fish more;
✓ fishermen do not have influences on the market prices;

A possible solution is to reduce running costs by reducing fuel consumption

It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change.

- Charles Darwin -

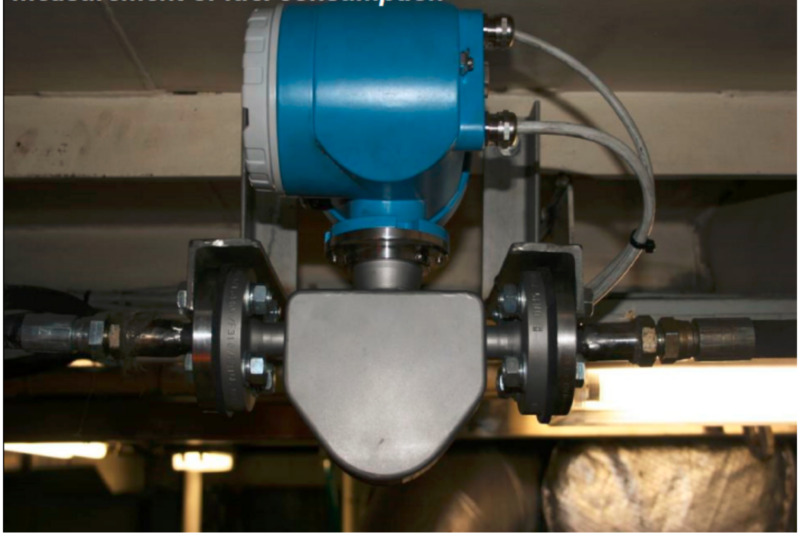
Coriolis Fuel Mass Flow Measuring System (*CorFu*-m)

A prototype instrument, named *CorFu meter* (*CorFu*-m), was conceived at CNR-ISMAR Ancona (Italy) and installed on board two semi-pelagic pair trawlers.

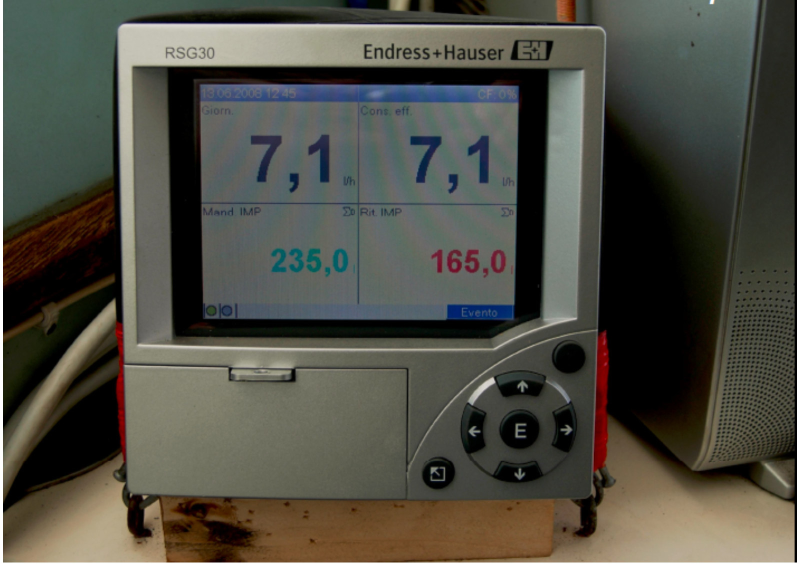
The *CorFu*-m system consists of three components:

a) **two mass flow sensors. The sensors use the *Coriolis* measuring principle, which permit to operate independently of the fluid's physical properties, such as viscosity and density. It is an economical alternative to conventional volume flowmeters;**
b) **one Multi Channel Recorder;**
c) **one GPS data logger.**

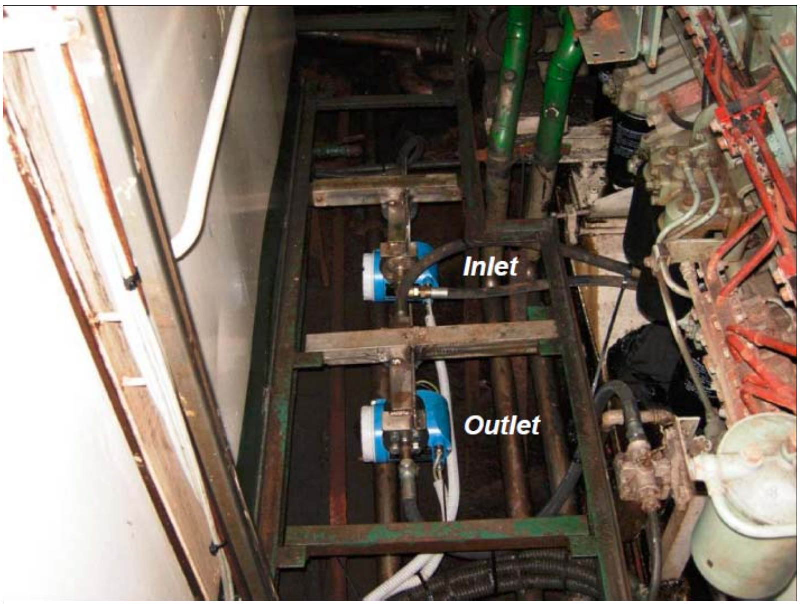
Mass flow sensors mounted onboard a fishing vessel for the measurement of fuel consumption

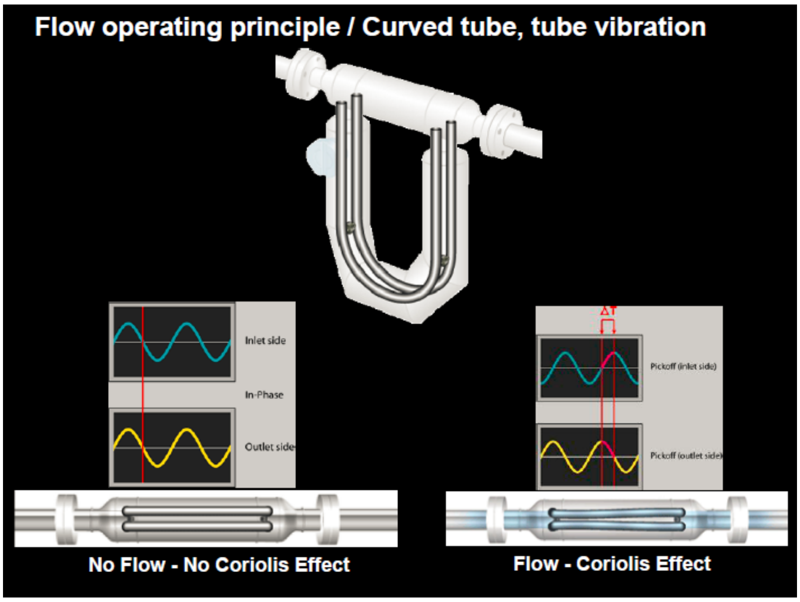


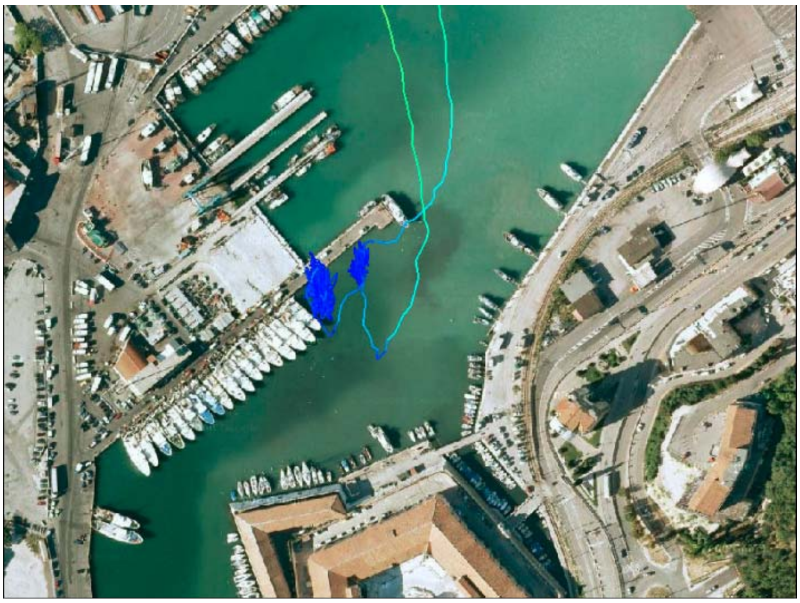
Multi channel recorder: visualization of the fuel consumption

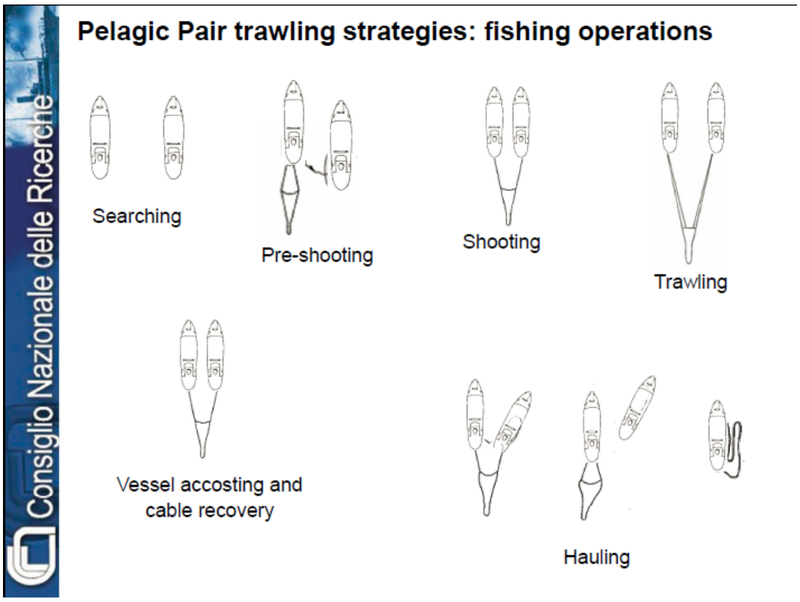



GPS data logger for the GPS data collection




Flow operating principle / Curved tube, tube vibration
Inlet side
In-Phase
Outlet side
ΔT
Pickoff (inlet side)
Pickoff (outlet side)
No Flow - No Coriolis Effect
Flow - Coriolis Effect

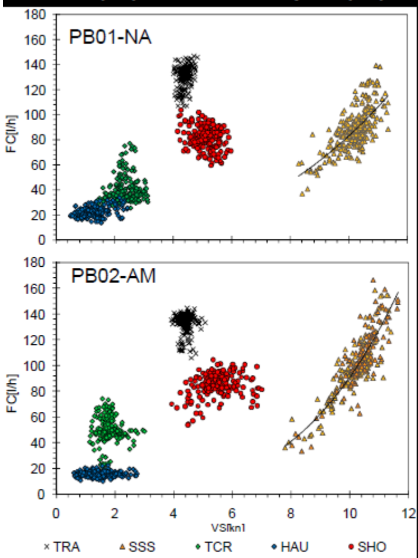




Pelagic Pair trawling strategies: pooled fishing operations

Fishing operation	Acronym	Description
Sailing departing Sailing back Searching	SSS	*Sailing from the harbour to the fishing grounds; Sailing from the last fishing grounds to the harbour; Sailing between the fishing grounds: searching of the schools (variable speed).*
Shooting	SHO	*Shooting the gear at sea, towing cables releasing.*
Trawling	TRA	*Trawling operations out and out.*
Hauling	HAL	*Gear hauling operations.*
Towing cable recovery	TCR	*Gear setting operations just before the gear shooting.*

Fuel rate (FC) versus Vessel Speed (VS) during the main fishing operations



LOA: 27.00 m; GRT: 117.71; Engine power: 809 kW; Propeller design: controllable pitch.

Sailing departing Sailing back Searching	SSS
Shooting	SHO
Trawling	TRA
Hauling	HAL
Towing cable recovery	TCR

LOA: 28.95 m; GRT: 117.71; Engine power: 940 kW; Propeller design: fixed pitch.

Fuel consumption under different working conditions

	PB01-NA			PB02-AM		
	VS[kn]	FC[l/h]	DFC [l/day]	VS[kn]	FC[l/h]	DFC [l/day]
SSS	**10.11** *0.75*	**85.43** *19.42*	**529.67** *148.86*	**10.24** *0.70*	**101.53** *25.31*	**548.87** *210.42*
TRA	**4.41** *0.17*	**129.32** *8.92*	**382.90** *127.41*	**4.40** *0.19*	**133.42** *7.69*	**441.26** *122.33*
SHO	**5.16** *0.47*	**79.68** *8.92*	**40.34** *14.87*	**5.50** *0.58*	**85.37** *8.97*	**38.42** *12.83*
TCR	**2.38** *0.42*	**40.90** *11.02*	**19.33** *8.51*	**1.81** *0.34*	**49.53** *11.10*	**21.50** *8.31*
HAU	**1.37** *0.61*	**22.78** *6.09*	**13.79** *6.67*	**1.42** *0.49*	**15.74** *2.09*	**13.38** *5.66*

Sailing departing Sailing back Searching	SSS
Shooting	SHO
Trawling	TRA
Hauling	HAL
Towing cable recovery	TCR

Mean (in bold) and Standard Deviation (in italics) of fuel consumption (FC), mean vessel speed (VS), and daily fuel consumption (DFC) for the first (PB01-NA) and second (PB02-AM) monitored vessel

Fuel consumption during steaming and searching operations

	PB01-NA			PB02-AM		
VS[kn]	FC[l/h]	*d*FC[l/h]	*d*FC%	FC[l/h]	*d*FC[l/h]	*d*FC%
9.0	63.20	-	-	62.43	-	-
9.5	72.73	9.53	13.10%	75.75	13.31	17.58%
10.0	83.09	10.36	12.47%	90.99	15.25	16.76%
10.5	94.31	11.22	11.90%	108.34	17.34	16.01%
11.0	106.42	12.11	11.38%	127.94	19.60	15.32%
11.5	119.44	13.02	10.90%	149.98	22.04	14.69%

Mean fuel consumption rate FC[l/h], obtained during the steaming condition (*sailing, schools searching operations*) through vessel speed VS[kn]. *d*FC[l/h] and *d*FC% are the estimated fuel saving and the ratio of the fuel saving in percentage respectively.

PB01-NA

LOA: 27.00 m; GRT: 117.71; Engine power: 809 kW; Propeller design: controllable pitch.

PB02-AM

LOA: 28.95 m; GRT: 117.71; Engine power: 940 kW; Propeller design: fixed pitch.

Investment required for the adaptation

The financial investment for one complete *CorFu-m* system, which is made up of two mass flow sensors one Multi Channel Recorder, including the electrical and mechanical fittings with installation and system tests is estimated around 9 kEUR.

Description	Qty Nr.	Cost Unit. [k€]	Total Cost [k€]
Mass flow sensors	2	3.50	7.00
Multi Channel Recorder	1	1.30	1.30
Electric fitting	1	0.40	0.40
Mechanic fitting	1	0.25	0.25
Total			8.95

Working Group for Fisheries Co-operation (AG-Fisk)
New technology for the Nordic fishing fleet - Fishing gear and effective catch handling
Workshop in Reykjavik, October 1-2, 2013

Fuel efficiency and fisheries' carbon footprint reduction

Where the energy is going? Energy Audit in fisheries

Antonello Sala

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Definition of Energy Audit

Regulatory references

- ✓ *Council Regulation (EC) Nr.* ***2371/2002****, Art. 33: "Conservation and sustainable exploitation of fisheries";*
- ✓ *Council Regulation (EC) Nr.* ***744/2008*** *del 24/07/2008: "A Community contribution should also be provided for collective actions aimed at delivering expertise to vessel owners in relation to* ***energy audits*** *for vessels".*

Energy audit is a systematic approach to evaluate energy consumption in fisheries.

Objectives

- to define the energetic profile of the fishing vessel trough energy indicators;
- to identify technological improvements;
- to evaluate technical and economical benefits of improvements.

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Energy Audit of a fishing vessel

1. **Preliminary investigation and inspection of fishing vessel;**
2. **installation of the instrumentations on board of fishing vessel;**
3. **sea trials during commercial cruises;**
4. **data post-processing;**
5. **evaluation of energy performance indicators;**
6. **evaluation of energy profiles obtained.**

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Measurement system: instrumentation installed

Instrumentation	Parameter
Fuel flow meters	Fuel consumption
Torque meter and shaft RPM counter	Delivered power
Oil flow and pressure meter	Hydraulic power
Ammeter claws	Electric power
Strain gauges	Gear drag
GPS	Position, course, speed
Gear monitoring system	Trawl geometry

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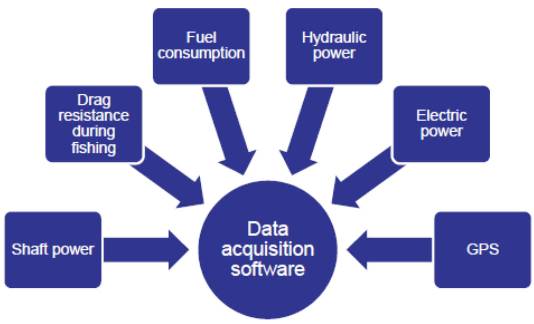
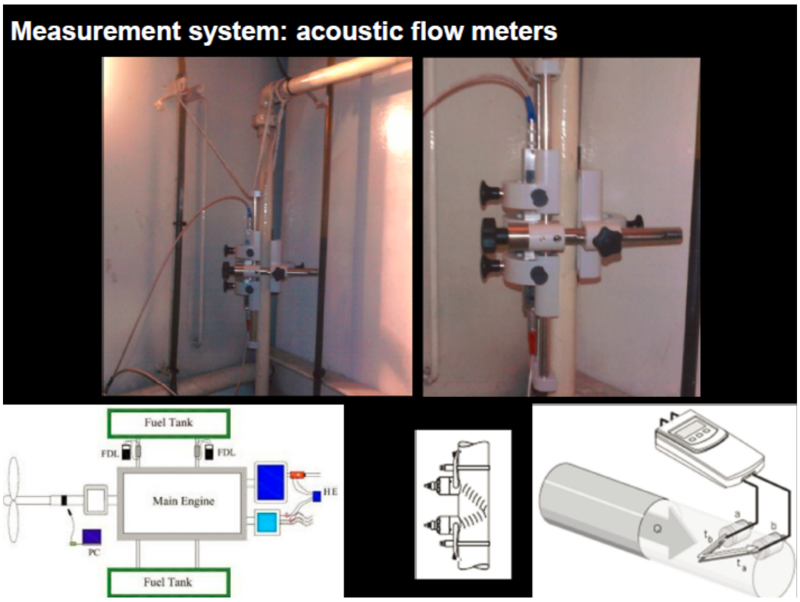
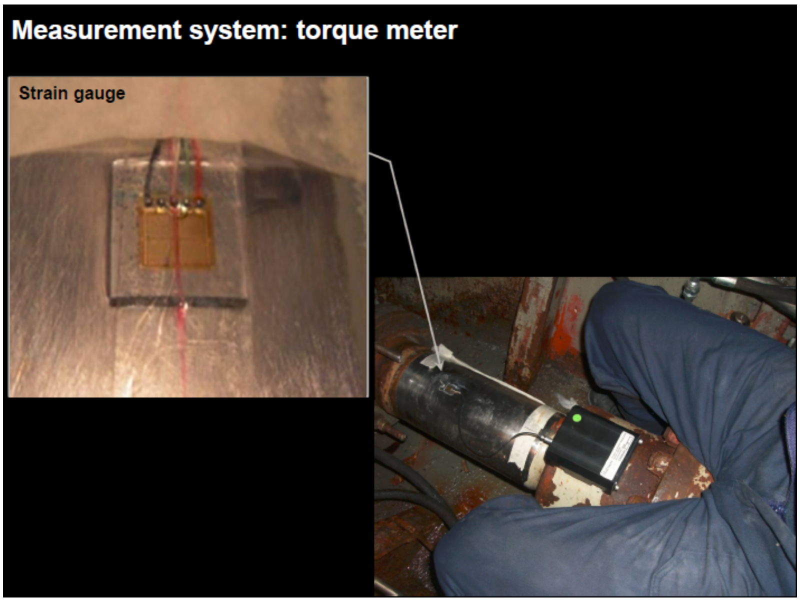
Measurement system: data acquisition software



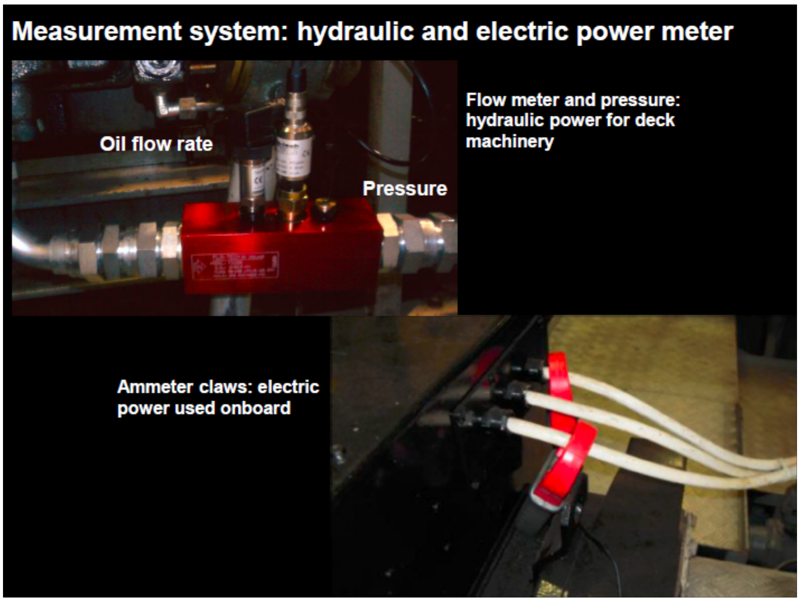
Data acquisition system conceived at CNR–ISMAR

- Post-processing and data synchronization;
- Control of the correct functioning of the acquisition;
- Data recording rate of 5 seconds.


Measurement system: acoustic flow meters
Fuel Tank
FDL
FDL
Main Engine
HE
PC
Fuel Tank


Measurement system: torque meter
Strain gauge


Measurement system: torque meter
RPM counter



Main characteristics of the vessels monitored

	L_{OA} [m]	L_{PP} [m]	B [m]	GRT [GT]	P_B [kW]	D [m]
OTB1	21.5	17.0	5.7	82	478	1.78
PTM1	28.6	21.2	6.9	99	940	2.18
OTB2	22.8	19.6	6.2	91	574	1.80
PTM2	29.0	24.3	6.9	138	940	2.20
OTB3	21.5	17.0	5.7	82	478	1.78
PTM3	26.5	21.5	6.8	96	870	2.20
OTB4	22.8	19.6	6.2	91	574	1.80
PTM4	25.5	20.1	6.6	132	772	2.00

OTB, PTM *bottom otter trawler; midwater pair trawler*
L_{OA} *length overall*
L_{PP} *length between perpendiculars*
B *beam*
GRT *international gross tonnage*
P_B *brake power*
D *propeller diameter*

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Energy performances indicators

Energy Consumption Indicator (ECI)

$$ECI = \frac{E_T}{P_D \cdot v}$$

$$[\text{ECI}] = \frac{[\text{kJ}]}{[\text{kW}] \cdot [\text{kn}]}$$

Fuel Consumption Indicator (FCI)

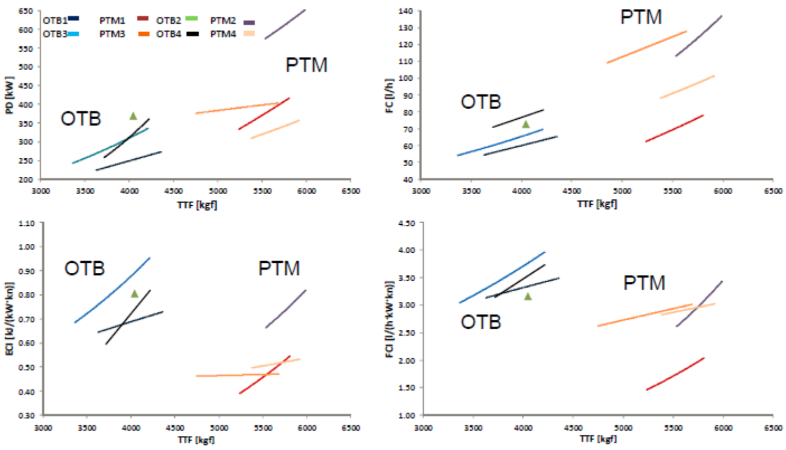
$$FCI = \frac{F_C}{P_D \cdot v}$$

$$[\text{FCI}] = \frac{[l/h]}{[\text{kW}] \cdot [\text{kn}]}$$

By fishing phase (e.g. sailing, trawling)

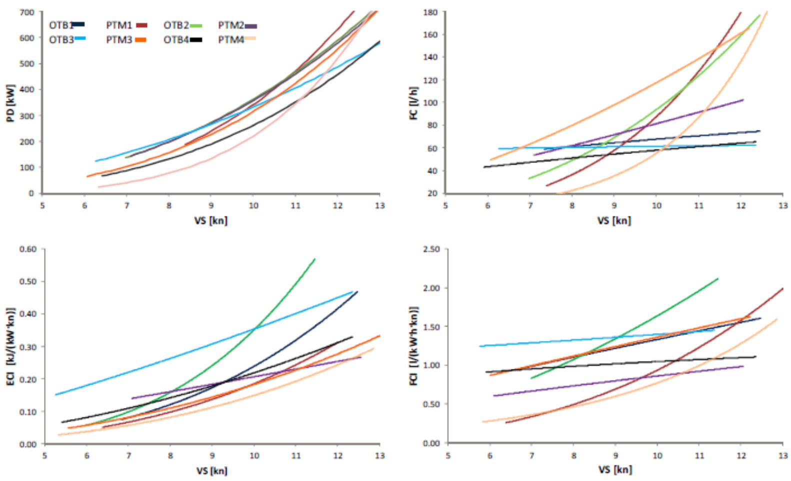
E_T *Total energy*
F_C *Total fuel consumption*
P_D *Power delivered*
v *Vessel speed*

Results: trawling phase



PD ***power delivered*****; FC** ***fuel consumption*****; TTF** ***total towing force*****; ECI** ***energy consumption index*****; FCI** ***fuel consumption index*****; OTB** ***bottom otter trawler*****; PTM** ***mid-water pair trawler.***

Results: sailing phase



PD *power delivered*; FC *fuel consumption*; VS *vessel speed*; ECI *energy consumption index*; FCI *fuel consumption index*; OTB *bottom otter trawler*; PTM *mid-water pair trawler*.

Results: ranking for vessels monitored

ECI of trawling and sailing conditions have been pooled.

PD *power delivered*; FC *fuel consumption*; ECI *energy consumption index*; FCI *fuel consumption index*; OTB *bottom otter trawler*; PTM *mid-water pair trawler*.

	Fishing				Sailing			
	ECI	FCI	ECI/FCI	Rank	ECI	FCI	ECI/FCI	Rank
OTB1	0.69	3.32	0.21	6	0.22	1.45	0.15	6
PTM1	0.47	1.76	0.27	1	0.20	1.00	0.20	3
OTB2	0.81	3.16	0.25	2	0.32	1.56	0.21	4
PTM2	0.74	3.01	0.25	3	0.21	0.88	0.24	2
OTB3	0.83	3.56	0.23	4	0.28	1.36	0.21	1
PTM3	0.47	2.84	0.16	8	0.16	1.32	0.12	8
OTB4	0.71	3.36	0.21	5	0.15	1.01	0.15	5
PTM4	0.52	2.93	0.18	7	0.15	0.87	0.17	7

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Main conclusions

- Monitored fishing vessels were not so efficient because of outdated technology. Restrictions on new constructions impose modernizations;
- Energy saving is the key to maintain acceptable and sustainable profitability in fisheries;
- An energy saving strategy is necessary in order to find potential areas of improvements;
- Gains in propulsive efficiency during free navigation might be attained using a controllable pitch instead of a fixed pitch propeller, which can permit an optimum combination of pitch ratio and propeller revolutions for each operating condition;
- In the steaming conditions fuel saving can be obtained by reducing vessel speed;
- Other energy users (hydraulic and electric users) did not show to have noticeably influenced energy consumption, compared to the propulsion system.

Working Group for Fisheries Co-operation (AG-Fisk)
New technology for the Nordic fishing fleet - Fishing gear and effective catch handling
Workshop in Reykjavik, October 1-2, 2013

Fuel efficiency and fisheries' carbon footprint reduction

Improvement of otterboard design

Antonello Sala

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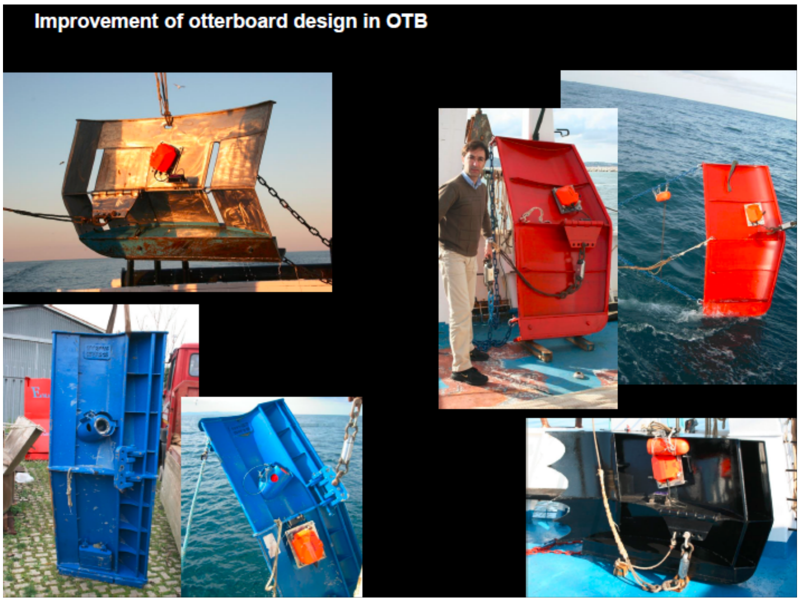
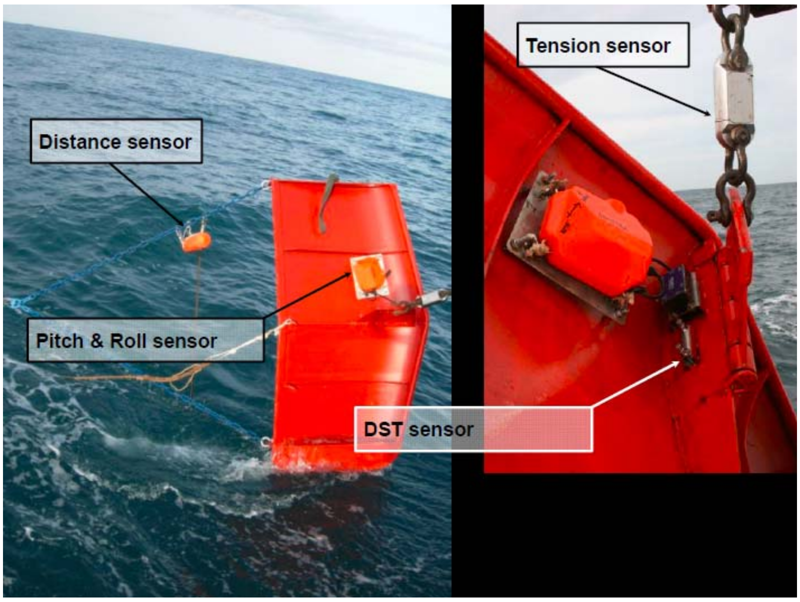
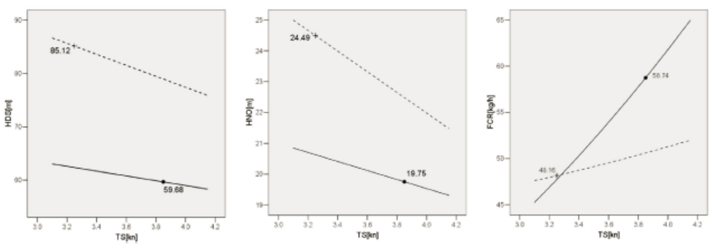




Consiglio Nazionale delle Ricerche

Comparison between the traditional VEE (VEE) and the Thyboron type VF15 (VF15) otterboard



Test comparison between the traditional VEE otterboard (circle points and continuous line) and the Thyboron type VF15 otterboard (cross points and dotted lines). HDS[m]: horizontal door spread; HNO[m]: horizontal net opening; FCR[kg/h]: fuel consumption rate; TS[kn]: towing speed. Values at TS of 3.25 and 3.85 kn were reported for the VF15 and the VEE otterboard respectively.

Comparison between the traditional VEE (VEE) and the Thyboron type VF15 (VF15) otterboard

Parameter		VEE	VF15	Diff.	Diff%
TS	[kn]	3.85	3.25	-0.60	-15.6%
HDS	[m]	61.13	86.57	25.45	41.6%
HNO	[m]	19.88	24.61	4.74	23.8%
VNO	[m]	1.67	1.70	0.03	1.6%
FCR	[kg/h]	58.74	48.16	-10.59	-18.0%
AEH	[1000m^2]	141.72	148.15	6.43	4.5%
FCH	[kg/1000m^2]	0.41	0.33	-0.09	-21.6%

Mean value of horizontal door spread (HDS); horizontal net opening (HNO); fuel consumption rate (FCR); vertical net opening (VNO); towing speed (TS); area explored in 1-hour-haul (AEH); fuel consumption per area explored (FCH).

Catch comparison between the traditional VEE (VEE) and the Thyboron type VF15 (VF15) otterboard

Door	COM [kg/h]	DEB [kg/h]	DIS [kg/h]	FC [kg/h]	COM [kg fish / kg fuel]
VEE	12.98	3.15	25.98	58.74	0.22
VF15	12.33	3.42	16.05	48.16	0.26
Diff.	-0.65	0.27	-9.93	-10.59	0.04
Sig. p	*0.883*	*0.916*	*0.303*		

COM: total commercial catch per hour;
DEB: total debris per hour;
DIS: total discards catch per hour.

Economic analysis

Fishing operation	Day: Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total: Weekly	Yearly
Steaming to and from fishing grounds	2	2	1	1	0	0	0	6	282
Shooting and hauling gears	4	4	4	2	0	0	0	14	658
Fishing	15	15	16	7	0	0	0	53	2491
Searching	0	0	0	0	0	0	0	0	0
Time in harbour during Working weeks	3	3	3	14	24	24	24	95	4465
Total	24	24	24	24	24	24	24	168	7896

Profile for a vessel of Ancona (Italy)	
Working hours/week	168
Closed weeks per year	5
Trawling hours/year	2491
Fuel cost (EUR/l)	0.60

Door investement	EUR
VEE	3,500
VF15	7,000
Extra Investement	3,500

Fuel cost per year	
VEE	70,238
VF15	57,580
Comparison	*12,658*

Conclusions

The VF15 otterboard produced horizontal openings much greater than those obtained with the VEE otterboard, but with less fuel demands.

The greater horizontal openings obtained with the VF15 have surely increased the net drag, therefore improvements of around 18% in the fuel saving, due to the change of the door, might have been underestimated.

Monitoring the height of the otterboards above the bottom has required appropriate acoustic instruments which have been used to adjust the door height by altering the towing speed and the trawl warp length.

The investment for two VF15 otterboards, including all the rigging components (weight, backstrops chains, etc.) is estimated at around 7.0 KEUR. A lower investment of 3.5 KEUR is required for the VEE otterboards.

Assuming that the catching power is equal for the two doors, the payback time for the new door investment will be less than 4 months.

Project Information collection in energy efficiency for fisheries (ICEEF)

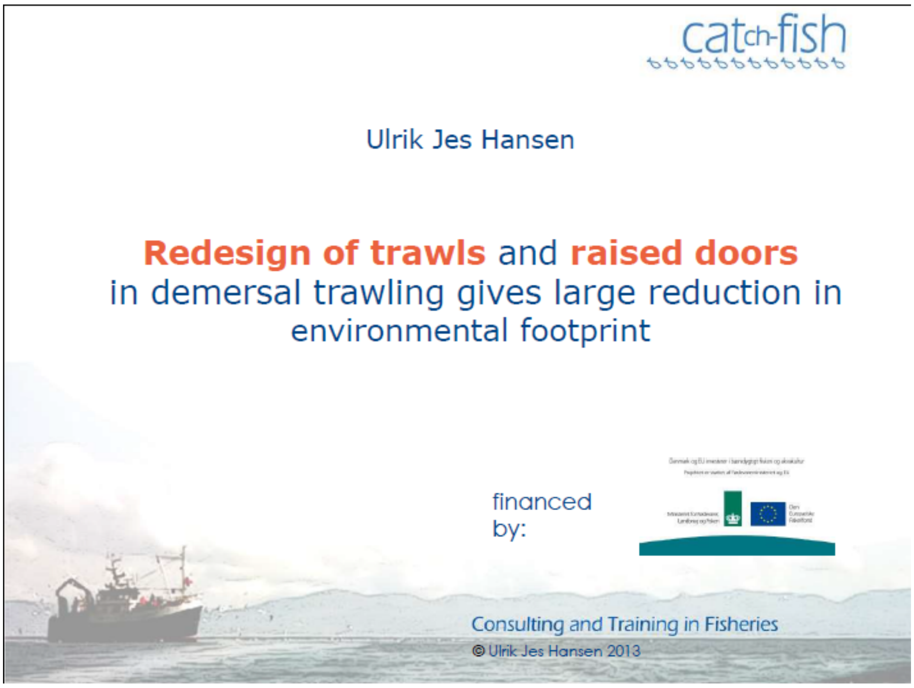
https://energyefficiency-fisheries.jrc.ec.europa.eu

Please visit the website, navigate through its pages and help us to improve its content. If you have any relevant material for inclusion on the site or any other suggestion, please send it to:

- energyefficiency-fisheries@jrc.ec.europa.eu
- a.sala@ismar.cnr.it
- e.notti@an.ismar.cnr.it

5.8 Redesign of trawls and raised doors in demersal trawling

Presented by Ulrik Jes Hansen from CATch-Fish in Denmark



catch-fish

Background

- Fuel costs are nearly 40 % of the operating costs of a modern fishing vessel and by far the largest operating cost
- Fuel costs will increase in future
- A new EU fisheries policy based on catch quotas will create incentives to use more efficient gear.
- Environmental concerns over towed fishing gear

Consulting and Training in Fisheries

catch-fish

Objective

- Reduce fuel consumption by 30-40 % per unit of catch.
- Reduce contact with the seabed
- Economic improvement due to result based fisheries management system
- Effort limitation and gear design rules are inferior to result based management

Consulting and Training in Fisheries

catch-fish

Best Available Technology

- Dyneema warps
- Pelagic Doors w/ heigth sensors
- Twin rig
- Dyneema trawls with nylon bands for elasticity
- 4-panel trawls, for better control
- T90 in codend for larger catches
- Redesigned trawls:
  - Huge trawls to compensate the reduced netting drag
  - Side panels – easier to manipulate trawl shape
  - Flymeshes (= drop-meshes) - large spread
  - T90 in belly - reduced drag from stickers, debris and algae, and large x-section area

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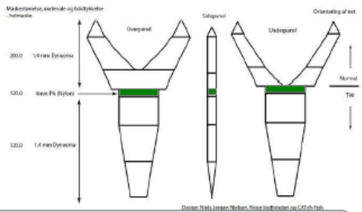
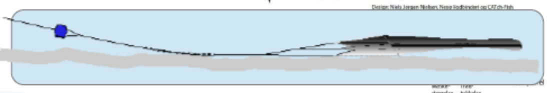
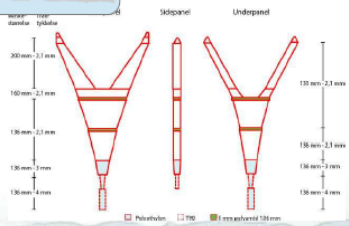
Specs







Consulting and Training in Fisheries

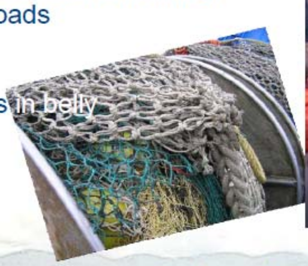
Materials

Dyneema

- Wings, square and belly 1,1mm – 2,0 mm
- Countless loads close to breaking,
  - but not peak loads

PA – Nylon

- Narrow sections in belly
- Codend



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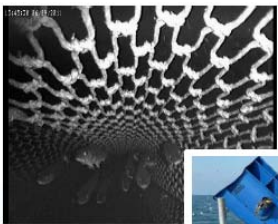
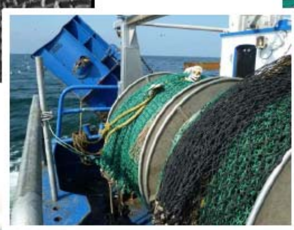
T90



T90



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Results

Vessel 17 m - Baltic cod

- Fuel cons. - 7.5%
- Catch per hour +17%
- Catch per litre +26%
- Combined effect +40%
- Investment 52,000 €
- Payback time 11 months
- Profitability +48%

Vessel 31 m - whitefish in the North Sea

- Catch +18%
- Gross earnings +13%
- Investment 120,000 €
- Payback time 7 weeks

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Conclusions – Trawl doors

- The doors contribute by 15% savings
- The shoe of the door

after 12 months in use:

- No maintenance

Consulting and Training in Fisheries

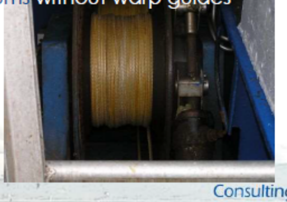
Conclusions – Dyneema warps

No cover on smaller diameters

New and used warp

Nylon sheaves

Warp drums without warp guides



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Conclusions – Dyneema nets

- No elasticity – therefore narrow sections of PA
- Reduced twine area should be used to build larger nets
- T90 to reduce increased amount of debris and algae (?)
- Longer lasting nets due to less uptake of sand etc. (?)
- Codend in thicker twine – PET or PA

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catch-fish

Thank you!

Aquamind, project leader

Local netmanufacturers, trawl design

Thyborøn Trawl Doors

CATch-Fish, gear design

Danish Technological Institute
(energy consumption measurements)

Local skippers, net manufacturers and fishermen associations

Contact:
Ulrik Jes Hansen – ujh@catch-fish.net
Poul Tørring – pt@aquamind.dk

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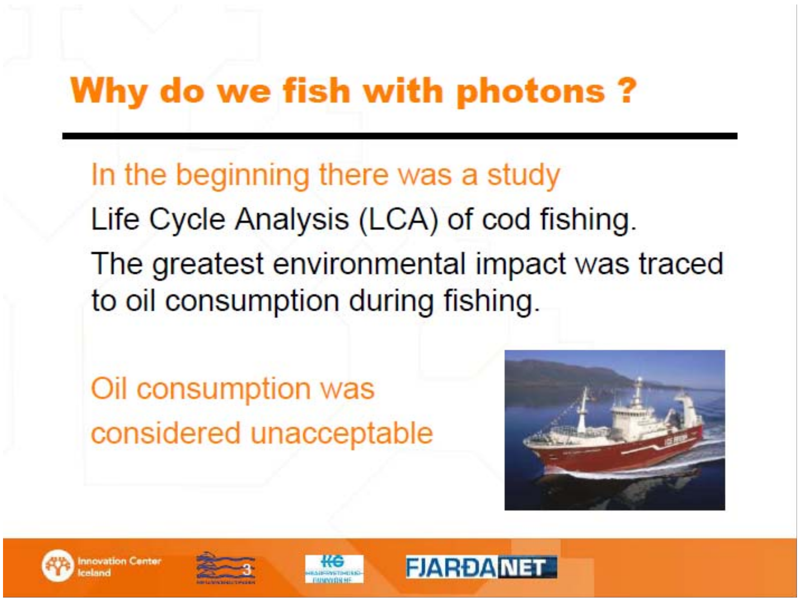
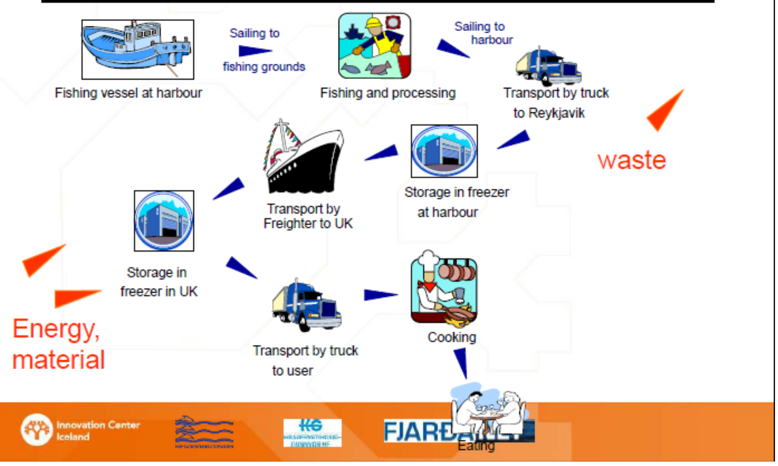
5.9 The light trawl

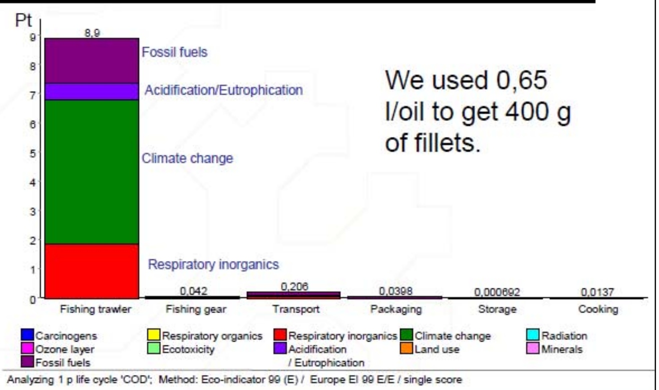
Presented by Halla Jónsdóttir from Innovation Centre Iceland



LCA: Environmental effects of fish on the consumers dish



Results: Environmental effects

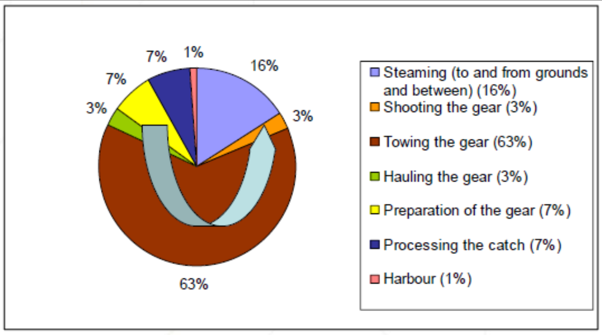


We used 0,65 l/oil to get 400 g of fillets.

Interesting values

- To catch 1 kg of ungutted mixed catch - on average 0,65 L oil was needed which gives approximately 400 g of fish fillets.
- The emission of CO_2 was around 1800 g for 1 kg of mixed catch
- The area swept per 1 kg of mixed catch is estimated to be 1000 m^2

Oil usage during fishing



More than 70% of the total oil consumption in a fishing trip is used to operate the fishing gear

The problem to focus on

Is the present fishing gear

- based on towing a rope through water
  = high drag = high energy consumption
- The trawls are
  - Energy consuming
  - More than a century old technology
  - Criticized for damaging sea bed

Our vision is !

- To reduce environmental effects
- To reduce energy per unit catch
- To produce a bottom trawl that will not damage the bottom

Our questions?

- Can we catch fish without touching it ?
- Can we release unwanted fish, for example desired brood stock or fish we do not have quota for ?

The way forward

Is to replace present drag causing gear with a structure that does not produce drag

Can we play on the sensory organs of fish ?

- Eyes - vision
- Chemoreceptors - taste and smell
- Lateral line system - currents and vibrations
- Electric currents

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The research question

How can we play on fish senses ?

Innovation Center Iceland FJARÐANET 11

Light in sea water

- Light beam produces visible virtual structure in sea water.
- The fish perceives the light beam as a solid rope.

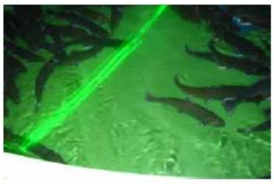
We know that we can attract fish with light

But our Question is

Can we herd fish with drag-free light beams ?

Innovation Center Iceland FJARÐANET 12

We can herd fish with light



Arctic charr in a tank

↓

Fish avoid the light

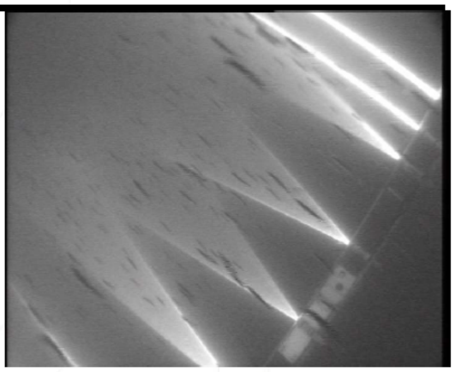
Can we do this in real situation in the actual fishing ground ?

?? !!!

Does it work ? – Prototype 1

During a fishing trip. You see lights, the trawl structure and fish being herded

BUT !!!



Prototype II

- Is in development
- Will be water tested this year

The goal is

A valuable innovative product

- That uses only half of the energy
- That meets the demands of sustainable fisheries

Technical progress

Ability expected

- To be positioned at an exactly defined place in the sea column (>40 cm above sea bottom)
- To herd fish with light

Specially designed

- Trawl winch
- Towing cable
  - High speed Ethernet connection
  - Power supply
- Lights
  - Beams move x/y -axes
  - Patterns can be made

Who are members of the crew ?

Innovation Center Iceland; Halla Jónsdóttir, Geir Guðmundsson, Torfi Þórhallsson, Jón Matthíasson, Ingólfur Örn Þorbjörnsson, Þorsteinn Ingi Sigfússon, Nils Gíslason, etc.

Icelandic Marine Research Institute; Einar Hreinsson, Hjalti Karlsson etc.

Hraðfrystihúsið Gunnvör; Einar Valur Kristjánsson

Fjarðanet; Jón Einar Marteinsson, Magni Guðmundsson

Various subcontractors

Supported by, TÞS, AVS, Átak til Atvinnusköpunar, V.V. Several companies etc.

Technical challenges

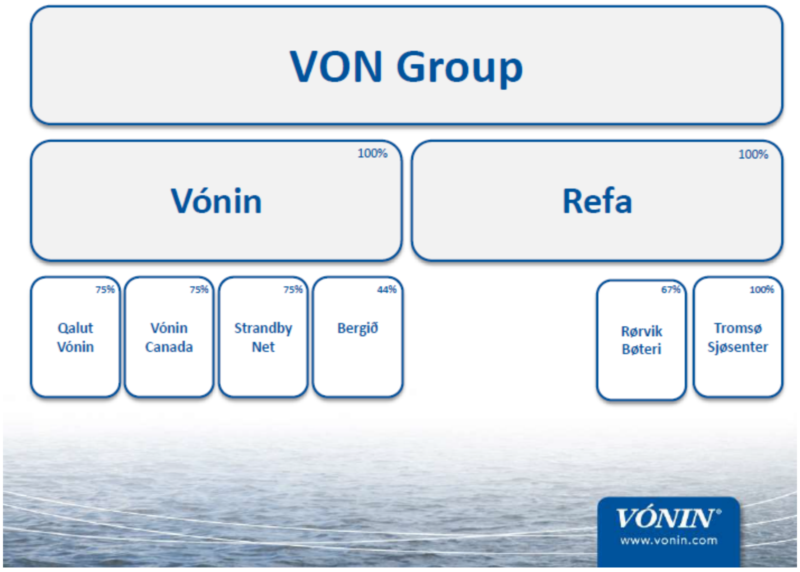
We are solving technical problems in the depths
-pressure, water and rough conditions

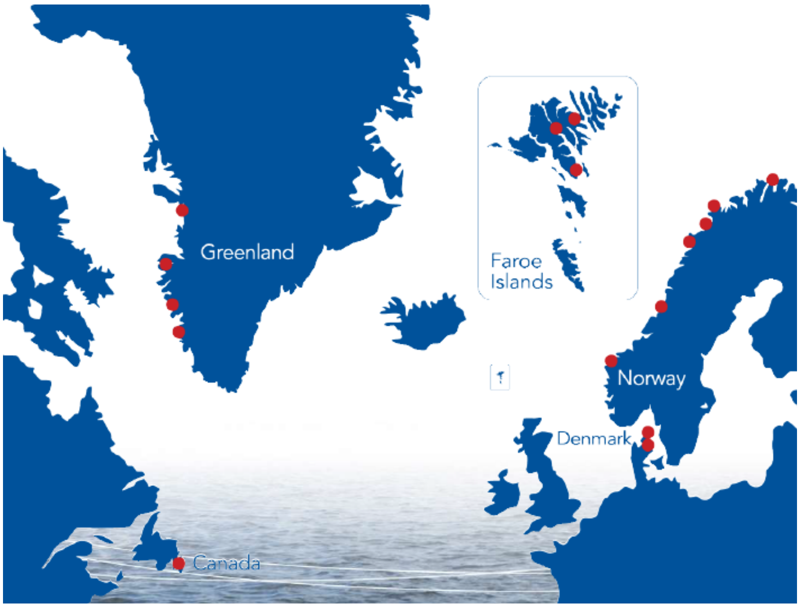
- Pressure vessels
- Electricity
- Data transfer
- Effects of light
- Keeping a given distance off the seabed

Innovation Center Iceland FJARÐANET 20

5.10 Developments on trawl technology, seen from a netmakers view

Presented by Kristjan Zachariassen from Vonin Ltd. In the Faroe Islands





Our focus are on

- Fishing effiency
- Oil consumption
- Selectivity
- Bottom impact
- User friendliness

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www.vonin.com

Oil Consumption

- Materials
- Design
- Optimize the opening for the species

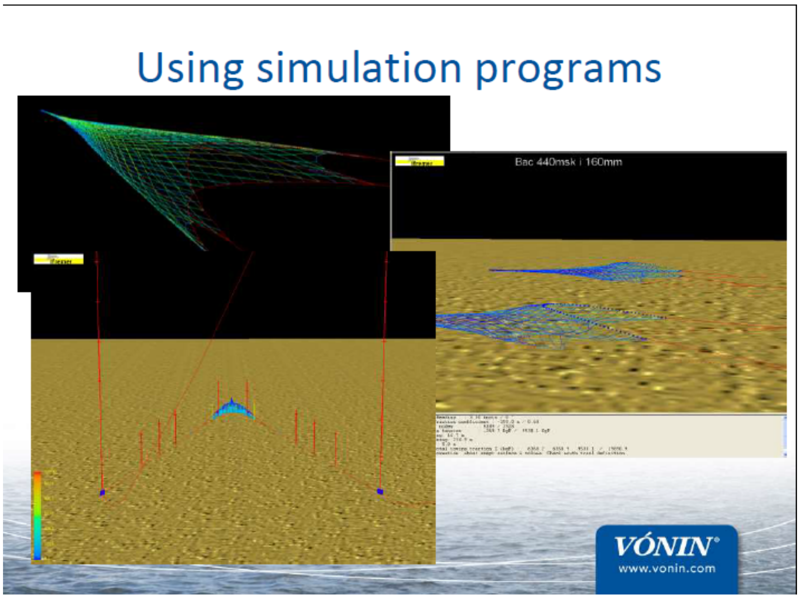
Better materials allows using thinner materials= less resisdance

but

Stronger materials more expencive

Design

Make a big difference in restinance


Using simulation programs
Bac 440msk i 160mm
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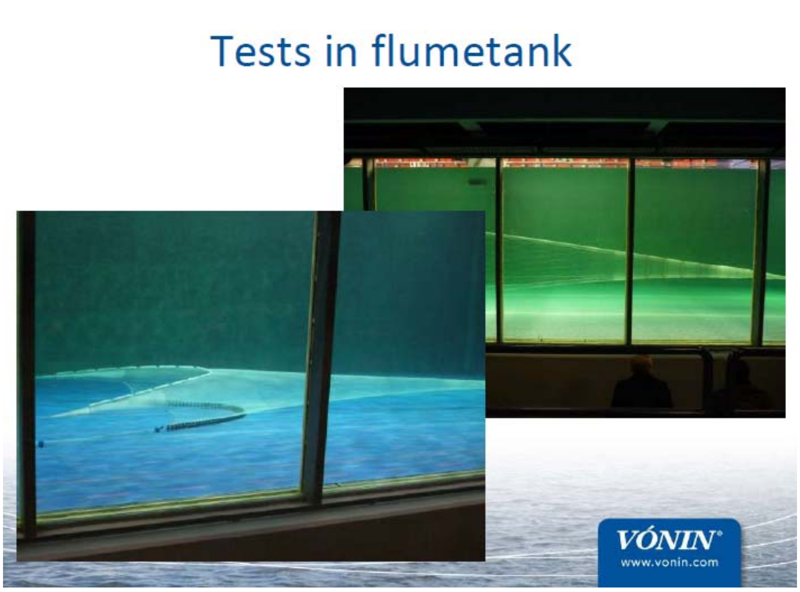
Tests in flumetank
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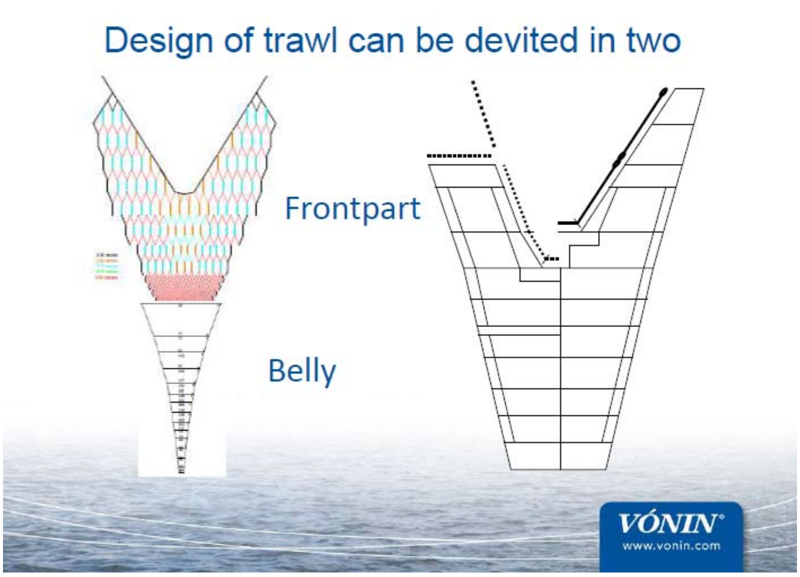
Design of trawl can be devited in two
Frontpart
Belly
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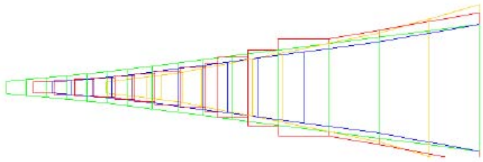
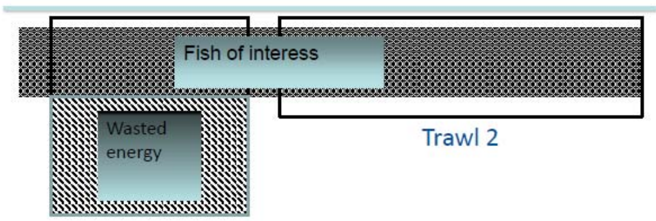
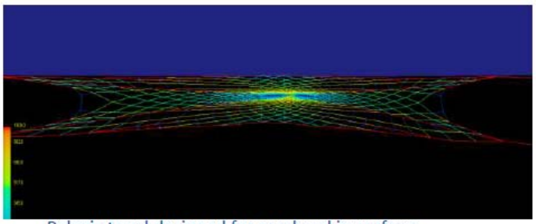
Design of the aft part of the trawl have big influence on the resistance

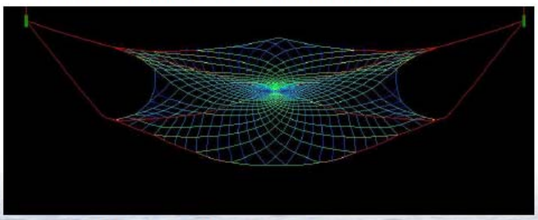


Design the trawl for the fish species

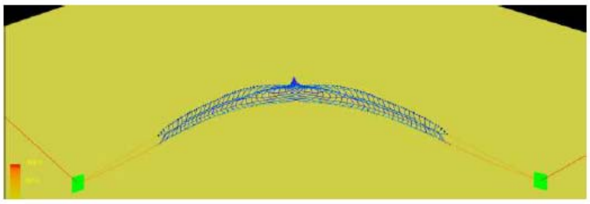




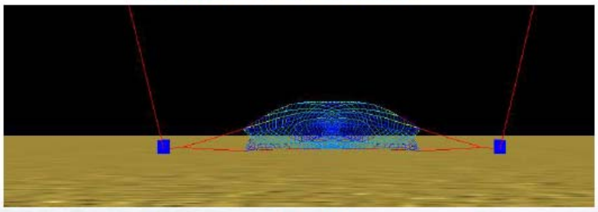
Pelagic trawl designed for mackerel in surface



Pelagic trawl for different species

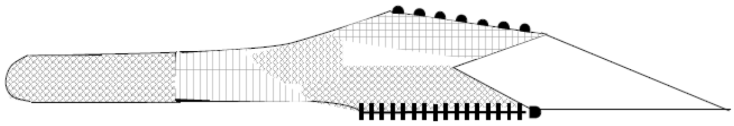


Bottomtrawl for monkfish



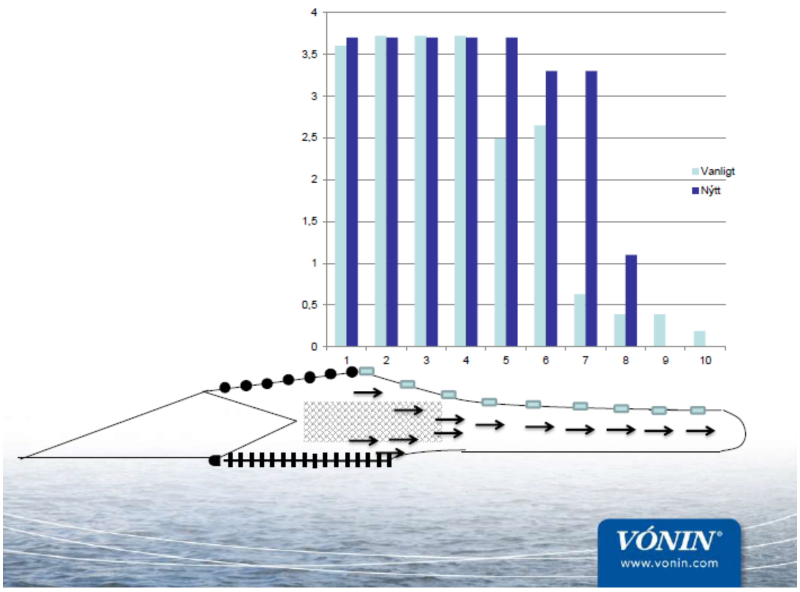
Bottomtrawl for different species

Optimal meshsize for the fish species



Also work with the waterflow in the trawl and fish behaviour

Using Aqua Dop and Underwater camera



Vanligt
Nýtt
VÓNIN
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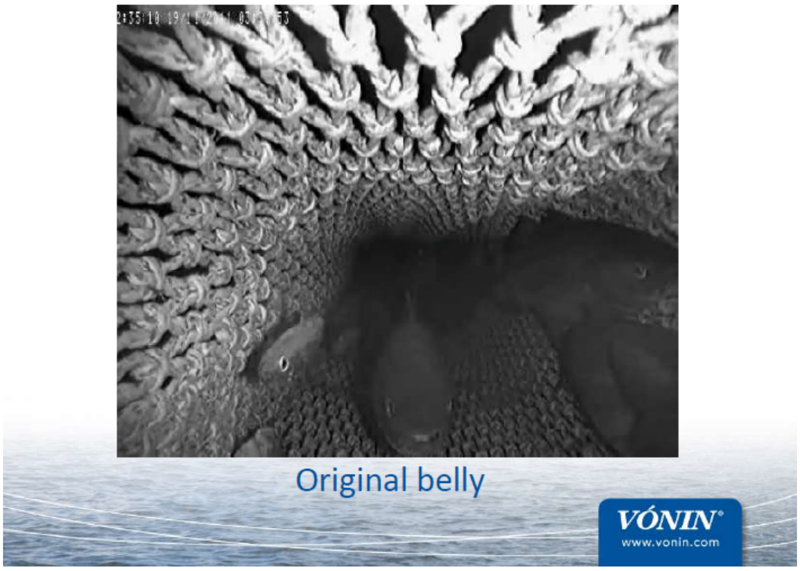

Original belly
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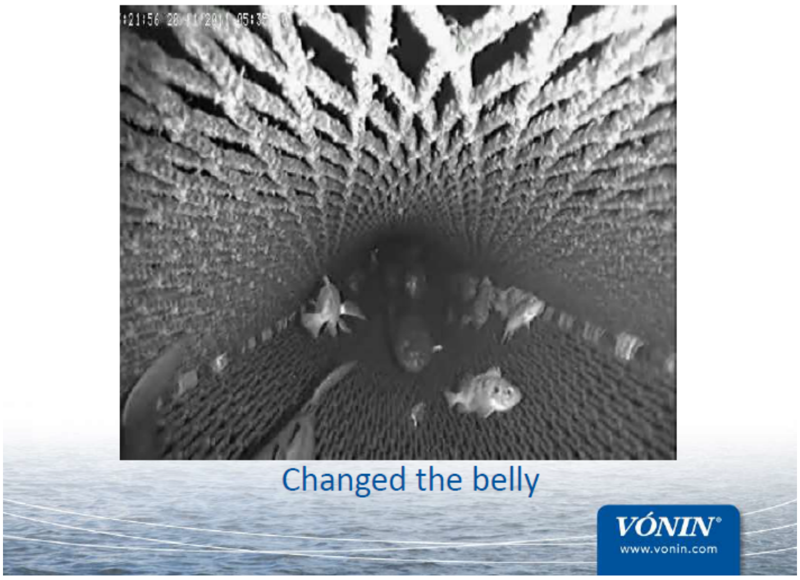

Changed the belly
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Selectivity

Selectivity can be both mandatory and voluntary

Fx Shrimp fishery, Blue whiting fishery, Cod Fishery and Mackerel Fishery

Trying to optimize the sorting grids

Work with the design and the materials

Do also work with selective devices where not mandatory


Blue Whiting grid
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Shrimp Grid
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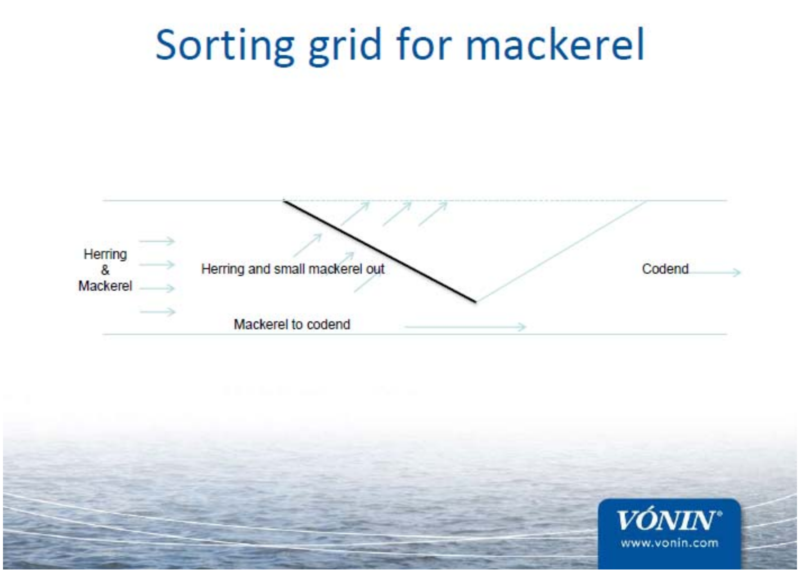
Sorting grid for mackerel
Herring
&
Mackerel
Herring and small mackerel out
Codend
Mackerel to codend
VÓNIN
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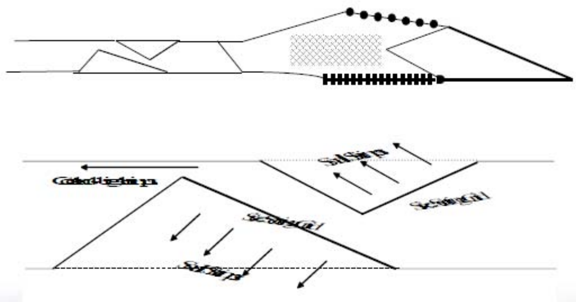
Sizesorting grid for shrimps



Bottom impact

Bottom trawl needs to have good bottom contact

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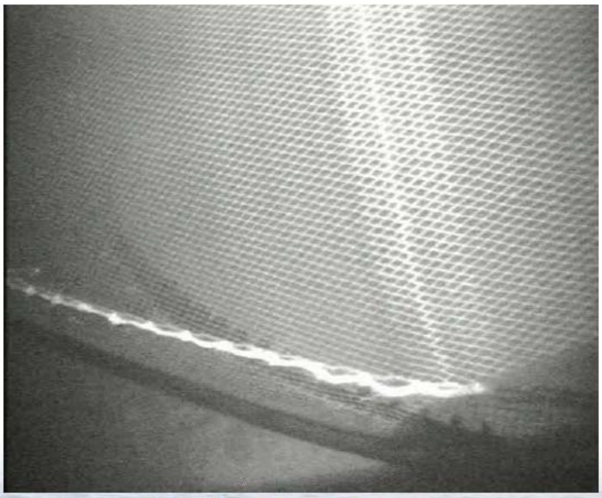

Rockhopper gear

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Alternative gear

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Netmakers need to be aware of the pressure from enviromental organisations

But

Less impact on the enviroment

=

Less oil comsumtion

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Vonin is partner in a big project in Canada to reduce impact from bottom trawling

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User friendliness

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Perhaps the most important

Trawls easy to work with

Can be a challenge

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Few meshsizes

Simple cuttings

Good materials

Double netting on selvegdes

Easy to work with when hauling and shooting

VÓNIN®
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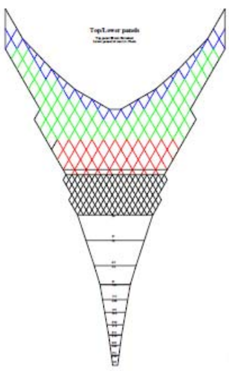
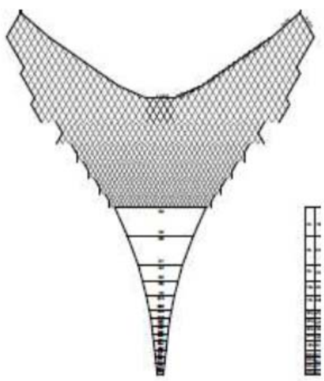


Simple cutting



Complex cutting

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To meet this we think that

Good relationship between customer, research institute and the netmaker is important

VÓNIN®
www.vonin.com

Thank you

VÓNIN®
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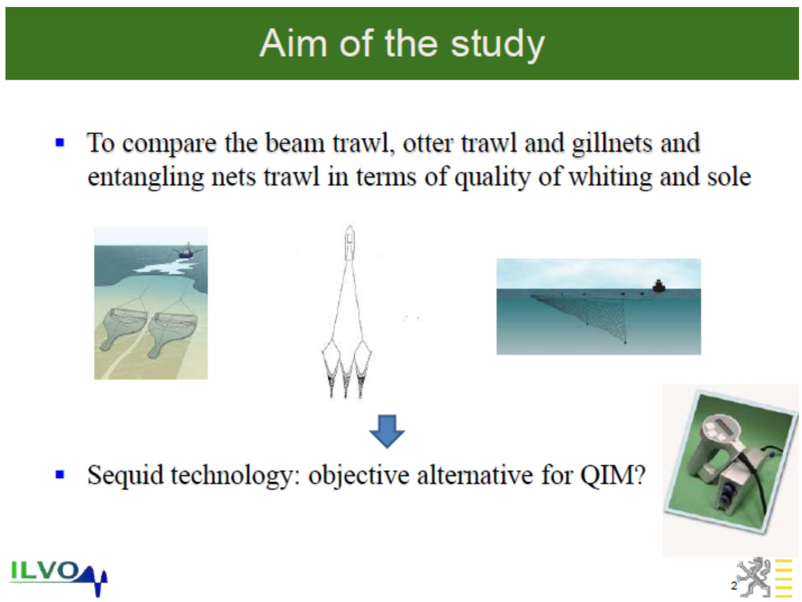
5.11 Effects of fishing gear on quality – the SEQUID project

Presented by Daphné Deloof from ILVO in Belgium



Aim of the study

- Convincing the ship owners and their national association to turn away from the beam trawl in order to switch to an alternative methods

- Improving the image and sustainability of the Belgian fleet, dominated by beam trawlers

3

Materials and methods

- 2011 : data collection on commercial ships (spring;summer;autumn/winter)

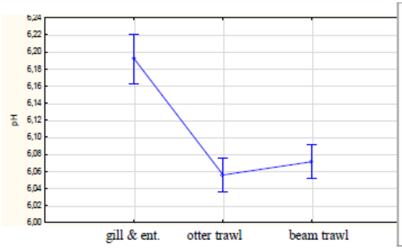
- Analysis on board of commercial ships:
  - Initial muscle pH
  - Onset of rigor mortis
  - External damages – Injury Index Method (IIM)
  - Mortality rate

- Analysis in the lab by shelf life study:
  - QIM
  - TVB-N

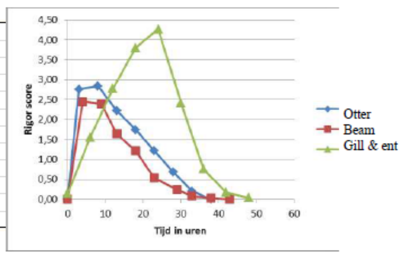
4

pH and rigor mortis in sole

pH



Rigor mortis

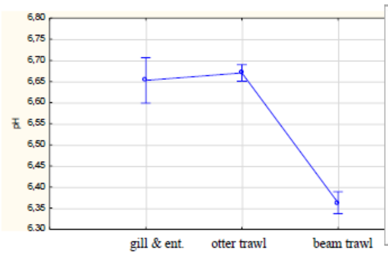


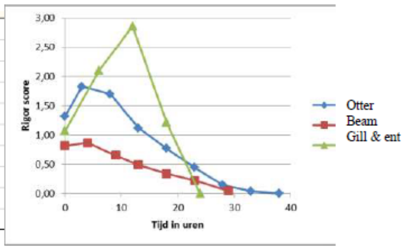
5

pH and rigor mortis in whiting

pH

Rigor mortis

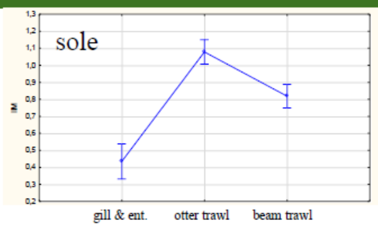


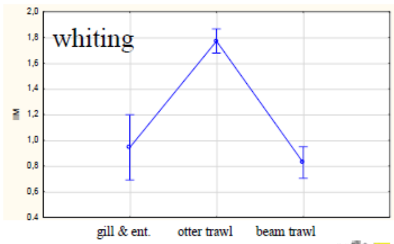


ILVO

Injuries

Injury categorie	Score	Description
Gear-marks	0	No injury
	1	Injury
Scale loss	0	No injury
	1	Moderate (0-50% of the body)
	2	Serious (>50% of the body)
Effusion of blood		
Head	0	No injury
	1	Moderate (weekly red)
	2	Serious (obvious red)
Tail	0	No injury
	1	Moderate (weekly red)
	2	Serious (obvious red)
Body	0	No injury
	1	Moderate (weekly red)
	2	Serious (obvious red)
Crushing of the fish	0	No injury
	1	Moderate (<30% of the body, one spot)
	2	Serious (>30% of the body, more spots)
Broken backbone	0	Broken
	1	Not broken
Fins and tail	0	No injury
	1	Moderate
	2	Serious
SUM	0-14	





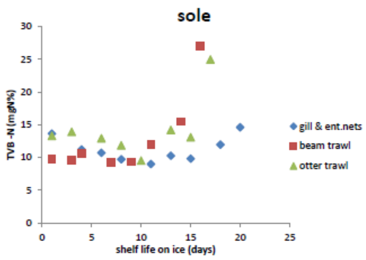
ILVO

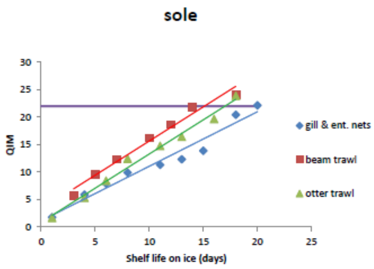
Mortality

	sole	whiting
Otter trawl	9%	7%
Beam trawl	60%	100%
Gill & ent.nets	15%	100%

ILVO 8

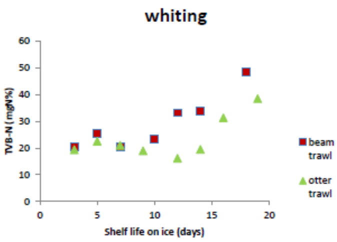
TVB-N and QIM (shelf life studies)

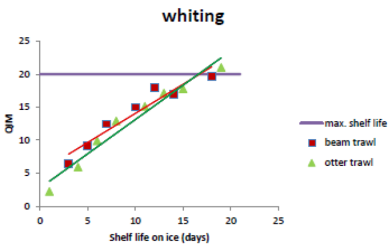




ILVO 9

TVB-N and QIM (shelf life studies)





ILVO 10

Conclusions

- Sole :
  - Gill& ent.nets trawling is less stressful than beam and otter trawling
  - Less injuries with gill& ent.nets trawl, followed by beam trawl
  - Few mortality with otter trawl and gill & ent. nets trawl
  - Shelf life$_{\text{beam trawl}}$ < shelf life$_{\text{otter trawl}}$ < shelf life$_{\text{gill\&ent.nets}}$
- Whiting :
  - Gill& ent.nets trawling is less stressful
  - Significant more injuries with otter trawl
  - Few mortality with otter trawl
  - Shelf life: no significant difference between beam & otter trawl

Changing trawling methods promotes better quality and contributes to more sustainable fisheries

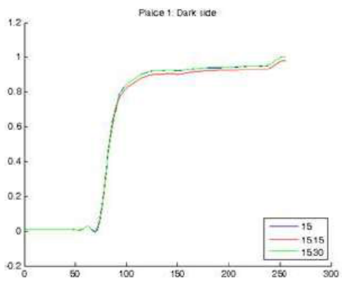
ILVO 11

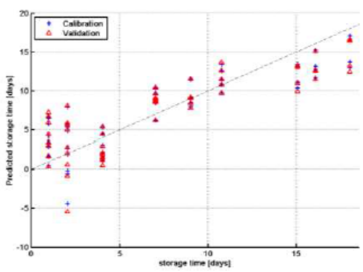
Sequid device: principle

- Objective alternative for QIM? (fish auction/ evaluation of catching methods in terms of fish quality)
- Tested species: sole and plaice
- Technology: diëlectric spectroscopy
- TDR-measurements

ILVO 12

Sequid device: principle



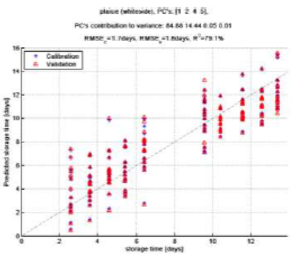


Sequid device : TDR measurement => Statistical PCA analysis
Fourier transformation

ILVO 13

Sequid device: results

Measurements	RMSE (sole)	Measurements	RMSE (plaice)
Dark skin side	2.3 days	Dark skin side	2.1 days
White skin side	2.1 days	White skin side	1.7 days
Deskinned	1.5 days	Deskinned	-
Fillets	1.4 days	Fillets	1.6 days



ILVO

Sequid device: conclusions

- R^2: 70% → 82%
- $RMSE_{\text{with skin}} > RMSE_{\text{deskinned}} > RMSE_{\text{fillet}}$

  $RMSE_{\text{dark skin}} > RMSE_{\text{white skin}}$

- Experiments: tagged samples => reality = more complex!

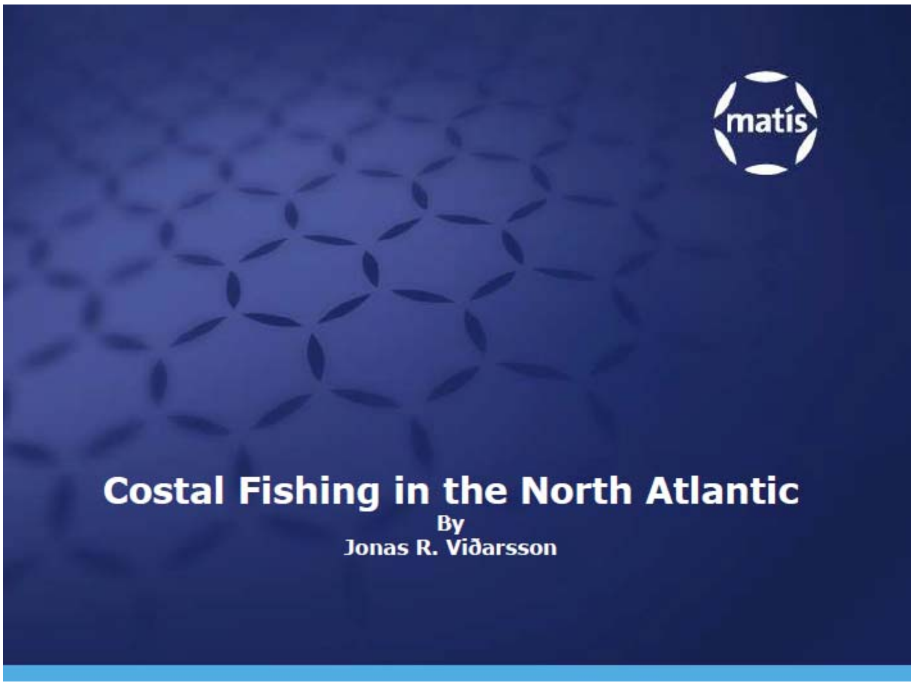
  ⬇

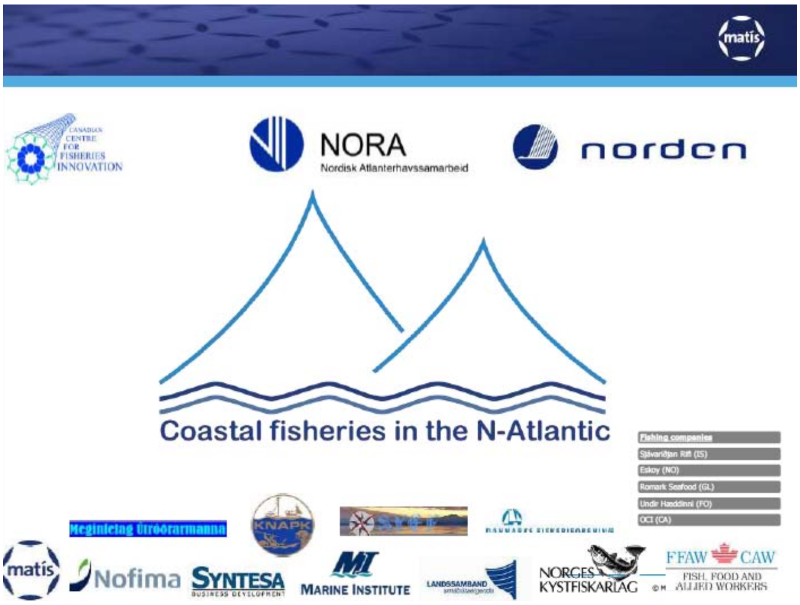
- Need for optimization of hard- and software for sequid device

ILVO

5.12 Coastal fisheries in the North-Atlantic – Project introduction

Presented by Jónas R. Viðarsson from Matís in Iceland





The purpose of the project

The focus of the project is on the coastal fishing fleet in Norway, Faroe Islands, Iceland, Greenland and Canada...............Denmark and Sweden are also included in parts of the project

The project has tree main objectives:

1. **To analyze the coastal fishing fleets in the N-Atlantic**
2. **Facilitate networking between key stakeholders**
3. **Initiate improvements in the value chain of pilot cases were knowledge is transferred and equipment and processes adopted and/or adapted**

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Progress of the project

Standardized reports on the coastal fleets in each country have been drafted and are currently being analyzed.

Next step is to compare the costal fleets of participating countries in respect to:

- ✓ **Fleet composition**
- ✓ **Catch**
- ✓ **Gear**
- ✓ **On-board handling**
- ✓ **Processing**
- ✓ **Logistics**
- ✓ **Marketing**
- ✓ **Etc**

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Challenges in comparison between these countries

What is a small vessel?

- There are different definition on small vessel

What is a Costal Fishing?

- It has not been standardized
- Commercial vs. leisure fishing
- What is most important
  - ➢ Creating jobs
  - ➢ Regional development
  - ➢ Efficiency
  - ➢ Economically feasible
  - ➢ Environmentally friendly

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Networking and workshop

Objective 2 is to facilitate networking

All of the small boat assassinations are partners in the project, which makes it an excellent tool for networking

- www.coastalfisheries.net
- Workshop in January
- Case studies in the second year

Expected impact

Exchange of knowledge

- Economic developing
- Improved on-board handling and quality
- Discussion support for fisheries policy makers
- Social development

Strengthening fishing communities

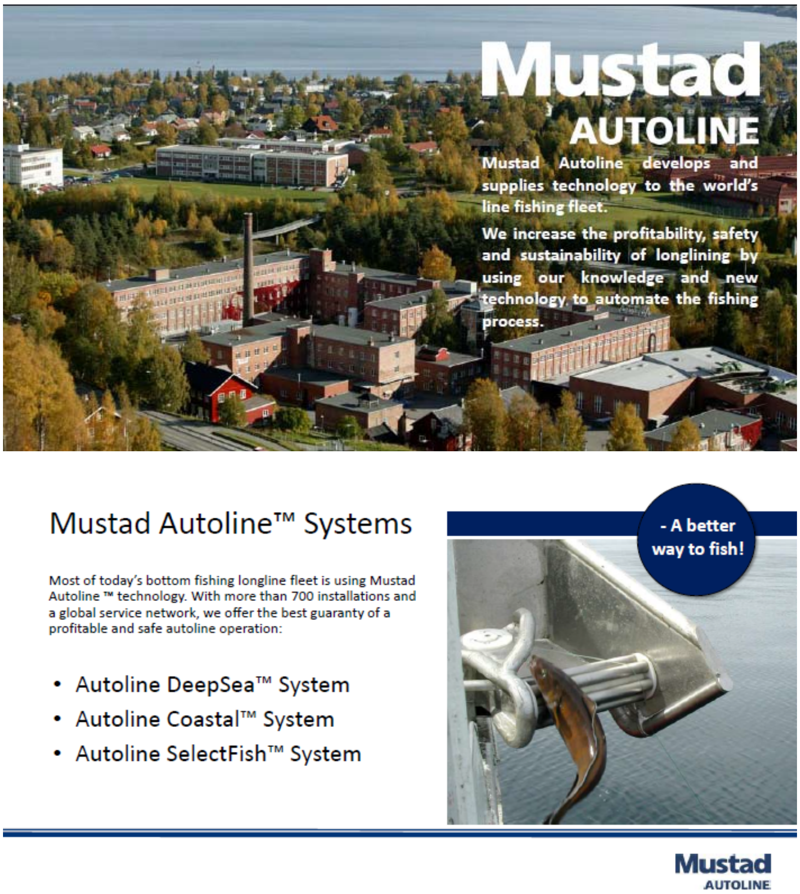
- Economically
- Socially

Transferring capability from one country to another

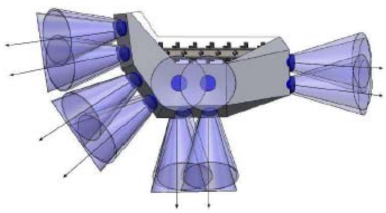
Together we are stronger

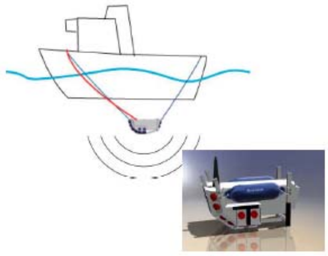
5.13 Autoline fisheries – Investments in efficiency and quality

Presented by Arne Tennøy from Mustad longline in Norway



OrcaSaver Project



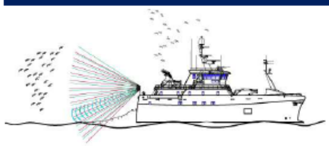


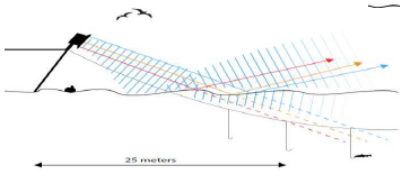
SaveWave

Mustad AUTOLINE

Seabird Saver Project

BirdSaver animasjon





BirdLife

SaveWave

eurostars

Mustad AUTOLINE

Autolining - a passive and sustainable fishing method

- Autolining is a commercial harvesting method that does not harm the seabed, and the impact on the ecosystem is minimal.
- Reduced by-catch - A continuous work is performed to avoid sporadic by-catch of marine mammals and birds.
- Reduced CO_2 footprint per kg. fish
- Fully sustainable with selective fishing

Mustad AUTOLINE

Autolining preserves the quality of the fish

- Individually caught, Immediate bleeding– alive and kicking
- Low stress level and less - Firmer filet
- Increased quality-consciousness among customers require traceability of line caught fish
- High value market demands line caught fish – increasing price differentiation.

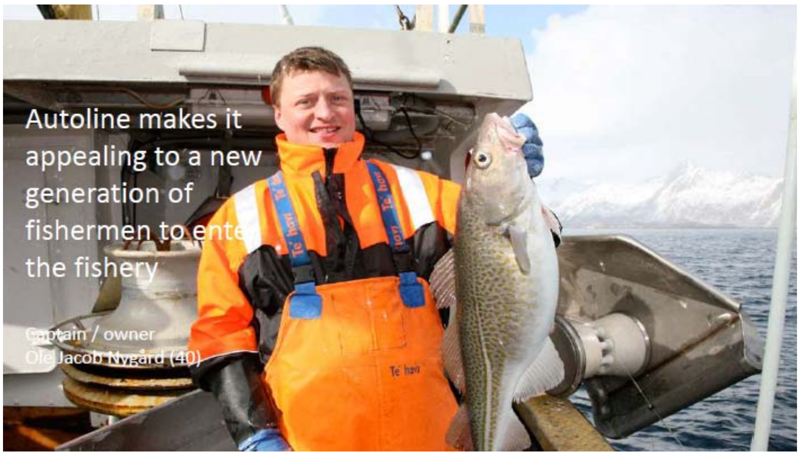
Mustad AUTOLINE

Autoline DeepSea™: Frøyanes

- Ervik Havfiske AS – Norway's larges longlining company
- Modern fishing and shipowning
- Global organisation
- Canning and filleting factory on board
- Setting and hauling approx. 60 000 hooks a day

Frøyanes is the world's most modern Autoliner – working with Mustad DeepSea™ System onboard

Mustad AUTOLINE

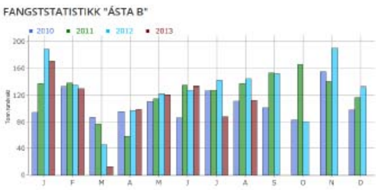


Why invest in automated Longline equipment

- Avoid infrastructure ashore
- Avoid the costs related to handbaiting and the difficulty finding people to do the job
- More flexibility in the choice of port of delivery
- Low maintenance and maintenance cost
- Decide the amount of gear in the fishing field

Mustad AUTOLINE

Case «Åsta B»



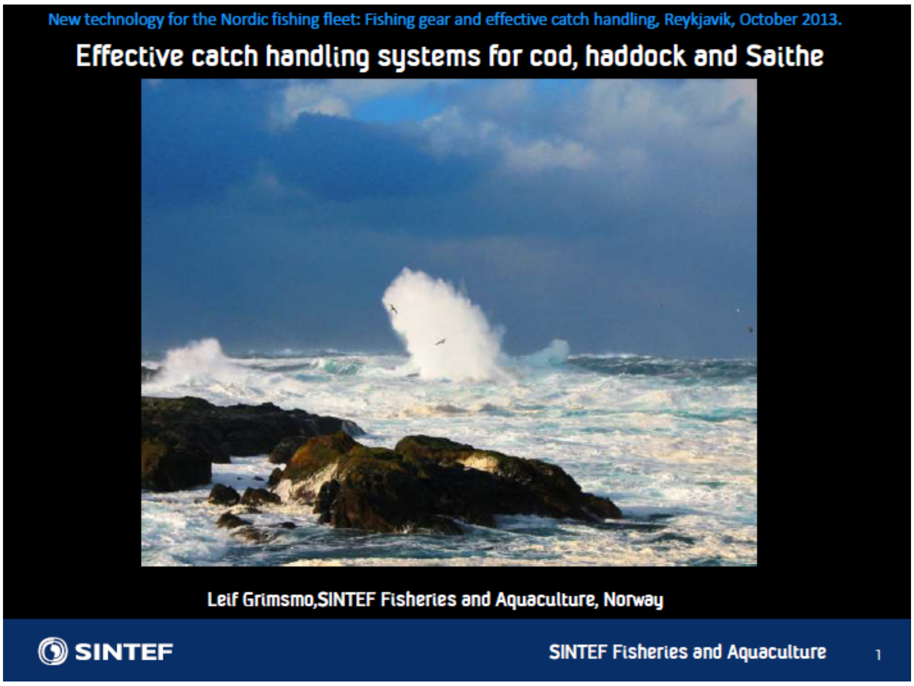
- Rigged with Mustad Autoline Coastal™ System

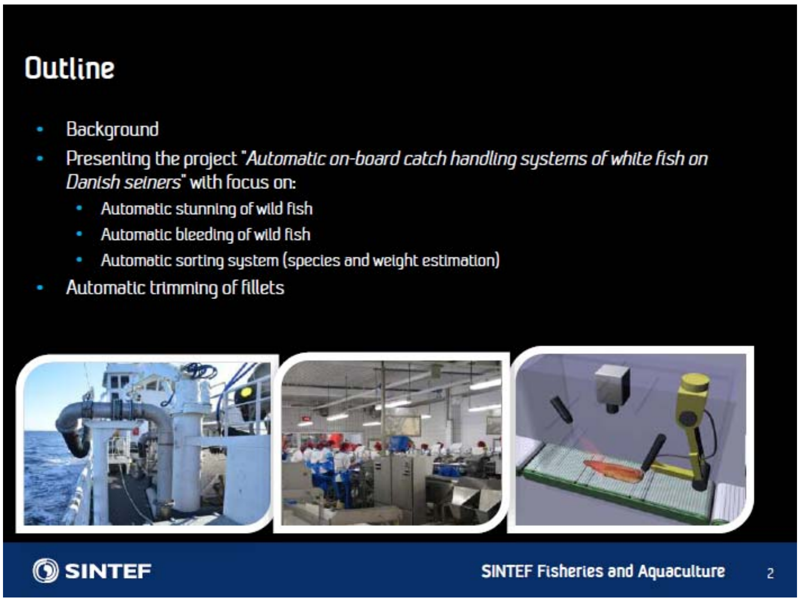
Quote the Eskøy website

Mustad AUTOLINE

5.14 Effective catch handling systems for cod, haddock and saithe

Presented by Leif Grimsmo from Sintef in Norway

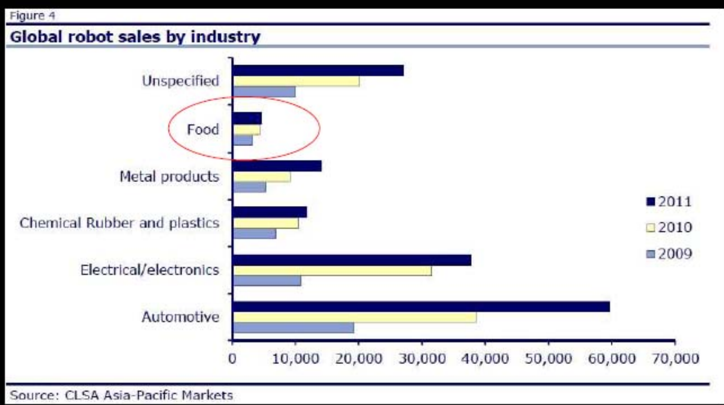




Why automation onboard?

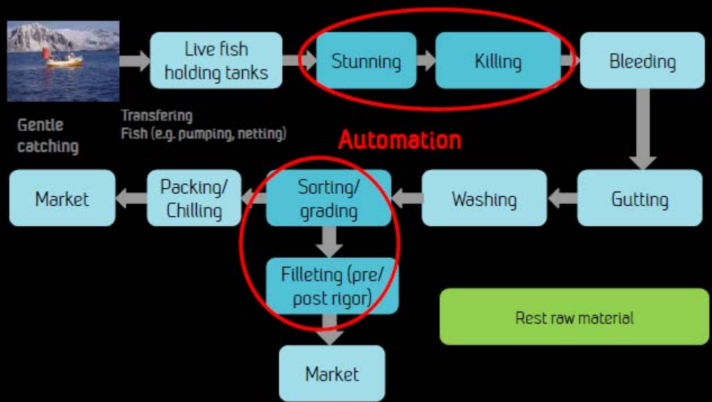
- Improved environment, health and safety for the fishermen
- Remove heavy workloads for the fishermen
- Improved effectiveness – increased kg produced fish per fisherman
- Improved quality of the fish
- Shorter time period from catch to processing
- Greater flexibility in product range
- It may provides a foundation for improved recruitment to the fishery profession
- Strengthen the Norwegian equipment industry in developing and integrating new technology
- Total utilization of by-products

SINTEF — SINTEF Fisheries and Aquaculture 3

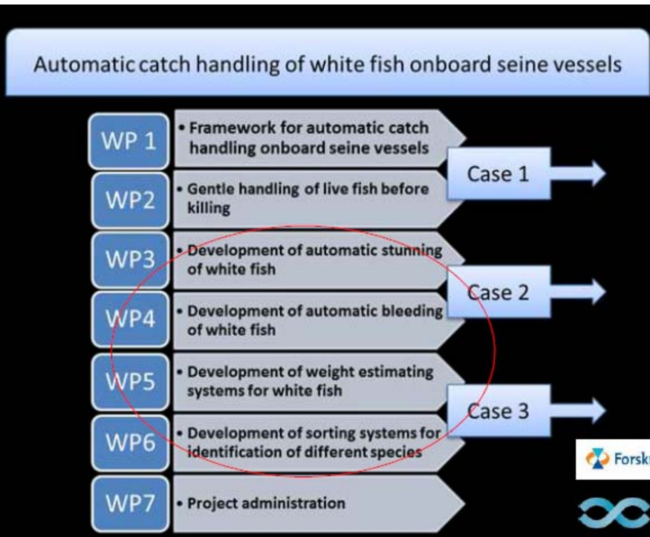


SINTEF — SINTEF Fisheries and Aquaculture 4

Future processing line



SINTEF — SINTEF Fisheries and Aquaculture



Forskningsrådet

About the project

- Main objective:
  - To improve the **fish quality** and the **EHS** (environment, health and safety) for the fishermen and to make the fish handling system **more effective**
- Main focus – development of technology for automatic
  - Stunning
  - Bleeding
  - Species sorting
  - Weight estimation

- Financed by the participating industrial partners, the Research Council of Norway, and the Norwegian Seafood Research Fund
- Partners: several vessels, equipment vendors and processing plants
- R&D budget including own efforst approx. 25 mill NOK

WP 3 Electrostunning of haddock, cod and saithe

- Several tests are performed onboard and in laboratory
- Electrical stunning makes it possible to immediate further process the fish after it is taken on board.
- Registration of :
  - Voltage (>40 V is recommended)
  - Behaviour (10 min recovery)
  - Handling stress
  - Quality assessments

Electrical stunning - results

- Fast and efficient method → easy fish handling
- > 40 v is sufficient for properly stunning of cod, haddock and saithe
- Induced by an electrical current
- Important factors :
  - Duration
  - Voltage
  - Fish species
- Two different electrostunners has been tested
  - Flaps +/-
  - Conveyor belt negative charged/flaps positive charged
- Quality assessments:
  - No damages or quality changes for haddock and cod
  - Saithe: between 10-45 % of the fish had broken vertebrae and ruptured blood vessels in saithe

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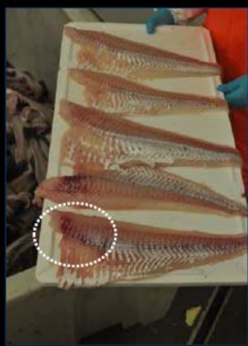
WP 4: Automatic bleeding of wild fish

Focus area: Improving bleeding routines



Problem: Inadequate bleeding, blood spots in the filets
Solution: Immediate bleeding of live fish (or no later than 30 min post mortem)

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Four different concepts for automatic bleeding

1. One-mans bleeding machine (small vessels)
2. Automated machine vision processing line (big vessels)
3. Partly automated mechanical processing line (big vessels)
4. Manual processing line (big vessels)

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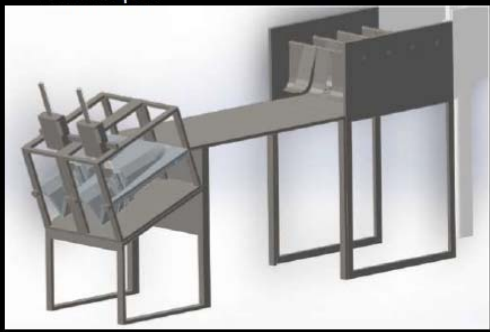
1. Bleeding machine for small vessels

- Developed for small vessels, manual singular/orientation and batch input

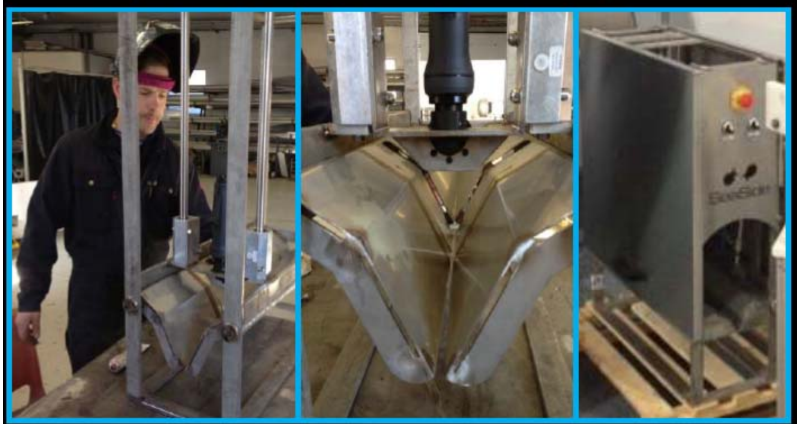


Seaside AS and SINTEF

SINTEF

SINTEF Fisheries and Aquaculture

Building & testing the machine in the laboratory



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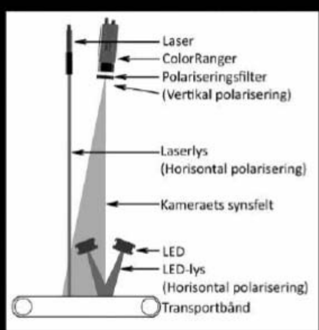
WP 5/6 Development of weight estimating and species sorting systems for wild fish



FoodScanner Mini – sorting (species, weight, quality)

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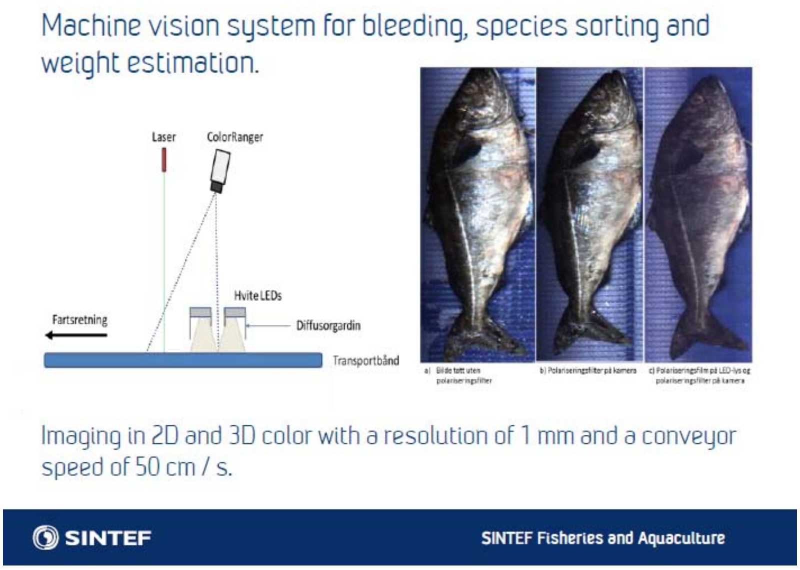
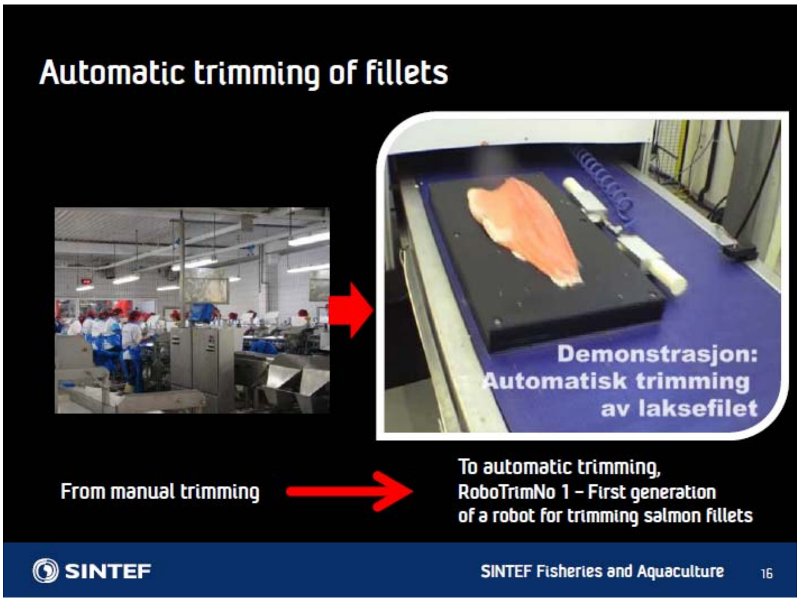
SINTEF Fisheries and Aquaculture 14


Machine vision system for bleeding, species sorting and weight estimation.
Laser
ColorRanger
Hvite LEDs
Fartsretning
Diffusorgardin
Transportbånd
Imaging in 2D and 3D color with a resolution of 1 mm and a conveyor speed of 50 cm / s.
SINTEF
SINTEF Fisheries and Aquaculture


Automatic trimming of fillets
Demonstrasjon:
Automatisk trimming
av laksefilet
From manual trimming
To automatic trimming,
RoboTrimNo 1 – First generation
of a robot for trimming salmon fillets
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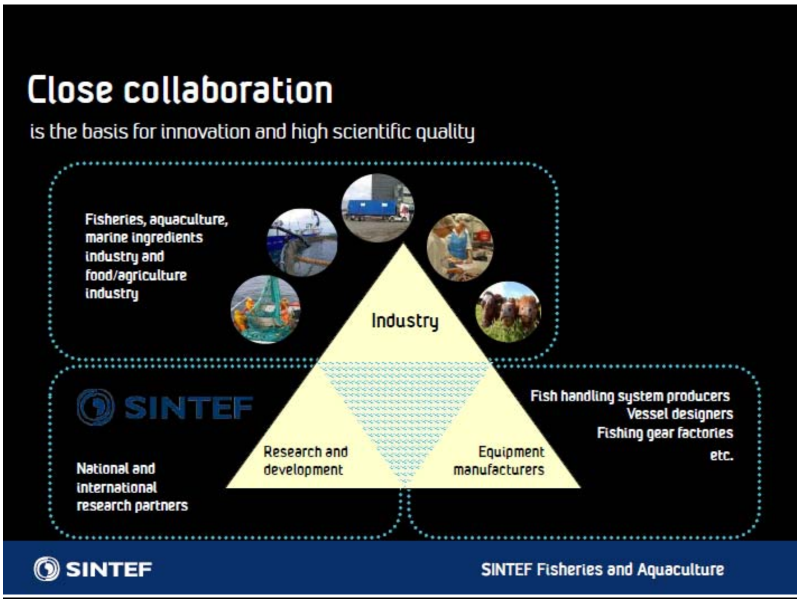
16


Close collaboration
is the basis for innovation and high scientific quality
Fisheries, aquaculture, marine ingredients industry and food/agriculture industry
Industry
SINTEF
National and international research partners
Research and development
Equipment manufacturers
Fish handling system producers
Vessel designers
Fishing gear factories
etc.
SINTEF
SINTEF Fisheries and Aquaculture


Thanks to:
• The Research Council of Norway, (MAROFF, BIA, Matprogrammet)
• The Norwegian Seafood Research Fund (FHF)
• SEASIDE, Melbu Systems, MMC, C-Flow, "Gunnar K", "Hardhaug", Helmer Hansen, amomg others.
Thanks for your attention!
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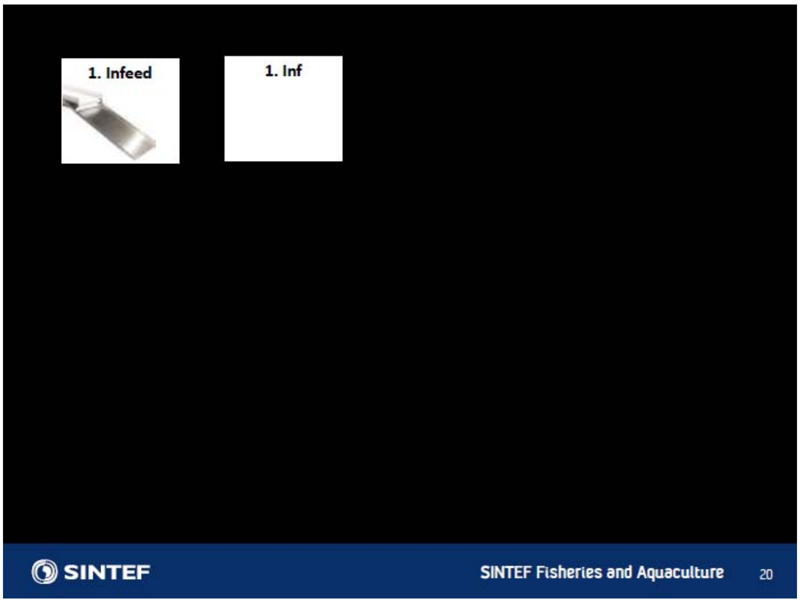
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5.15 Mackerel pump system

Presented by Hardi Hansen from Varðin Ltd. in the Faroe Islands

Mackerel pump system

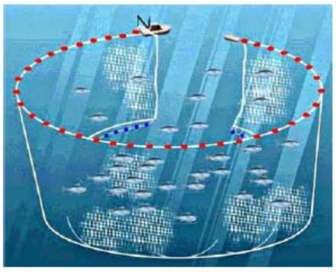
Fishing Gear Workshop
Reykjavik
October 2013

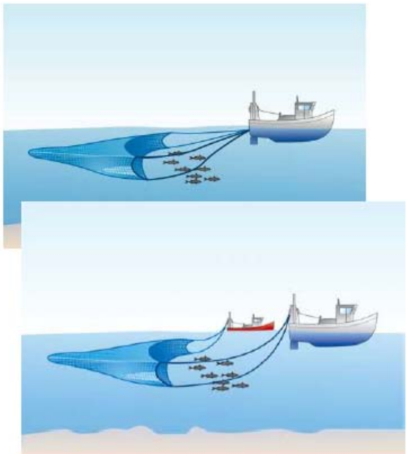
Name: Hardi Hansen
Occupation: Chief Engineer
Vessel: m/v Finnur Fríði
Company: Varðin

VARÐIN

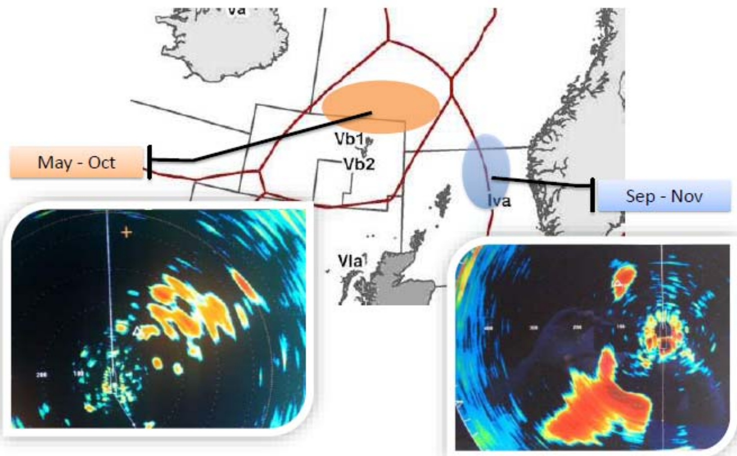
- Problem (challenge)
- Solution
- Advantages/Disadvantages

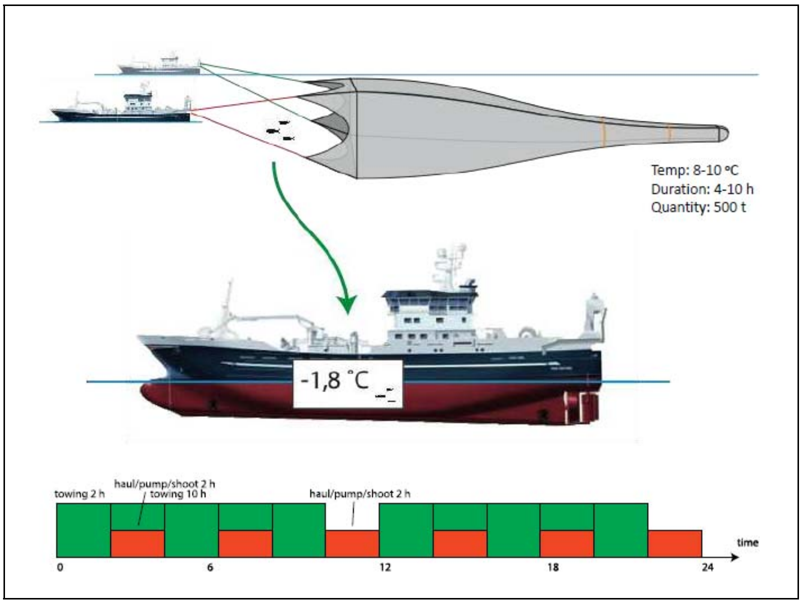
m/v Finnur Fríði

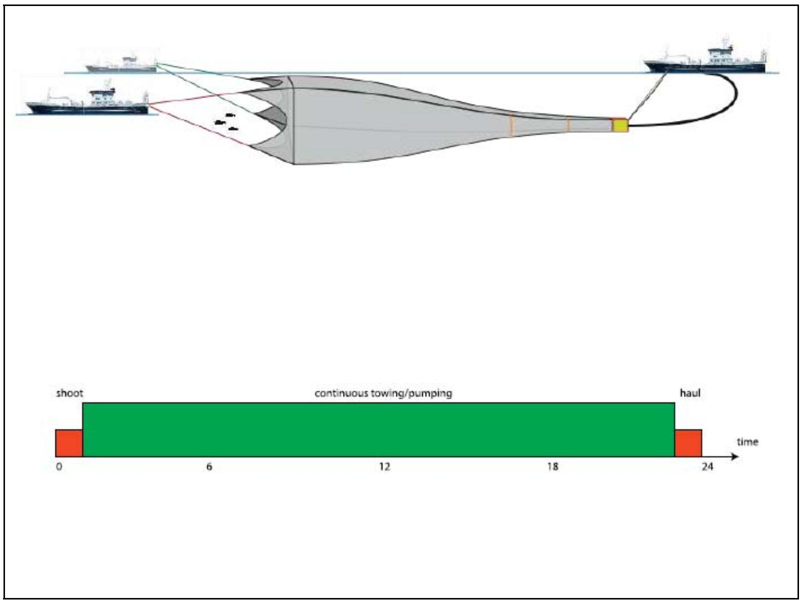


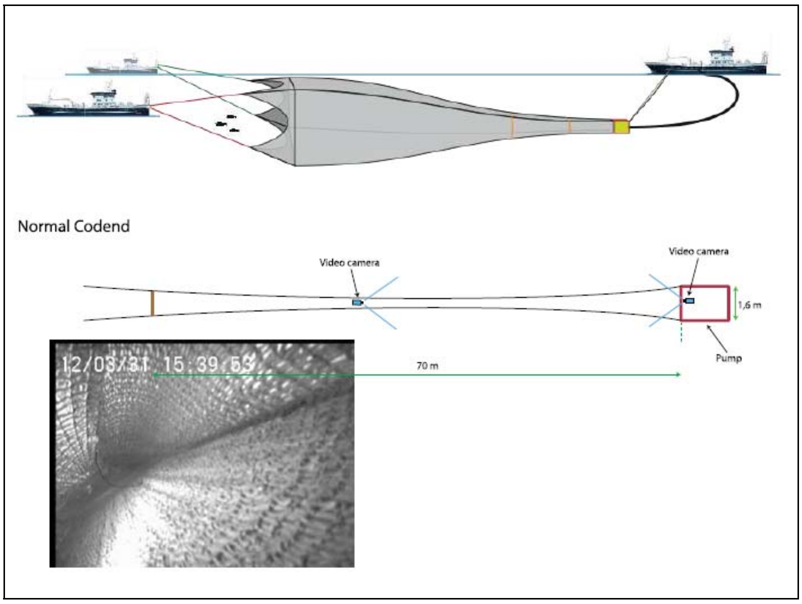


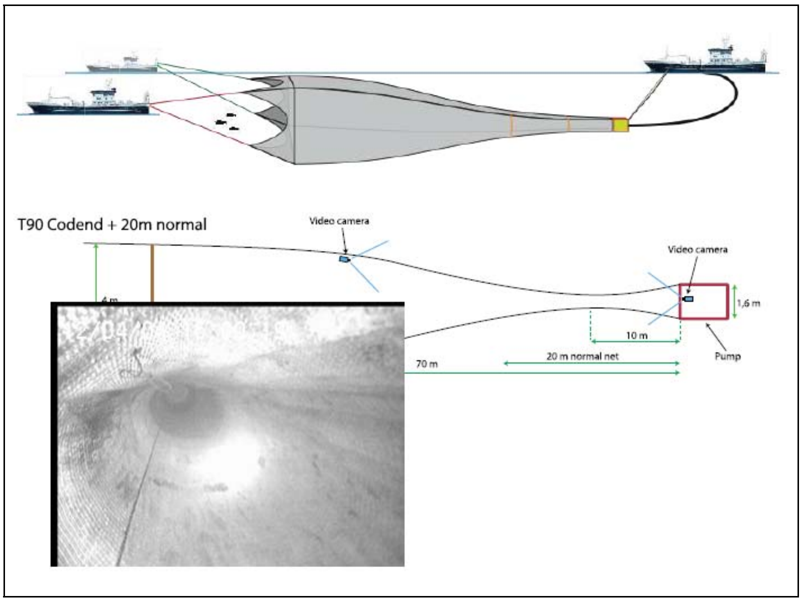
Mackerel fishing for Faroese vessels before and after 2010:

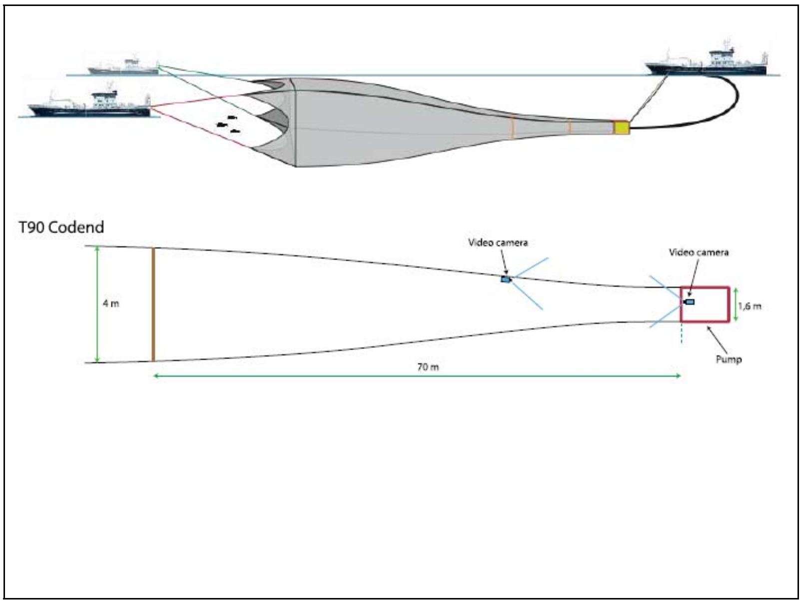


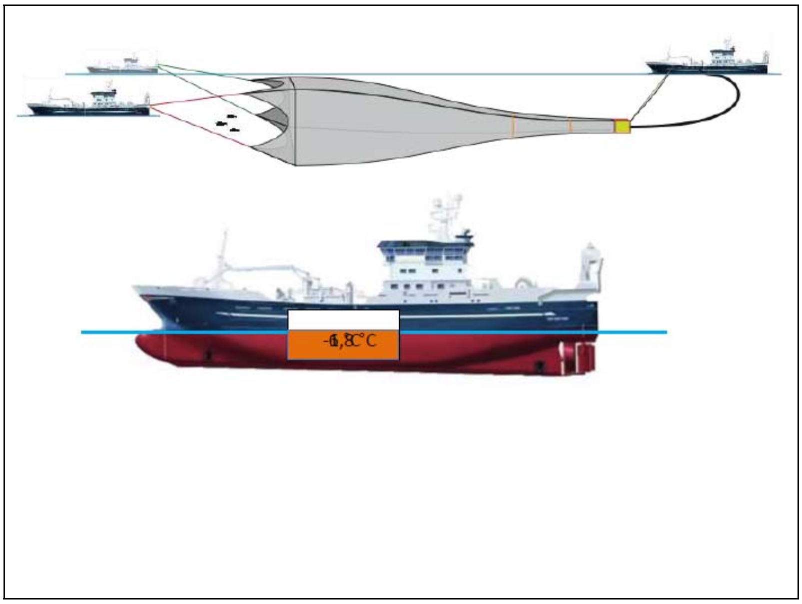

Temp: 8-10 °C
Duration: 4-10 h
Quantity: 500 t
-1,8 °C
towing 2 h
haul/pump/shoot 2 h
towing 10 h
haul/pump/shoot 2 h
time
0
6
12
18
24

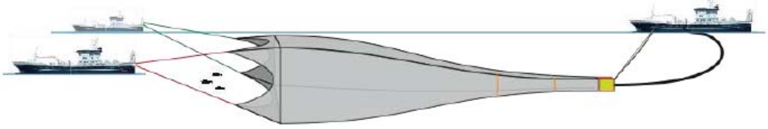

shoot
continuous towing/pumping
haul
time
0
6
12
18
24

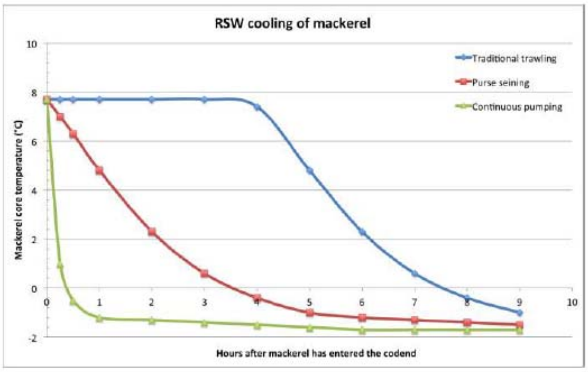

Normal Codend
Video camera
Video camera
1,6 m
Pump
70 m
12/03/31 15:39:53

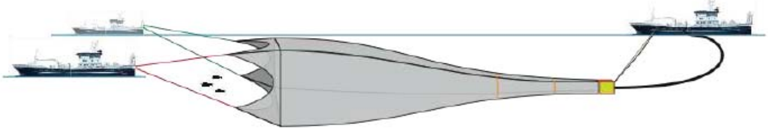

T90 Codend + 20m normal
Video camera
Video camera
1,6 m
10 m
Pump
20 m normal net
70 m


T90 Codend
Video camera
Video camera
4 m
1,6 m
Pump
70 m

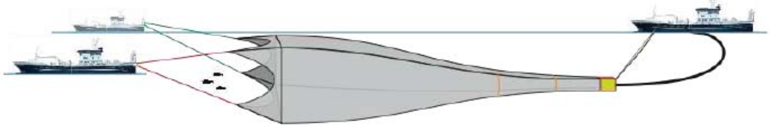





RSW cooling of mackerel
Traditional trawling
Purse seining
Continuous pumping
Mackerel core temperature (°C)
Hours after mackerel has entered the codend
10
8
6
4
2
0
-2
0
1
2
3
4
5
6
7
8
9
10




FINNUR FRÍÐI
HH



Advantages:
- Gentle to the fish. No stuffing in the codend.
- Instant indication of specie and size.
- Constant feed. Faster cooling of fish, by several hours.
- Possibility for sorting and other equipment in codend.
- Enhances skippers experience on reading the sonar picture.
- Time efficiency. Only need to shoot/haul once per trip.
- Gentler pumping. 50-100 t/h vs 1000 t/h

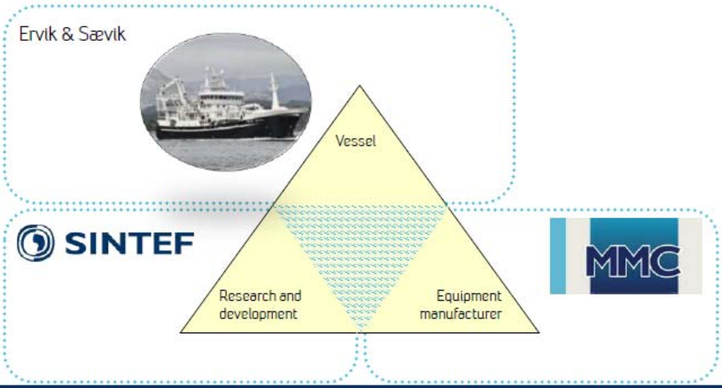
Disadvantages:
- Currently needs 3 vessels.
- More equipment, more things to break.
- Trawling normally not as energy efficient as purse seining.

5.16 New concept for gentle and effective catch handling and storage of pelagic fish onboard

Presented by Ida G. Aursand from Sintef in Norway

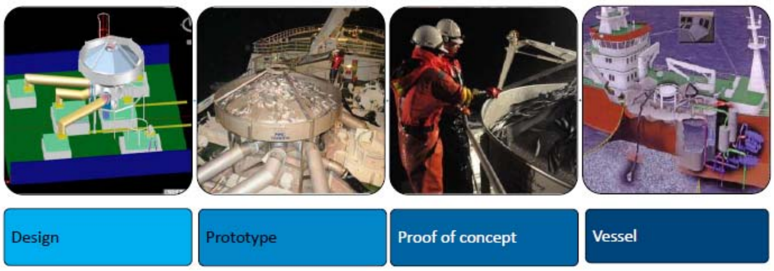
Close collaboration

is the basis for innovation and high scientific quality



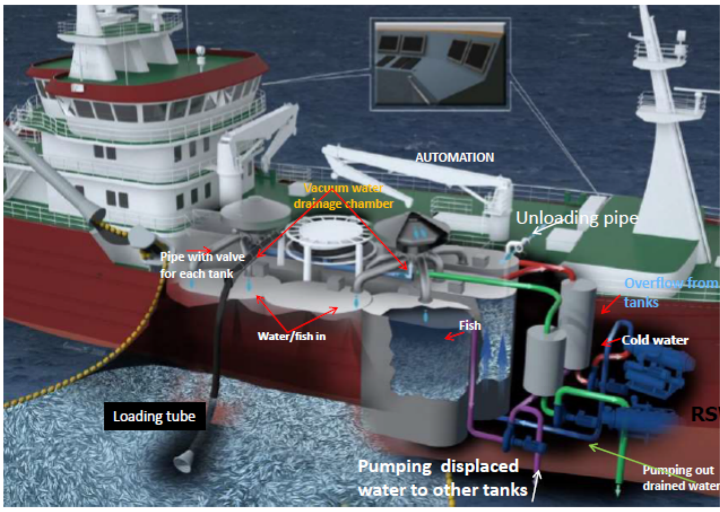
Research and innovation phases

Close collaboration between the equipment vendor, researchers and vessel through all steps of the development from design to construction



The new concept

- **Loading by negative pressure:** Effective loading avoiding pump blades that can cause damage to fish and blood spots on fillets
- **Water separator with a larger drainage area:** Effective separation of sea water and fish
- **Cylindrical RSW-tanks with good RSW flow pattern:** Rapid and stable chilling of catch
- **Automatic cleaning of RSW-tanks:** Improved hygiene and HSE for the fishermen
- ***Automatic fish sampling and single fish weighing:*** *Accurate weight estimate of single fish before auction, easier operations for fishermen*
- **Unloading of catch by pressure instead of vacuum-systems with flap-valves:** Effective unloading avoiding pipe bends and valves that may damage fish



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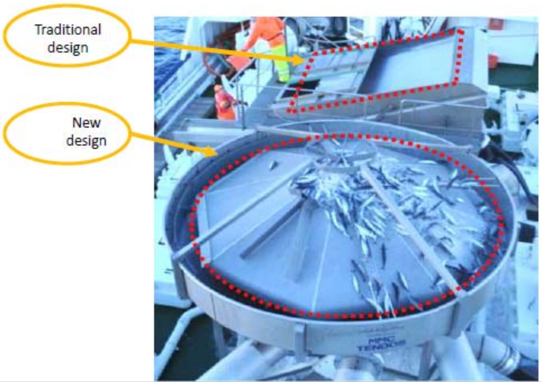
Prototype testing

Research cruise 2010: Water separator



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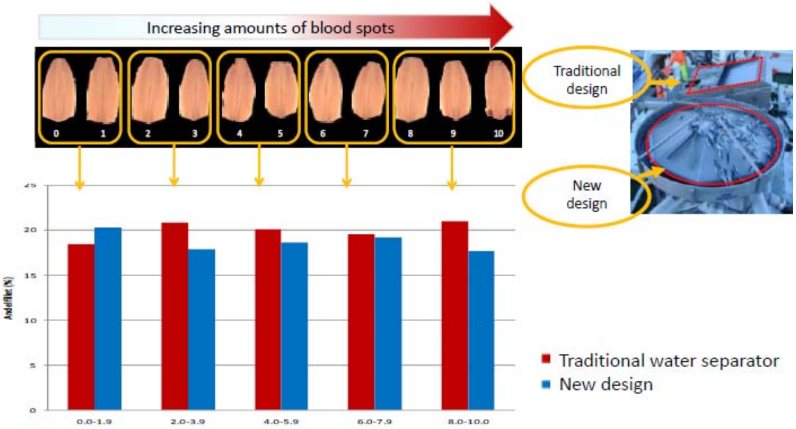
Prototype testing

Evaluation of blood spots on herring fillets after landing of catch



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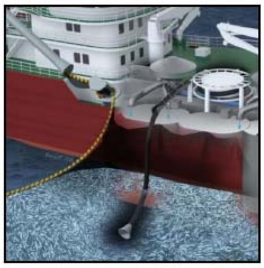
Prototype testing

Research cruise 2011: Loading system

Traditional design loading of catch

New design loading of catch



SINTEF — SINTEF Fisheries and Aquaculture

Prototype testing

Research cruise 2011: Unloading system

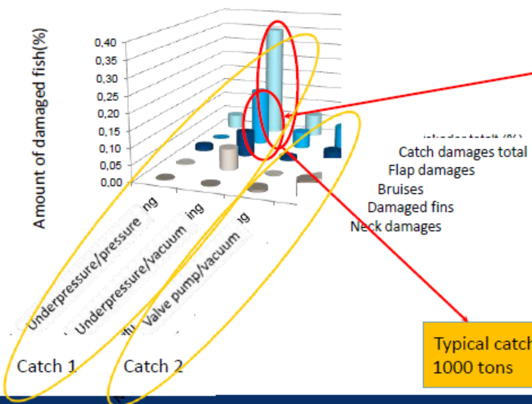
Traditional design unloading of catch

New design unloading of catch

SINTEF — SINTEF Fisheries and Aquaculture 10

Prototype testing

Evaluation of % damaged mackerel after landing of catch



Typical catch of 1000 tons → Approx. 3500 kg damaged fish

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The new concept is installed in the vessel M/S Christina E

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Automated processes

Controlling loading of catch

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Implemented system testing

Research cruise September 2012

- Catching Norwegian Spring Spawning herring
- Evaluation of raw material quality after landing
- Comparison of catches from 5 vessels catching fish in the same area at the same time

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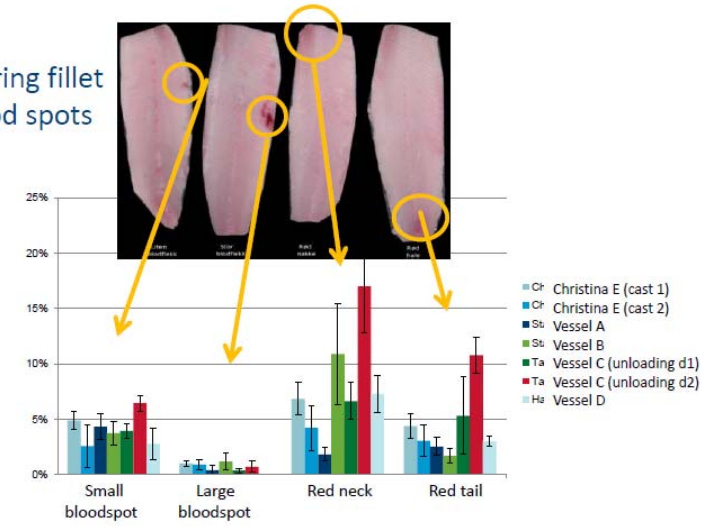
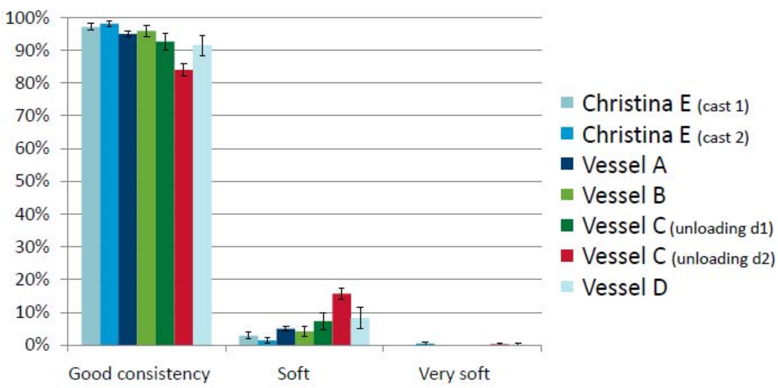
Fisheries and vessel data

	Christina E	Vessel A	Vessel B	Vessel C	Vessel D
Vessel length	81 m	-	43,8 m	64 m	68,1 m
Total volume RSW tanks	2043 m³	-	500 m³	1550 m³	1100 m³
Fishing gear	Purse seine	Purse seine	Purse seine	Purse seine	Purse seine
Loading system	Under pressure	Vane pump , Karm	Vane pump 16"	Vane pump 18"	Vane pump 18"
Φ pumpeslange	18 inches	16 inch	18 inches	18 inch	16 inches
Unloading system	Pressure	Vacuum pump	Vacuum pump	Vacuum pump	Vacuum pump
Length of pumping tube	20 m	30 m	30 m	-	22 m
Loading operation	Direct pumping	Pumping from Vessel A to Christina E	Pumping from Vessel B to Christina E	Pumping from Vessel C to Christina E	Direct pumping
Weather during fishing	Strong breeze	Strong breeze	Strong breeze	Strong breeze	Strong breeze
Weather during transport	Strong breeze	Strong breeze	Strong breeze	Strong breeze	Strong breeze
Number of casts	2	1	1	1	3
Catch size	300 m³	50 m³	150 m³	420 m³	350 m³
Loading capacity (speed)	300 m³/hour	200 m³/hour	225 m³/hour	388 m³/hour	350 m³/hour
Storage time onboard	60-90 hours	60-90 hours	60-90 hours	60-90 hours	60-90 hours

Herring fillet blood spots

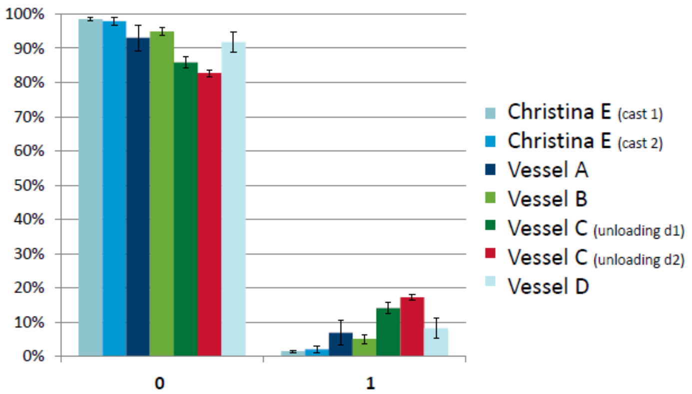


Herring fillet consistency/hardness



Herring fillet gaping

0: No gaping – small gapes (< 5)
1: Small gapes (> 5) – some large gapes (< 5)
2: Pronounced gaping (> 5 large gapes)
3: Extreme gaping



Feedback from the industry after landing the catch

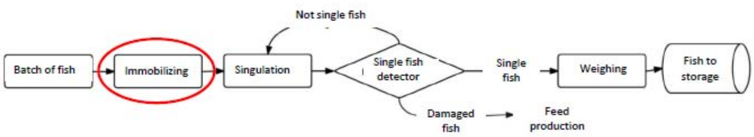
"This is the start of a revolution in the handling of pelagic fish onboard"

Magnus Strand
Managing Director
Norway Pelagic Emy Fish

"This catch has the highest quality ever delivered to our plant"

Roar Aasen
Managing Director
Fosnavaag Seafood AS

Further work: Automated fish sampling and weighing of single fish



FHF
MMC

Research cruise September 2013

Immobilizing mackerel before singulation and weighing

Varying frequency, voltage and current

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Evaluation of quality

- No broken back bones were found in mackerel.
- Some broken backbones were observed in herring. Further studies are planned in November 2013.

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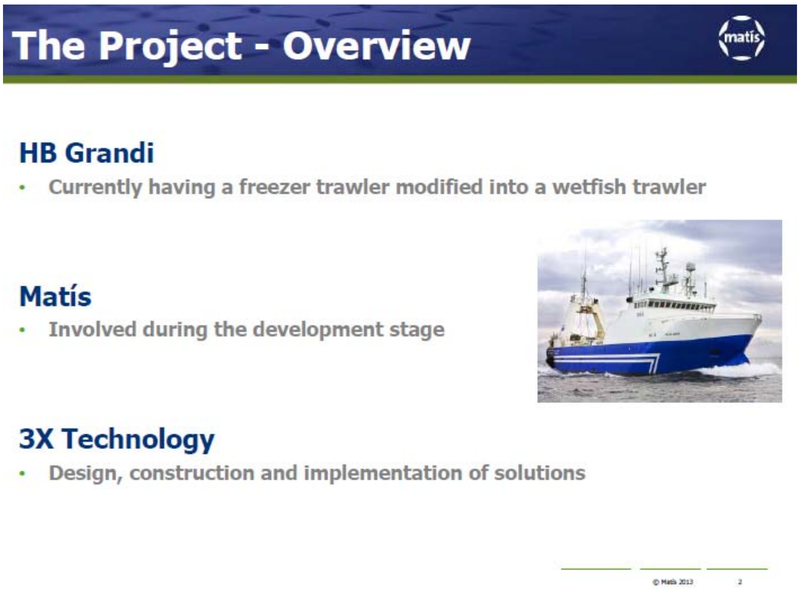
Researchers + fishermen = True

SINTEF | SINTEF Fisheries and Aquaculture

5.17 Redesign of demersal wetfish trawler processing decks

Presented by Sæmundur Elíasson from Matís in Iceland



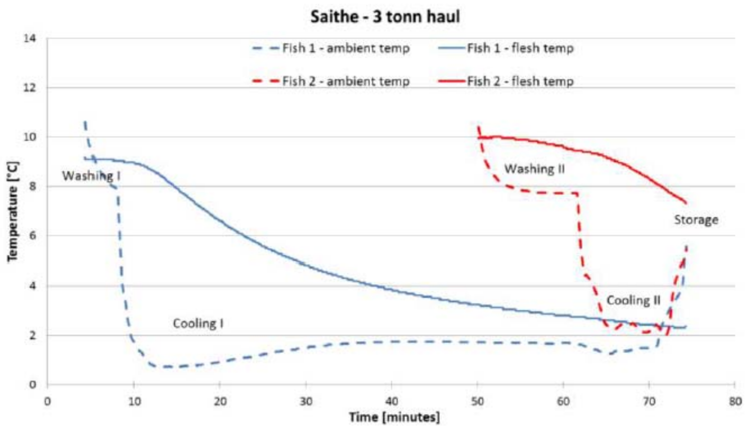
Experimental setup

Experiments onboard wetfish trawler Ottó

Main focus on Saithe and fillet color

Current system

Current system measurements



Experimental setup - Groups

Haul	Groups	Description
1	1a	0 hour in reception area
	1b	1 hour in reception area
	1c	2 hour in reception area

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Quality evaluation

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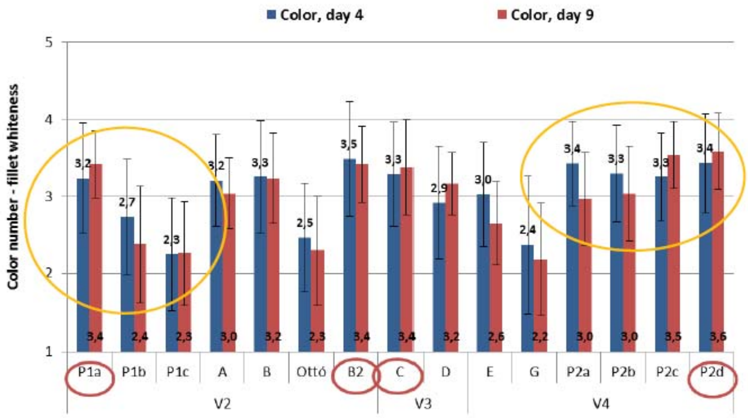
Results – Color



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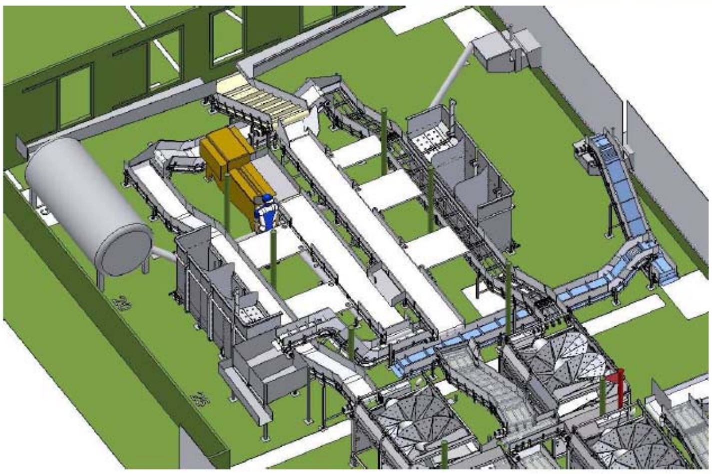
Main conclusions

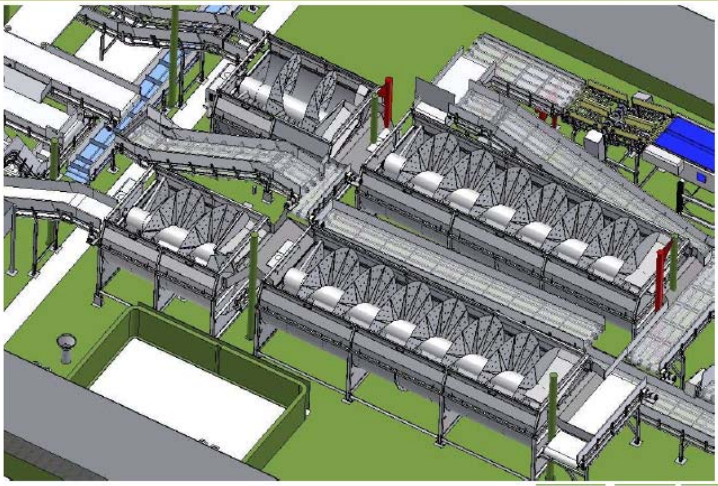
- The effect of variable bleeding time notable after a few days
- Time from catch to bleeding the single most important factor influencing fillet color
- Improved cooling resulted in more uniform quality and less gaping

Design - overview

Design – Reception hold and gutting



Design – Bleeding and chilling



 12

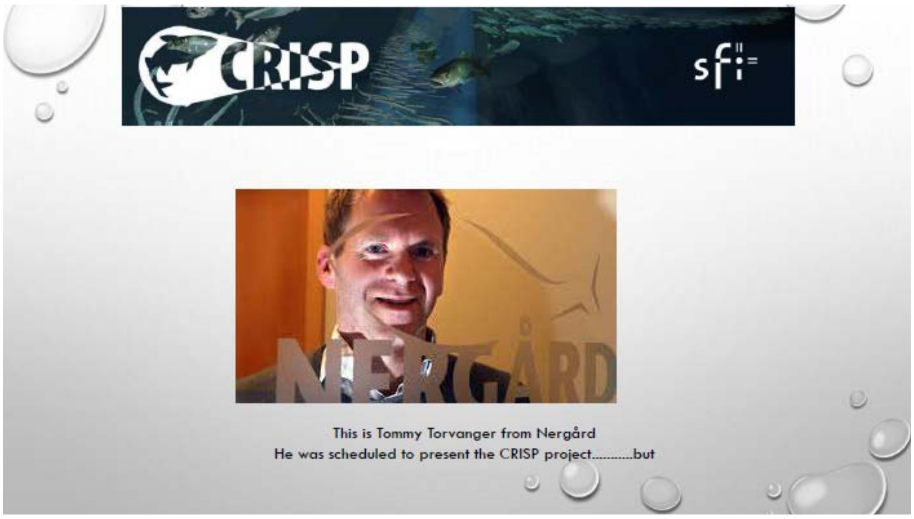
Thanks

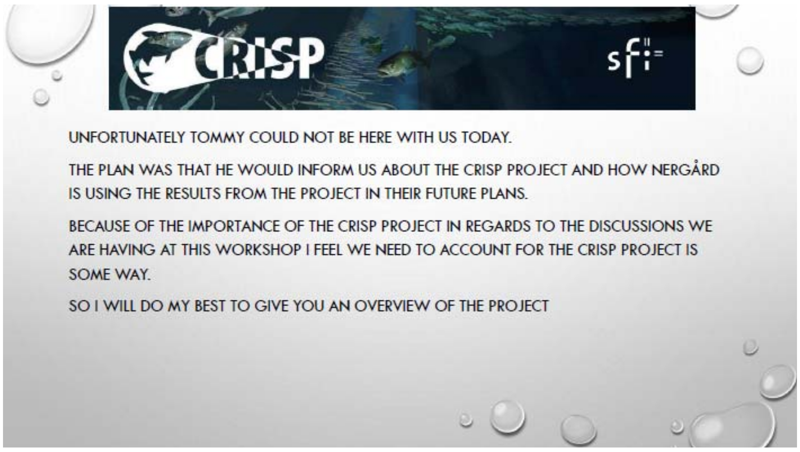
Questions?

 14

5.18 The Crisp project

Presented by Jónas R. Viðarsson from Matís in Iceland





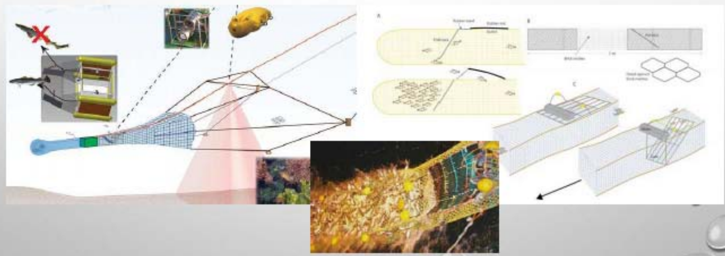
FOCUS:

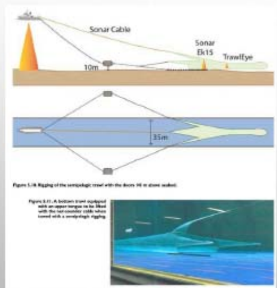
CRISP WILL FOCUS ON TWO MAIN MODES OF INDUSTRIAL FISHING AND ITS PRODUCTS, NAMELY **TRAWLING AND PURSE-SEINE FISHING**. SOME 90% OF TOTAL NORWEGIAN LANDINGS (BY WEIGHT) ARE TAKEN BY THESE GEARS. THROUGH THIS INITIATIVE AND RESEARCH STRATEGY, THE CENTRE AIM TO TRANSFORM FISHERIES TECHNOLOGY, AND BRING THE INDUSTRY A MAJOR STEP FORWARD WITH RESPECT TO REDUCED ENVIRONMENTAL IMPACT AND IMPROVED FOOD QUALITY

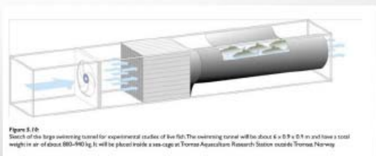
- PILLAR 1: TECHNOLOGY FOR FISH DETECTION, CLASSIFICATION AND CAPTURE PROCESS MONITORING
- PILLAR 2: LOW-IMPACT AND SELECTIVE FISHING GEARS
- PILLAR 3: QUALITY AND VALUE ADDING

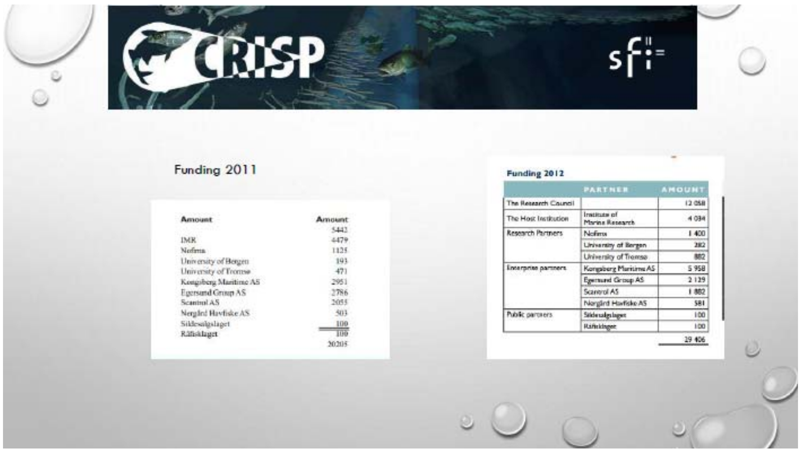
THE PRACTICAL RESEARCH AND DEVELOPMENT WORK OF CRISP WILL TAKE PLACE WITHIN THE FRAMES OF **SIX WORK PACKAGES**, EACH CONSISTING OF SEVERAL PROJECTS. THESE WORK PACKAGES ARE:

- WP 1. PRE-CATCH IDENTIFICATION OF CATCH
- WP 2. MONITORING OF FISH BEHAVIOUR AND GEAR PERFORMANCE
- WP 3. ACTIVE SELECTIVITY AND RELEASE IN FISHING GEARS
- WP 4. LOW-IMPACT FISHING GEARS
- WP 5. QUALITY IMPROVEMENT BY GEAR AND HANDLING MODIFICATIONS
- WP 6. VALUE ADDING IN A SUSTAINABLE FISHERY FRAMEWORK









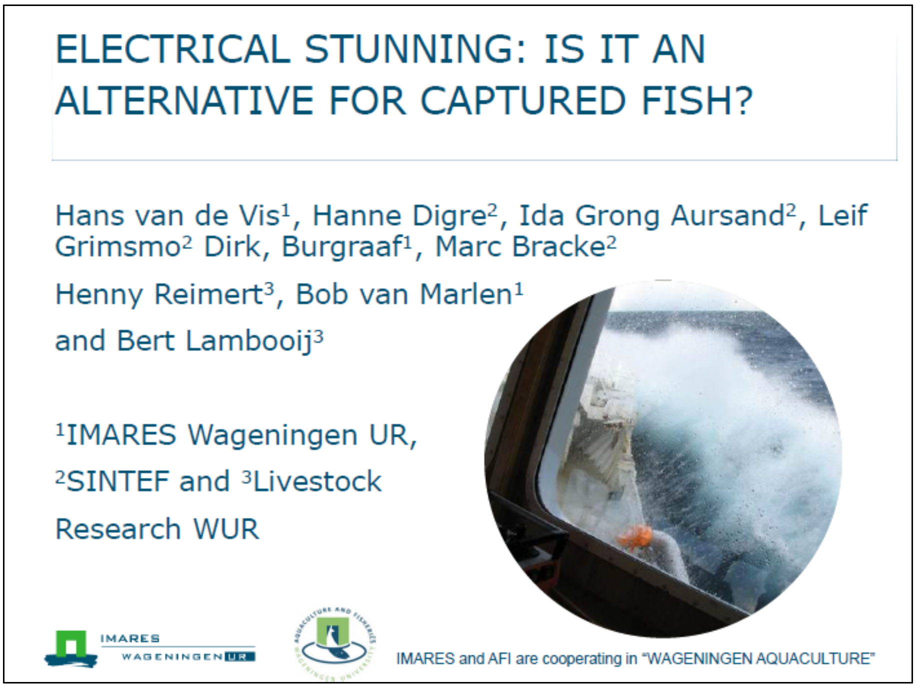
Amount	Amount
	5442
IMR	4479
Nofima	1125
University of Bergen	193
University of Tromsø	471
Kongsberg Maritime AS	2951
Egersund Group AS	2786
Scantrol AS	2055
Nergård Havfiske AS	503
Sildesalgslaget	100
Råfisklaget	100
	20205

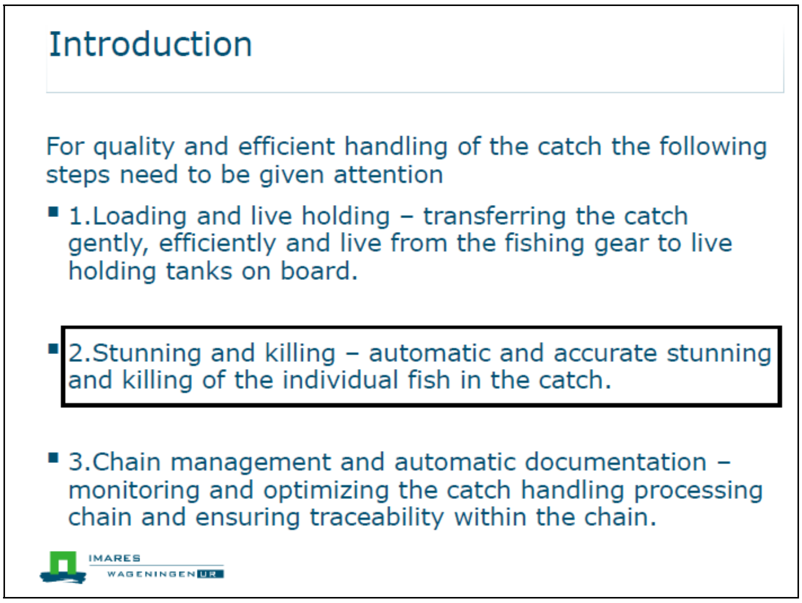
Funding 2012

	PARTNER	AMOUNT
The Research Council		12 058
The Host Institution	Institute of Marine Research	4 034
Research Partners	Nofima	1 400
	University of Bergen	282
	University of Tromsø	882
Enterprise partners	Kongsberg Maritime AS	5 958
	Egersund Group AS	2 129
	Scantrol AS	1 882
	Nergård Havfiske AS	581
Public partners	Sildesalgslaget	100
	Råfisklaget	100
		29 406

5.19 Electrical stunning: is it an alternative for captured fish?

Presented by Hans Van de Vis from IMARES in the Netherlands





Introduction

- Stunning and killing are two handling operations that are essential in order to establish a high quality in the catch after loading and holding.
- A stunned fish is motionless and this facilitates further processing of the catch on board.
- Stunning and killing of e.g. farmed African catfish is a more efficient process than live chilling of batches.

IMARES WAGENINGEN UR

Introduction

- Stunning should render the fish unconscious immediately (< 1sec) and permanently. However...
- Electrical stunning does not kill fish; they recover.
- Hence, the approach is stunning followed by a killing method to avoid recovery. For instance, chilling in ice water or a combination of gutting and chilling can be used as killing methods.

Stunning with a electrical current that is too low may lead to carcass damage (haemorraghes, a broken spine, loss of scales) in fish.

IMARES WAGENINGEN UR

Introduction

- Data on assessment of killing methods.

Killing method	Time to loss of consciousness (EEG)	Time to loss of self-initiated behaviour
Asphyxia	5.5 min (seabream)	4.0 min
Gutting	Electrical stunned plaice and sole recover	Not determined
Freezing	>> 0.5 min (eel)	Not determined
Chilling on ice	5.0 min (seabream)	5.0 min
Bleeding	Decapitated eel:13 min Gill-cutting after electrical stunning: A. salmon recovered 3 min post-stun Nile tilapia recovered 10 min post-stun.	Not determined VORs absent After 10 min not lost
Throat cutting	Not determined	Not determined

Introduction

- The objectives were
  - 1) for a Norwegian project DANTEQ, led by Sintef:
    - To measure consciousness and survival, using measurements of brain (EEGs) and heart activity (ECGs) and behaviour of cod (*Gadus morhua*) and haddock (*Melangrammus aeglefinus*) landed on deck
    - To establish conditions to provoke immediate loss of consciousness without recovery in cod and haddock by electrical stunning on board, using a so- called "dry" stunning.

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Introduction

- Objectives-continued
  - 2) for a Dutch project, coordinated by Ekofish and managed by Scienta Nova:
    - To establish conditions to provoke immediate loss of consciousness without recovery in plaice (*Pleuronectes platessa*) and dab (*Limanda limanda*) by electrical stunning on board, using a so-called "dry stunning".
    - Construct and test a first prototype for electrical stunning of caught cod, sole (*Solea solea*), dab, turbot (*Psetta maxima*) and plaice.

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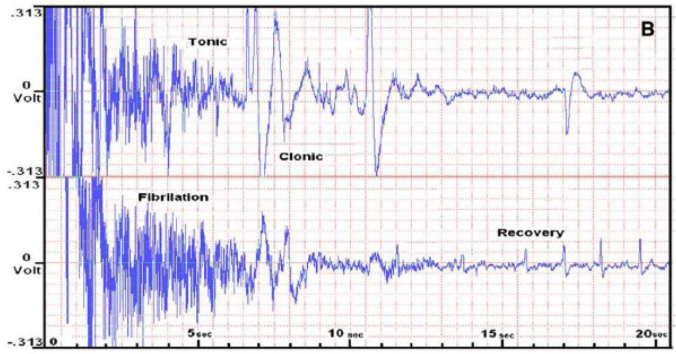
Criteria for the construction of a stunner-established for farmed fish

- A brief summary of criteria for the construction of equipment for "dry electrical stunning"
  - a dosing system to avoid that 1) fish are exposed to pre-shocks when they are not between the electrodes yet; 2) fish do not enter the stunner tail-first; 3) more than one layer of fish is present in stunner.
  - The power source needs to be stable when the stunner is filled with fish. The voltage remains sufficiently high, regarding the electrical current).
  - Exposure to the electricity is sufficiently long to avoid recovery during the application of a killing method

IMARES WAGENINGEN UR

Introduction

Assessment of a 1 second electrical stun.



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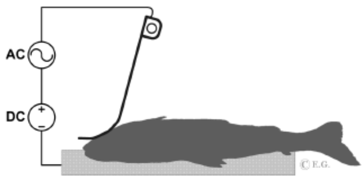
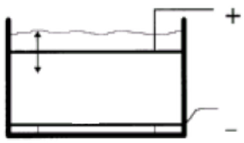
Options for electrical stunning

- For example electrical stunning prior to killing in a slurry of ice and water. Two approaches- expose to electricity after dewatering (so-called "dry stunning" or expose to electricity in water.





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Assessment of survival of landed fish and of electrical stunning

- EEG. Electrical activity in the brain to assess whether consciousness and sensibility are lost.
- ECG. Electrical activity in the heart as measure for survival and to assess whether electrical stunning results in defibrillation.
- Behaviour. Responses to administered stimuli. Observation of behaviour only has to be used with caution.

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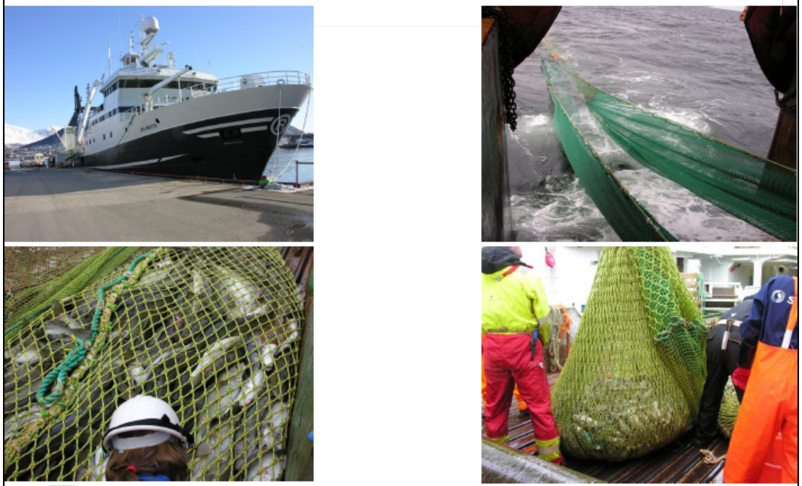
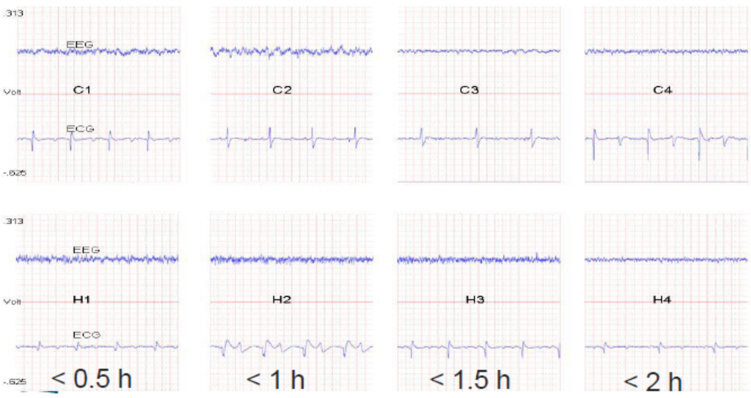
Results-Norwegian project



Results-Norwegian project

- EEG and ECG of a cod and a haddock stored "dry".



Results-Norwegian project

- Observation of behaviour
  - For cod we observed that the capacity to respond in behaviour was lost after 2 h elapsed, while the EEG traces revealed that these animals were still conscious.
  - For conscious haddock we observed that after 2 h of storage responses in behaviour to administered stimuli were absent.

Results-Norwegian project

- For cod and haddock we established that by exposure to 52 V_{rms} sufficient current (0.34 $\pm$ 0.09 and 0.36 $\pm$ 0.12 A_{rms}, respectively) was passed through individual cod and haddock for an instantaneous stun.
- When these fish species are exposed to electricity for at least 3 s recovery can be prevented by applying throat cutting as killing method.

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Results-Dutch project

- Dab: 106 V_{rms} for 1 s to pass sufficient current through the fish. Exposure for 15 s followed by killing by bleeding (cutting the artery along the spinal cord behind the head) avoided recovery. Fillet yield, however, is low.
- Plaice: 106 V_{rms} for 1 s to pass sufficient current through the fish. Exposure for 15 s combined with killing in ice water for 15 min avoided recovery. This killing method is slow. Improvement is needed.
- Conditions for stunning and killing of turbot (106 V_{rms}) and sole (106 V_{rms}) are available.

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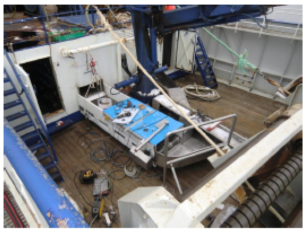
Results-Dutch project

Installation of first prototype on board



First prototype being installed on board.

Fish between the electrodes

Preliminary trials revealed that the first prototype needs to be adapted with respect the dosing system.

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Conclusions

- Norwegian project
  - Since the cod and haddock remain conscious for at least 2 h after landing on deck.
  - Electrical stunning by applying 52 V_{rms} for at least 3 s and immediate killing by throat cutting is recommended to pass sufficient current through a fish for an instantaneous stun.

IMARES WAGENINGEN UR

Conclusions

- Dutch project
  - Preliminary tests of the stunner in the Dutch project reveals that optimisation is needed.
  - Dab and plaice can be rendered unconscious within 1 s by applying 106 V_{rms}. Both stunned species can be killed without recovery after exposing them for 15 s to the electricity followed by chiling in ice water.
  - Optimisation of killing of stunned fish is needed.

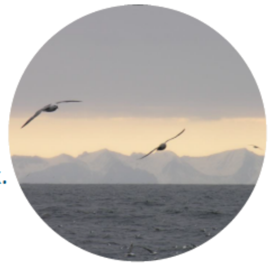
IMARES WAGENINGEN UR

Acknowledgements

- IJsbrand Velzeboer, Scienta Nova, Raalte, The Netherlands.
- Louwe de Boer, Ekofish, Urk, The Neterlands
- Frode Kjølås, SeaSide, Stranda, Norway
- The crew of the research vessel *Jan Mayen.*

IMARES WAGENINGEN UR

Thank you for your attention



My motivation to perform experimental work.

To read about is one thing but to feel, see, hear and smell is a competely different thing in order to understand (A. Kiessling, 2010).