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REPORT

New active fishing gear
Report from project workshop in Hirtshals, Dec. 14-15 2009

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SINTEF Fisheries and Aquaculture
Fisheries Technology

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SINTEF REPORT

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ABSTRACT

A few initial ideas for new active fishing gear concepts based on trawl and seine were presented at a workshop in Hirtshals, 14-15 December 2009. These initial concepts are described and the comments and feedback from the workshop participants included in this report.

The outcome of the workshop is summarized in the form of a matrix (Table 4.1) of specific concepts and gear configurations that are to be followed up in the further work and tests in the project. Such a matrix provides both a clear overview of the concepts/configurations to be followed up, and a structured way to evaluate and systemize them wrt. applications and combinations in specific fisheries and for specific vessels.

The further concept development consists of planning further model tank tests of these concepts and configurations, including establishing a set of relevant user oriented criteria for what makes a concept or configuration interesting or not for implementation in actual fishing. This will decide how the further tests should be carried out, what should be varied and measured etc.

Also, the project should use the matrix to start proposing a set of one or a few of the gear concepts that may be realistic to have on board a specific or a typical vessel.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Fishing technology	Fiskeriteknologi
GROUP 2	Trawl	Tråd
SELECTED BY AUTHOR	New concepts	Nye konsept

TABLE OF CONTENTS

1 Objective

SINTEF Fisheries and Aquaculture have been granted a research project aiming at developing a new active fishing gear by combining the best from trawl gear and anchor seining/flyshooting technologies. The research project has been divided into three levels of research tasks: *strategic, conceptual and technical.* The conceptual research task will:

- identify the overall requirements new concepts must meet, e.g. operational time windows, dimensions, depths, bottom contact, one gear suited for several methods vs. several gears optimized for each method, gear handling, catch quality, main equipment needed and vessel requirements and limitations
- propose and describe new concepts based on fishing strategies, methods and requirements, choosing one or a limited number of cases, e.g. upscaling, modification and more active towing of seine nets
- evaluate and refine concepts iteratively

Such initiatives include the completion of workshops which aims at contributing knowledge and experience from fishermen and industry. The present report documents the workshop held at the flume tank of SINTEF Fisheries and Aquaculture in Hirtshals, Denmark, during the 14th and 15th of December 2009 (c.f. Appendix A).

In agreement with the objectives which found the conceptual research task, SINTEF had prepared four concepts for evaluation at the workshop. These include:

- Self spreading ground gear for seine fisheries (improved efficiency)
- Flexible spreading devices (kites) for seine fisheries (improved efficiency)
- Combination seine (improved flexibility)
- Alternative seine net design (improved catch ability and selectivity)

A detailed description of the suggested concepts is found in Appendix B.

2 Participants

Norway	**Organization**
Svein Helge Gjøsund (Project manager)	SINTEF
Eduardo Grimaldo	SINTEF
Karl Johan Reite	SINTEF
Birger Enerhaug	SINTEF
Bjørnar Isaksen	Institute of Marine Research
Ian Kinsley	Norges Fiskarlag
Tormund Grimstad	Nordnes AS
Dagfinn Lilleng	Fiskeridirektoratet
Denmark	
Michael Winther	SINTEF
Ulrik Jes Hansen	SINTEF
Kurt Hansen	SINTEF
Iceland	
Larus Palmason	Sudurnes Comprehensive College
Hörður Jónsson	VT – Fishing supplies
Haraldur Einarsson	Hafro, Marine Research Institute

3 Day 1

3.1 Agenda

Time	Task	Responsible
12.00-13.00	Lunch	
13.00-13.20	Welcome/Background for the project	Ulrik Jes Hansen/Svein Helge Gjøsund
13.20-14.00	Recent developments in Icelandic seining and trawling	Larus Palmason/Haraldur Einarsson
14.00-14.30	Recent developments in North Sea seining and trawling	Ulrik Jes Hansen
14.30-15.00	Recent developments in Norwegian seining and trawling	Bjørnar Isaksen
15.00-15.15	Coffee break	
15.15-15.45	Seine simulation	Karl-Johan Reite
15.45-16.15	Recent developments in trawl design	Kurt Hansen
18.30	Dinner	

3.2 Minutes of Meeting

The workshop was initiated by workshop organizer Ulrik Jes Hansen and project manager Svein Helge Gjøsund of SINTEF who welcomed the participants and gave a short introduction to the subjects of the research project.

Having completed the introduction Larus Palmason of Sudurnes Comprehensive College proceeded with the presentation entitled "Fishing into the Future" (c.f. Appendix C). The presentation covered historic aspects of seining in Iceland and gave an overview of the different types of gear in use by Icelandic fishermen.

Haraldur Einarsson of the Icelandic Marine Research Institute, continued within the topic of Icelandic fisheries with the presentation entitled "Seine Net Fisheries" (c.f. Appendix D). Here Mr. Einarsson talked about energy consumption, discard rates and environmental impact of seining seen in relation to other methods of fishing. A small research project on impact of seine fisheries in Icelandic coastal waters was presented and its results were commented.

Ulrik Jes Hansen of SINTEF continued the list of presentations by talking about North Sea seining and trawling. His contribution entitled "Snurrevod" (c.f. Appendix E), gave a concise introduction into the subject. Mr. Hansen talked about the various methods of seining in Danish fisheries and elaborated on the vessels and deck handling equipment presently in use by Danish fishermen. Besides Danish seine fisheries Mr. Hansen also talked about seining in New Zealand. Based on knowledge acquired during a recent stay he elaborated on seining as carried out in New Zealand coastal waters.

After the presentation of Mr. Hansen, Bjørnar Isaksen of the Institute of Marine Research in Bergen, Norway talked about seining as undertaken in Norwegian waters. His presentation was entitled "Description of the Norwegian Seine Fishery; History, Gear Characteristics, Current Projects and Challenges" (c.f. Appendix F). Mr. Isaksen initiated by looking at Norwegian seining in an historic perspective and characterised the Norwegian method of seining as a combination of "flydragging" and "Japanese tow dragging". The exact catch principle of Norwegian seining was explained and the typical design principles were presented. Mr. Isaksen clarified the vessels and their deck handling equipment, the various species caught by seining, the catching areas along the coast and the energy consumption by Norwegian seining. In addition Mr. Isaksen talked about the current projects undertaken by the Institute of Marine Research. These projects are related to

capture-based aquaculture where seining is used for capturing wild cod and then store these in net pens until ready for further processing.

After a short coffee break, Karl-Johan Reite of SINTEF talked about gear simulation. Mr. Reite presented the numerical simulation tool developed by SINTEF Fisheries and Aquaculture called FhSim. By a series of real-time simulations the participants was introduced to the capabilities of the program.

Kurt Hansen closed the session of presentations with his contribution entitled "Recent developments in trawl design". Two videos were presented showing a Norwegian groundfish trawl fitted with a special plate ground gear during operation. This particular ground gear was developed within the scope of the DEGREE[1] research project which aims at reducing bottom impact within trawl fisheries.

[1] Development of fishing Gears with Reduced Effects on the Environment

4 Day 2

4.1 Agenda

Time	Task	Responsible
9.00-12.00	Flume tank testing	
	Danish seine	Ulrik Jes Hansen
	Norwegian seine	
	Icelandic seine	Hörður Jónsson
	New combination seine	Michael Winther
	Norwegian groundfish trawl (Degree trawl)	Kurt Hansen
	Selstad 400m Hex	Kurt Hansen
12.00-13.00	Lunch	
13.00-16.00	Discussion and conclusion	

4.2 Flume tank testing/demonstration

The second day of the workshop was dedicated to practical testing and demonstration. The participants gathered in the flume tank where Ulrik Jes Hansen of SINTEF initiated the session by presenting the characteristics of a typical seine as used by Danish fishermen. Trawl and seines ranging in scale from 1:10 to 1:25 was demonstrated. Hörður Jónsson of VT – Fishing supplies presented a seine with a light rockhopper gear developed for the Icelandic cod fisheries and Michael Winther of SINTEF presented the combination seine developed within the scope of the project as an initial concept prepared for further improvement (see Appendix B). Two tests were carried out, one with the combination seine rigged as a seine and another with the combination seine rigged as a semi-pelagic trawl. The test session was concluded by Kurt Hansen of SINTEF who presented a Norwegian groundfish trawl complete with self spreading minimum impact ground gear together with a semi-pelagic 400 meter HEX trawl. The 400 meter semi pelagic HEX trawl has been developed for energy efficient fisheries, targeting round fish such as saithe.

4.3 Discussion and conclusion

After lunch the participants gathered in plenum to discuss and condense the findings of the workshop. The discussion was stimulated by Michael Winther of SINTEF who presented the initial ideas for an improved gear (see Appendix B). The main outline for this proposal was well received. In brief it includes:

1) Self spreading ground gear for seine fisheries
   Development of more efficient and robust self spreading gear aimed at seine and combination fisheries.
2) Flexible spreading devices (kites) for seine fisheries
   Kites are known in some trawl fisheries where they provide additional spreading forces both in the vertical and horizontal plane. By mounting hydrodynamically efficient kites to the seine along the side panels the netting will be affected by additional horizontal forces. Such forces will ensure the mouth of the seine to be open for prolonged time, hereby increasing the efficient fishing time and area.
3) Combination seine
   Fishermen have requested a multipurpose gear for use in both pelagic/semi-pelagic and seine type fisheries. We envision the creation of a gear with extra long wings, adjustable bridles and easy attachable/detachable ground gear. When operating in pelagic mode the fisherman will have the possibility to collapse the mouth of the gear when seeking alternative fishing grounds.

4) Alternative seine net design

Introduce seine design based on the Y-design principle as invented by the Swedish net designer Stig Rune Yngvesson. The Y-design is a design concept which is characterized by the fact that it allows the designer extended control of the mesh opening. The improved control makes it possible to open the meshes to their full extent and hereby enable a larger circumference at a lower material consumption.

Ad. 1) Tormund Grimstad of Nordnes AS expressed concern about mounting traditional self spreading ground gear on a seine. Mr. Grimstad was of the opinion that the reduced speed (1-2.5knots) by which a seine net is dragged could impose problems in relation to the stability of a traditional plate gear. Normally a plate gear mounted on a bottom trawl is dragged at 2-4.5 knots, resulting in relatively large forces which aids in maintaining the plates at an upright position. If a more efficient and robust plate gear were to be developed Mr. Grimstad would not refuse implementation on a seine. After the completion of the workshop, participants further discussed these matters on e-mail agreeing on the fact that a seine, compared to the traditional bottom trawl, is fitted with much lighter bottom gear and made of finer netting material requiring less spreading force. Smaller spreading forces would demand a lighter gear and therefore a more robust spreading gear with regards to stability. Participants all agreed that self spreading gear was advantageous as it could prolong the efficient fishing time.

The concept of mounting a skirt, as an alternative to a relative heavy ground gear along the footrope was intensively discussed. The skirt, made from netting material, enables the seine to negotiate rough seabed in the same manner as the rock hopper gear and are most commonly used by Norwegian fishermen. It lifts the netting material from the seabed during the tow and reduces wear and tear. The skirt can provide safety with regards to entanglement. If the seine should encounter large obstacles and get stuck, then the lower part of skirt is designed to give way, enabling it to fold back and clear the impediment. Part of the discussion dealt with skirts in combination with spreading gear.

The Norwegian groundfish trawl with its low impact self spreading ground gear received considerable attention. Participants found the design very interesting and raised comments with regard to further development.

Ad. 2) The workshop participants unanimously agreed that horizontal spreading kites could be further improved as they did not achieve the desired effects during the tests carried out on day 2 of the workshop. These difficulties related to the fact that the kites could easily entangle the netting when operating in a seine configuration (zero or low speed). Kites were mounted on the combination seine and tested on the gear in both semi-pelagic and seine configurations. Here a more satisfactory effect was observed as the kites resulted in a larger entrance area.

Ad. 3) The ideas behind the combination seine (see Appendix B) were met with general approval. Having the gear operating both as traditional seine and pelagic/semi-pelagic trawl mounted with pelagic doors. However, the concept of collapsing the mouth of the netting was met with scepticism from Mr. Birger Enerhaug of SINTEF. He was of the opinion that such initiative would constitute only a minor reduction in drag. This statement was based on Mr. Enerhaugs experience from tests carried out on fine meshed netting structures. Contrary to this statement, Kurt Hansen of SINTEF have recently carried out tests on behalf of a German netmaker, which have shown that collapsing the mouth of the trawl do constitute a difference in drag.

Ad. 4) The discussion with respect to the alternative seine net design (Y-design) was limited but its implementation was met with positive remarks.

Overall the workshop participants agreed to further pursue the initial ideas as presented in Appendix B. Based on the workshop discussion we have decided to further pursue the following main concepts:

A) Combination seine (see B.3 for detailed description)

B) Seine design based on the Y-design principle (see B.4 for detailed description)

C) Improved Norwegian Groundfish trawl (ING Trawl)

Each of the concept designs will be tested in various configurations for pelagic, semi-pelagic and seine operation, attached with different ground gear and spreading devices (see table below). At the present stage, 19 configurations will be tested. In order to quantitative asses the improvements in relation to the bottom gear we intend to test each concept using traditional rock-hopper and plate gear.

Configuration	Main design concept						Gear					Spreading device		
	Combination Seine			Y-design		ING Trawl								
	pelagic	semi-pelagic	Seine	semi-pelagic	Seine	Semi-pelagic	Rock-hopper	Traditional plate gear	Improved plate gear	Skirt	Chains	Kites	Pelagic doors	Ropes
1	x										x		x	
2		x					x						x	
3		x						x					x	
4		x							x			x	x	
5		x							x	x		x	x	
6			x				x							x
7			x					x						x
8			x						x					x
9			x						x	x				x
10				x			x						x	
11				x				x					x	
12				x					x			x	x	
13				x					x	x		x	x	
14					x		x							x
15					x			x						x
16					x				x					x
17					x				x	x				x
18						x			x				x	
19						x			x	x			x	

Table 4-1 Test matrix for design concepts A, B and C

The main focus points include:

1) **Improved self spreading plate gear.**
Particular attention will be given the development of more hydrodynamical efficient plates. In addition, robustness will receive main focus by developing a system which is easily adjusted and self up righting. Experience and knowledge accumulated from the EU funded project DEGREE project with respect to minimum ground impact is transferred to the present project.

2) **Cushioning skirt.**
As the majority of the workshop participants found the skirt advantageous it will be part of concepts allegeable for further treatment. Concepts which include skirts will be developed in combination with self spreading plates. We envision a combined configuration complete with a skirt in the centre of the footrope and partially attached along the sides together with self spreading plates mounted at various positions along the lower wings. Skirts have a wide variety of beneficial characteristics which will be transferred to the present project.

3) **Horizontal spreading kites.**
Kites are chosen for further treatment, trying to establish a better hydrodynamical performance. Horizontal spreading kites will be developed for attachment on concepts A and B (see above) where the combined influence from these will demand smaller doors and hereby lower fuel consumption. As kites are most efficient at higher speeds (1.5-4 knots), their implementation will have main interest for configurations including pelagic and semi-pelagic operation. From tank tests a great deal of difficulties were observed for kites mounted on seine gear. This relates to the fact that the seine during shooting easy can entangle the kite and result in negative or erroneous angle of attack causing the seine mouth to collapse. In pelagic operation were these difficulties not observed as the doors aids in opening the mouth and hereby provide the kites with sufficient angle of attack.

4) **Collapsible trawl mouth.**
The experience among workshop participants with regards to manual control of the trawl entrance area was somewhat contradictory. As this feature received a great deal of attention and was widely discussed we feel that it should be part of one of the concepts chosen for further development. Much knowledge can be transferred from tests carried out on krill-trawls and be further extended/improved, resulting in a practical solution for the combination seine concept when operating in a pure pelagic configuration (configuration 1, Table 4-1). Such work will once and for all establish if the concept of the collapsible trawl mouth constitutes a viable solution when trying to obtain a significant reduction in drag.

The seine configurations will all be thoroughly tested to establish the most advantageous relationship between buoyancy and weight, trying to achieve the highest sink speed without compromising requirements with respect to ground contact and towing forces.

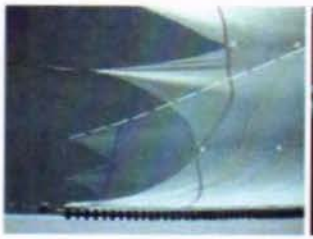
The outcome of the workshop is summarized in the form of a matrix (Table 4.1) of specific concepts and gear configurations that are to be followed up in the further work and tests in the project. Such a matrix provides both a clear overview of the concepts/configurations to be followed up, and a structured way to evaluate and systemize them wrt. applications and combinations in specific fisheries and for specific vessels.

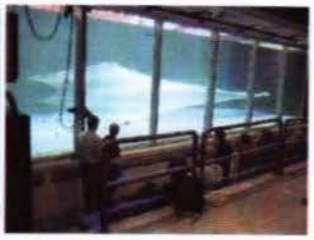
The further concept development now includes planning further tanks tests of these concepts and configurations, including establishing a set of relevant user oriented criterias for what makes a concept or configuration interesting or not for implementation in actual fishing. This will decide how the further tests should be carried out, what should be varied and measured etc.

Also, the project should use the matrix to start proposing a set of one or a few of the gear concepts that may be realistic to have on board a specific or a typical vessel.

Appendix A. Invitation to the New Active Fishing Gear workshop in Hirtshals 14-15 December 2009.

SINTEF





Workshop 14 – 15 December: New Active Fishing gear

Invitation

SINTEF Fisheries and Aquaculture have been granted a new research project aiming developing a new active fishing gear combining the best from trawl gear and anchor seining/fly shooting. We are certain that you have interest in such a project and hope that you will share your interest and your experiences with others. We will therefore invite you to a workshop at the SINTEF flume tank in Hirtshals December 14 – 15, 2009

Project objective (from the application to the Norwegian Research Council):

The main objective of the project is to reduce NOx- and other environmental emissions and impacts from demersal fisheries, by proposing new fuel- and catch efficient active fishing gear concepts based on trawl- and seine technology. By seine we here primarily mean Danish and Scottish seine. Sub-goals for accomplishing the main objective are:

- Propose new rational fishing strategies.
- Develop new, feasible gear concepts.
- Investigate gear deployment and operation by numerical simulations.
- Optimize gear design wrt. net design, towing resistance and catch efficiency.

Organization, board and lodging

The workshop will be organised by SINTEF, Hirtshals.

SINTEF will pay for the travel, board and lodging, except evening meals. The participants are advised to book their travel well in advance to get reasonable fares, especially in case of air flight tickets, economy class.

Single rooms will be booked at Motel Nordsøen (www.motelnordsoeen.dk). Breakfast and lunch will be provided by the motel and The North Sea Science Park respectively.

Programme

The programme for the venue is still under consideration and has not been settled. Please feel free to contact the organizer if you have topics you think should be considered or demonstrated. Almost certainly the following topics will be dealt with:

Variations over a Theme: different seine and trawl net fisheries targeting bottom dwelling species, an overview

Trawl vs. Seine nets (anchor and flyshooting), pro's and con's

- Energy
- Bottom contact
- Challenges varying spread in Danish seine

Videos

- Danish seine in Flaxaflói
- Others??

Tank testing

- Danish Seine
- Norwegian fly-shooting seine
- Trawl with kites
- Others??

Brainstorm

What features from trawls and seines should be incorporated in a new concept for an active fishing gear?

21-10-2009

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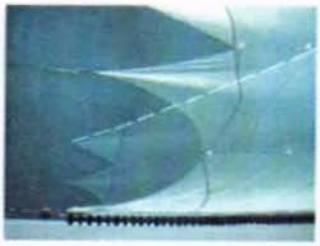
SINTEF

Workshop:
New Active Fishing gear



Invitations have been sent to:

Norway

Svein Helge Gjøsund, SINTEF, Project leader
Eduardo Grimaldo, SINTEF
Karl Johan Reite, SINTEF
Birger Enerhaug, SINTEF

Arild Engås, Marine Institute
Bjørnar Isaksen, Marine Institute

Merete Bjørgan Schrøder, Norges Fiskarlag
Joakim Martinsen, Norges Fiskarlag

Tormund Grimstad, Nordnes AS

Odd Johan Fladmark, Aker Seafoods
Bjørn Fredriksen, Nergård

Per Frøystad, Refa Frøystad Group
Hans Petter Selstad, Selstad.

Denmark

Michael Winther, SINTEF
Ulrik Jes Hansen, SINTEF, Organizer of the workshop
Kurt Hansen, SINTEF

Flemming Ruby, Nordsøtrawl
Jens Peter Hjermitslev, HG95 Rose Marie
Tonny Nees, (building a new fishing vessel)

Iceland

Larus Palmason, Fjölbrautaskóli Suðurnesja
Hörður Jónsson, Veiðarfæraþjónustan ehf
Haraldur Einarsson, Hafro, Marine Institute

Registration

Please register your participation at your earliest convenience with Ulrik Jes Hansen at ujh@sintef.dk or +45 9894 4300 before December 1.

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Appendix B. Initial concept-ideas developed for presentation at the New Active Fishing Gear workshop in Hirtshals 14-15 December 2009.

A workshop is scheduled to take place in Hirtshals during two days in week 51. Here the project group has committed itself to the presentation of feasible concepts for a new active fishing gear. Based on brainstorming and input from the industry four feasible concepts has been devised.

Due to the favorable characteristics of seining we have decided to use this method as a platform on which to develop a more efficient and environmental sound method for fishing. The pros and cons of seining are:

- More selective – avoids cod to a greater degree than trawl
- Less plaice
- Seine netting highly adaptable and flexible, allowing use under changing conditions
- Fuel efficient (~50% of fuel consumption of similar sized trawler)
- It is an effective fishing method
- Target species are similar to that of trawl fisheries
- Catch value (better quality) is high compared to that of trawls
- Low bottom impact
- Vessels are generally smaller than trawlers and as such can be constrained by weather
- Operations generally restricted to shallower water (constrained by installed rope length)
- Operations generally restricted to fine ground

We want to incorporate and further improve the already favorable characteristics of seining and leave out the less fortunate. In agreement with the latter we have identified four concepts which we find interesting and feasible for implementation into a state-of-the-art fishing gear. The four concepts are:

- Self spreading ground gear for seine fisheries (improved efficiency)
- Flexible spreading devices (kites) for seine fisheries (improved efficiency)
- Combination seine (improved flexibility)
- Alternative seine net design (improved catch ability and selectivity)

In the following, the four concepts are described in detail.

We plan to demonstrate the concepts by having two scale models built. One scale model will incorporate the technical solution relating to improved flexibility (Combination seine) and one model will demonstrate our solution for improved catch ability and selectivity (Alternative seine net design). Both scale models will be used for demonstrating our concepts in relation to improved efficiency (Self spreading ground gear and flexible spreading devices).

Several methods of seining are available but due to the fact that Scottish seining is the most widespread in Norweigian coastal waters, and in fact are the most efficient, we have decided to use this method as our reference.

B.1 Self spreading ground gear for seine fisheries

Self spreading ground gear is known to have a range of beneficial characteristics in relation to bottom trawl fisheries. It aids in spreading the gear with only a slight resulting increase in drag and in the same time it can negotiate the same rough seabed as the rock-hopper ground gear but leaves only a reduced signature of seabed impact compared to the latter. In addition, the self spreading gear has by practical tests shown to limit the amount of escapees which normally swims under the footrope of traditional ground gear.

In relation to seining will the successful implementation of self spreading ground gear enable the netting to maintain a horizontal opening for longer time, as the fishing vessel will steam ahead, resulting in a total increased swept area.

There are some inherent drawbacks affiliated with the current design of the self spreading ground gear. Presently the design consists of equally spaced rubber plates, connected by heavy chains. The heavy chains results in a less favorable relation between the dynamic fluid forces and the conservative gravitational forces. A fact which makes the rigging of the present design susceptible to incorrect adjustment, i.e. the gear tends to easily overturn at reduced speeds if not carefully adjusted.

We want to transfer the beneficial characteristics of plate gear to the seine, leave out the adjustment difficulties and develop a ground gear perfectly adapted to the latter. Such initiative will result in a gear, which should function at speeds between 0.5 and 2.5 knots, is easily adjusted and not susceptible to wrong adjustment. This implies the creation of special plates with a favorable placed center of gravity (CG) and connected by lighter linkage elements. The present discussion has already resulted in a design which makes use of plates with a very low CG, connected at the fishing line and with spherical floats attached at certain points to ensure an upright position at low speeds. The creation of an optimal configuration will demand testing of several plate designs, connectors and floats, all in model scale.

B.2 Flexible spreading devices (kites) for seine fisheries

Flexible spreading devices such as kites are widespread in pelagic trawl fisheries where they are mainly used for maintaining the vertical opening of the trawl netting, substituting spherical floats. Kites are most efficient at higher speeds (2-5knots) where the ratio between drag and lift is most optimal.

For the present project, special kites will be developed which aids in spreading the seine in the horizontal plane, keeping it open for prolonged time during the haul. We adopt the same strategy as described above, relating to the fact that longer time of horizontal opening enables a larger area to be swept.

We envision the creation of a multi-chamber kite design with a well defined high aspect ratio, attached at the wing tips between the headline and the fishing line of the seine. The kite system will be permanently attached to the seine and designed to perfectly wrap around the net-drum onboard the vessel. Several kite designs will be tested, attached at various angels of attack. Some of them with camber which is known to improve lift characteristics.

Of course the seine kites will attain increased size (area) compared to kites used in pelagic fisheries due to the fact that we have to compensate for the reduced speed. However, we believe that by designing a high aspect-ratio, multi-chamber kite with camber we will be able to maintain the needed area at a minimum.

B.3 Combination seine

By fitting a seine with large meshes in the front panels, increase the height of the side panels and develop a simple system to effortless and easy remove/mount the ground gear we believe that pelagic fisheries should be possible using a seine. Of course such initiative requires the use of steel trawl doors to keep the seine mouth open in the horizontal plane. The doors should be attached at the point of convergence for the upper and lower bridle lines and rigged in either a Vee-or parallel configuration. Some set-back (i.e. extension of lower bridle) might be required but this could easily be accomplished by insertion of chain segments.

Traditional seine ropes can not be used during pelagic operation; they would simply be too heavy and weigh down the structure. Additional wire drums needs installation onboard the fishing vessel

for storing the warps needed when undertaking pelagic fishing. We recommend the use of Dyneema SK 75 for the warps. A material which is gradually replacing combination wire and pre-stretched rope. It has the advantage of high strength, light weight and high abrasion resistance.

In addition to the above described features we will incorporate a system that enables the fisherman to collapse the mouth of the pelagic seine. From tests carried out in the flume tank on fine meshed trawls a significant reduction in drag is achieved if the entrance area is reduced.

By having the option of collapsing the netting enables the fisherman to seek alternative fishing grounds without having to haul the gear if the fish density reduces or fall below expectations.

We envision the implementation of a noose along the headline and fishing line connected to a third cable/warp which is fixed to a wire drum onboard the fishing vessel. By tightening this cable the noose gets tight and closes the mouth of the trawl, reducing the overall entrance area and hereby the resistance.

B.4 Alternative seine net design

The seine used by Norwegian fishermen has traditionally been based on a four panel design with two large wing sections joined together at the top and bottom of the seine. The innovations in relation to this design have been long winded and slow without any major changes to the well proven designs.

We intend to introduce and test a novel seine design based on the Y-design principle as invented by the Swedish netdesigner Stig Rune Yngvesson. The Y-design is a design concept which is characterized by the fact that it allows the designer extended control of the meshes. The improved control makes it possible to open the meshes to their full extent and hereby enable a larger circumference at a lower material consumption.

The larger circumference impacts the catch ability and the increased meshes degree of opening improves the selectivity and reduces the hydrodynamic drag of the trawl.
By introducing the special cutting rates which signify the Y-design principle, we will be able to concentrate the tension further aft in the trawl, and hereby have full control of larger areas of the trawl.

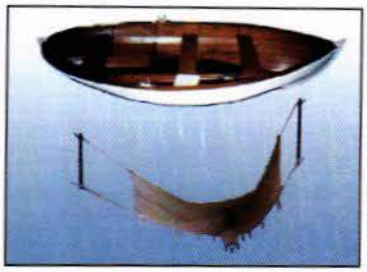
Appendix C. Recent developments in Icelandic seining and trawling (L. Palmason)

Fishing into the future

The wonderful world
of the seine, 2009

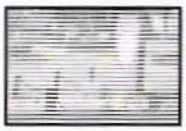
18/12/2009 Larus Thor Palmason 1

The first danish seine was rigged 1848



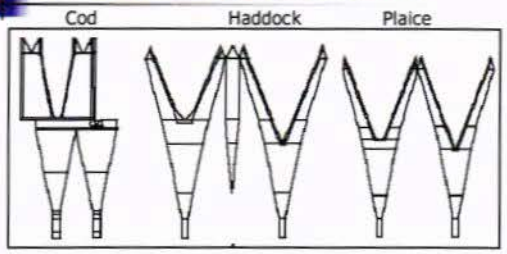
18/12/2009 Larus Thor Palmason 2

Jens Væver



18/12/2009 Larus Thor Palmason 3

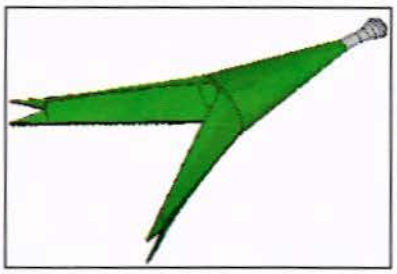
Different seine in Iceland



Techical drawings of 3 diffrent types of seine

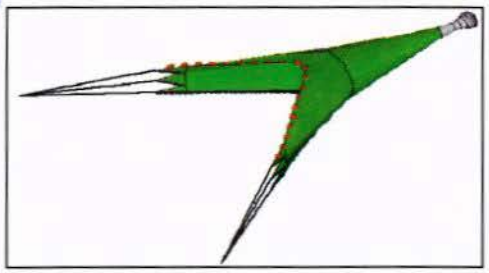
18/12/2009 Larus Thor Palmason 4

Cod seine



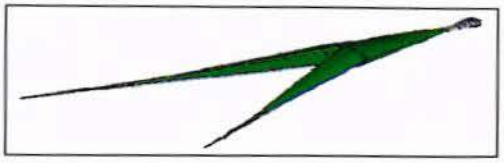
18/12/2009 Larus Thor Palmason 5

Haddock seine

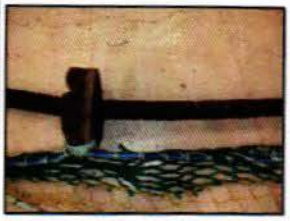


18/12/2009 Larus Thor Palmason 6

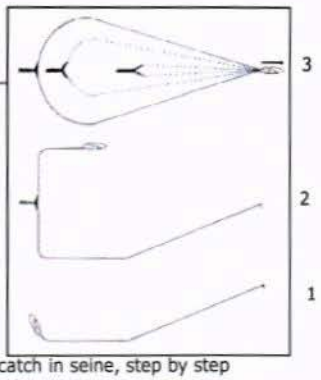
Plaice seine



Footrope

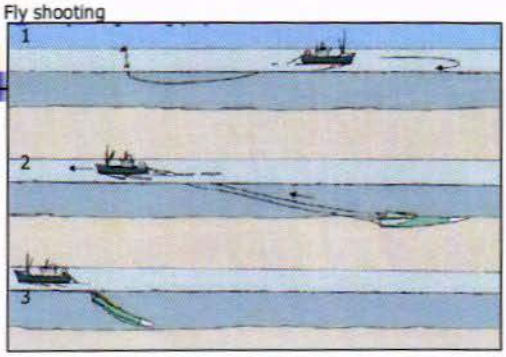


Fly shooting



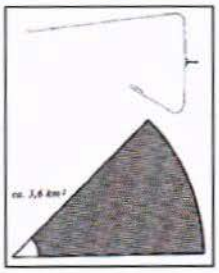
How to catch in seine, step by step

Fly shooting



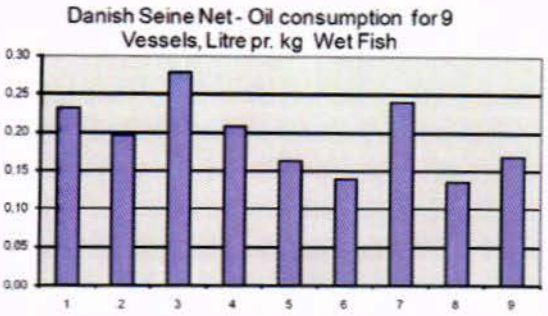
How to catch in seine, step by step

The arial of one catch



Appendix D. Recent developments in Icelandic seining and trawling (H. Einarsson)

Seine Net Fisheries



From Guðbergur Rúnarsson Federation of Icelandic Fish Processing plants

Oil consumption factors for some Fishing Vessels by Fishing Gear in liter pr. kilogram Wet fish

Year	Small Vessels =< 10 GRT	Vessels > 10 GRT	Trawlers	Purse Seiner
1990	0,16	0,21	0,38	0,04
1991	0,16	0,21	0,44	0,04
1992	0,18	0,22	0,46	0,04
1993	0,15	0,22	0,43	0,04
1994	0,17	0,22	0,43	0,04
1995	0,16	0,21	0,46	0,04
1996	0,15	0,2	0,44	0,03
1997	0,15	0,21	0,43	0,03

From Guðbergur Rúnarsson Federation of Icelandic Fish Processing plants

Based on data gathered in 1990 to1997, 2000 and 2008

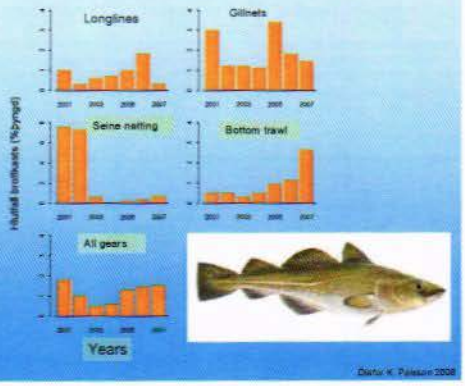
	Min l/kg	Max l/kg
Trawlers	0,37	0,5
Danish Seine*	0,14	0,24
Long Line	0,13	0,17
Gilnets	0,07	0,13
Purse Saine	0,03	0,04
Pelagic Trawl**		0,089*

* 2008

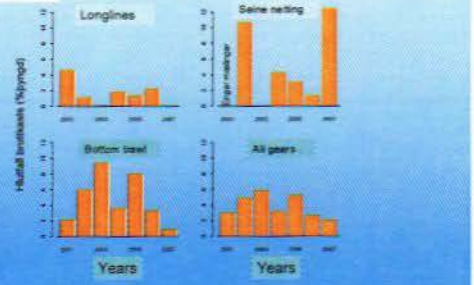
** Average 2000

From Guðbergur Rúnarsson Federation of Icelandic Fish Processing plants

Discards rate in weight of cod from 2001- 2007 by gears



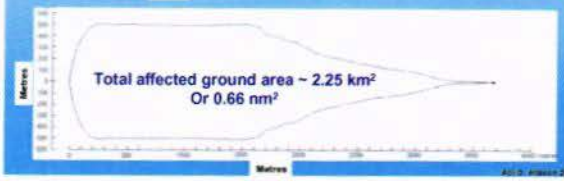
Discards rate in weight of haddock from 2001- 2007 by gears



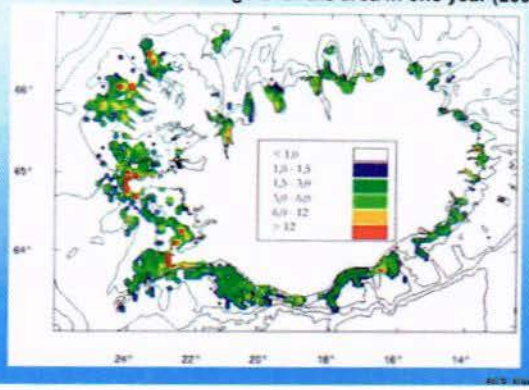
Example of typical seine net haul

One seine net haul is covering large area but the variation between vessels and hauls is probably large.

All haul in the year 2004 would have cover 101 thousand km². (Iceland is 103 thousand km²)

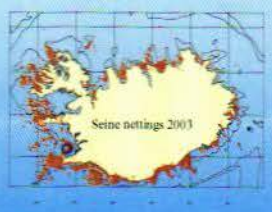


Fishing pressure, at bottom with fly-dragging. Number of times a haul go over the area in one year (2004)



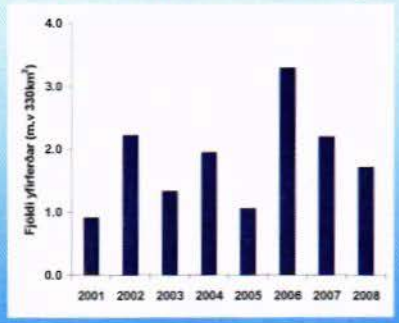
Then, how can we estimate environmental impact from use of Fly-shooters?

- We know where the fishing area are (every haul from the logbooks').
- We know the gear is mainly used on relative smooth seabed
- The recovery time may be short but are likely to vary among species groups.
- We need to map the seabed and habitat types.



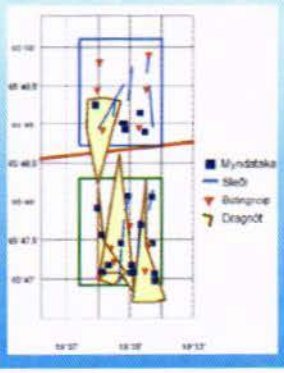
A small research on impact by seine netting

Fishing pressure in Skagafirði



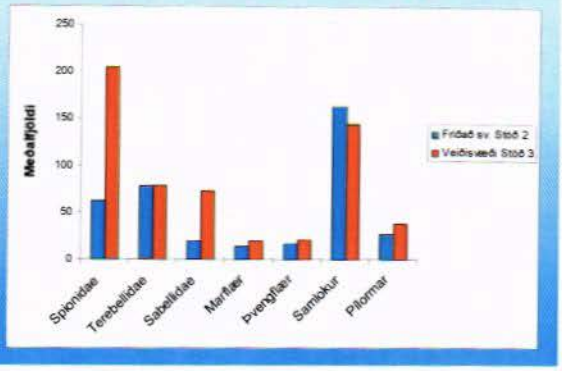
Number of overhauling by fly-dragging in Skagafirði from the years 2001-2008 (if the overhauling is even distributed at all the area)

Samples taken

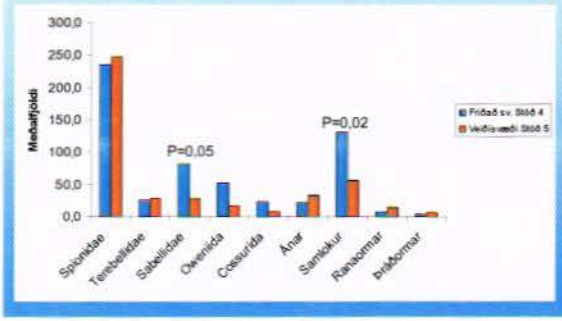


Samples taken

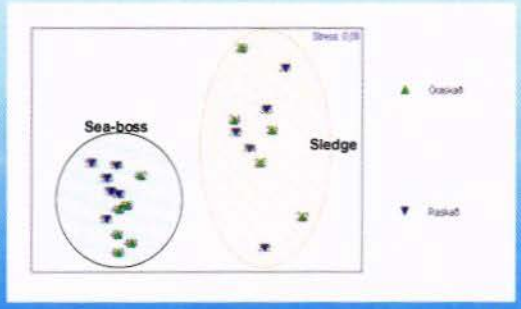
Results from the sledge



Results from the sea-boss



Results from MDS



What we get out of this!

Mistök hjá HAFRO á rannsóknum í Skagafirði

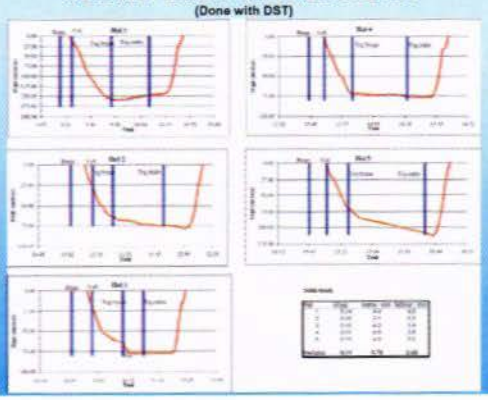
Eftir Ragnar Sigbvats

Ragnar Sigbvats

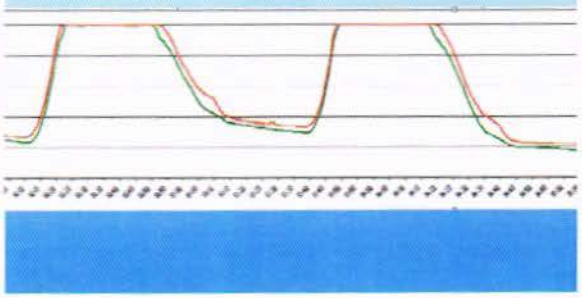
» Það er algeng sjón héðan frá Sauðárkróki að sjá dragnótabáta að veiðum á hrygningarsvæðinu hér innfjarðar og er þess vegna sýnatakan og skýrslugerðin ómarktæk eins og hver annar moðreykur.

How fast does the seine net sink?

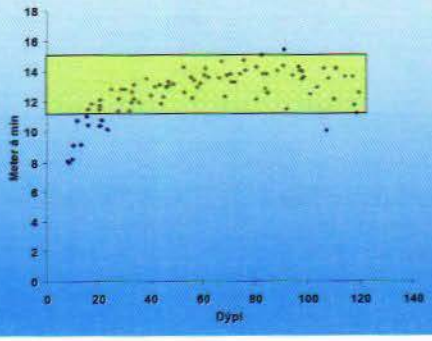
(Done with DST)



One busy day one fly-dragging.
DST marker on headline and footrope.



Sinking-speed of the seine net
11-15 m/mín



WGFTFB-Topic group about seine nets

ICES CIEM

ICES-FAO Working Group on Fishing Technology and Fish Behaviour

- a) Identify all seine net fisheries globally and describe the gears being used in terms of net design, rope material and construction, as well as areas being worked.
- b) Critically assess these fisheries, identifying the positive aspects in terms of reduced fuel consumption, high fish quality and low bottom impact, as well as any negative aspects with respect to gear selectivity and techno-logical creep.
- c) Evaluate methods for determining selectivity in these gears to allow comparison with conventional towed gears, e.g. otter trawls.
- d) Make recommendations for research/monitoring work to substantiate (or otherwise) claims for environmental friendliness, discarding etc.

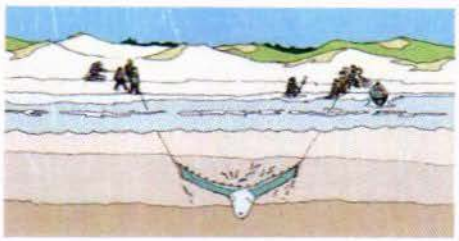
http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=13

Chaper 10

Appendix E. Recent developments in North Sea seining and trawling (U. J. Hansen)

Snurrevod

Beach seine, where it started ...



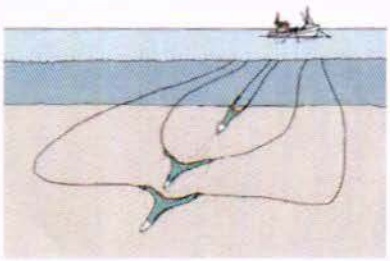
Different seines

Traditional flatfish seine

Seine for cod and haddock

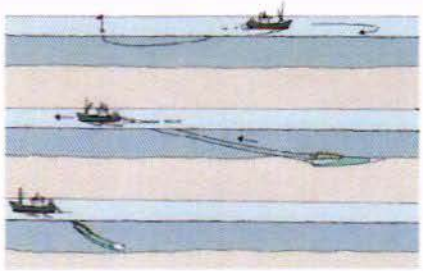
Value, weight and av. price/kg

4.4 - Et trekk satt i fugleperspektiv

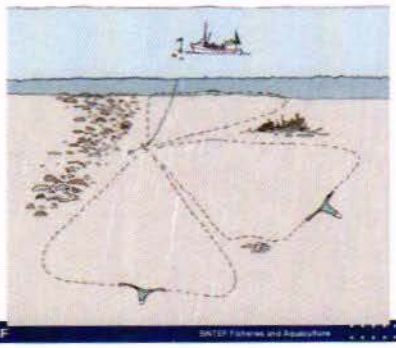


Value, weight and av. price/kg

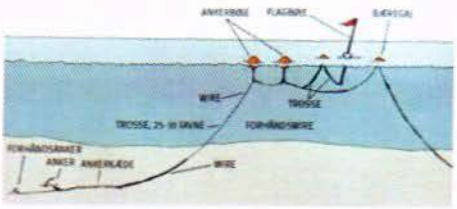
4.6 - Fly-shooting trekk i fugleperspektiv



Utilization of fishing ground



Anchor assembly



Danish vessels

Power block

Rope rollers, guiding the ropes to the capstans

Capstans for hauling the ropes

Rope reels

Rollers in the railing keeping the seine ropes out of the propeller

Raised pounders for gutting

North Sea vessels

SINTEF

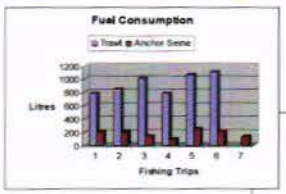
NZ fly-shooting

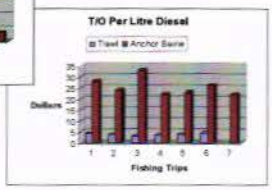
SINTEF

NZ anchor seining

SINTEF

NZ anchor seining





SINTEF

Appendix F. Recent developments in Norwegian seining and trawling (B. Isaksen)

Description of the Norwegian Danish seine fishery; history, gear characteristics, current projects and challenges

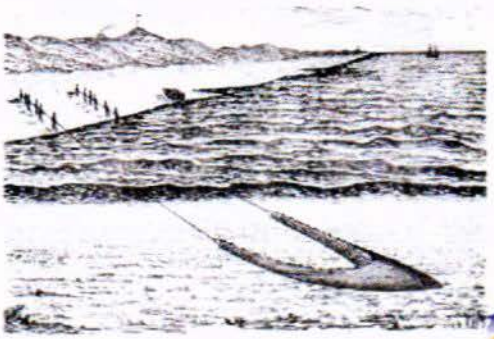
Odd-Børre Humborstad and Bjørnar Isaksen

Fish Capture Division,
Institute of Marine Research, Bergen, Norway

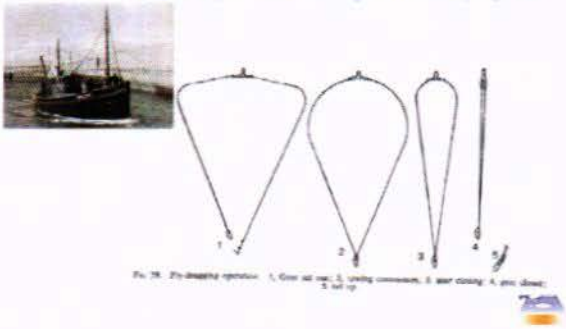
Definition of seine net (Norway)

A catch system composed of a conical shaped net cylinder equipped with net wings that is pulled forward in the sea by two long ropes put out in the sea in a circle or elliptical shaped pattern.

Beach seine; the forerunner of the seine net in Denmark

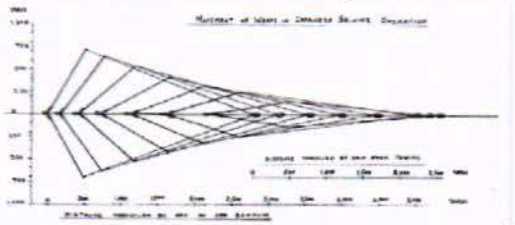


1920 Scottish seining (flydragging) The vessel is kept stationary or moves slowly forward while slowly hauling ropes. The vessel keeps its position by using motor and propeller.



Japanese tow dragging

The vessel is heading slowly forward during the whole fishing period, without hauling any rope. Hauling of the ropes starts when the net is closed and fishing has ceased.



Seine net methods

With anchor:

"Danish seining = Anchor seining (Original/traditional seine net)

The vessel are kept stationary by the use of heavy anchor

Without anchor:

A. "Scottish seining = "Flydragging"

The vessel is kept stationary or moves slowly forward while slowly hauling ropes. The vessel keeps it position by using motor and propeller.

B. "Japanese tow dragging"

The vessel is heading slowly forward during the whole fishing period, without hauling any rope. Hauling of the ropes starts when the net is closed and is not longer in any fishing position.

C. "Norwegian seining"

Fishing pattern is a mixture of A) and B). The vessel is moving slowly (1.5kn) forward. Hauling of ropes starts when the gear is almost closed."

History- Norway

" Company for the Norwegian Fisheries Promotion"

1887 - Experimental fishery with Danish seine for plaice. Fishery mostly performed by Danish vessels and skippers, low interest for the new fishing method

1904- Some of the first coastal vessels with engine interested in plaice fishery (live plaice).

1919 - 24 vessels in Lofoten Island have converted from gillnet to seine net when fishing for plaice.

1925 - 96 vessels in Lofoten-Vesterålen district; mostly plaice

1930- Total catch 4000 - 5000 tons pr year
Plaice , NOK 0,50 pr kg. Cod NOK 0.10-0.15 pr kg

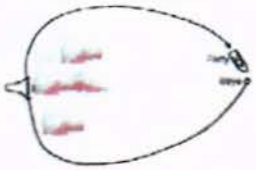
History Norway; continued

1950 Traditional wooden fishing vessels normally using gillnet and longline for cod and haddock starts to convert to seine net. Northern Norway

1970- Seine net become highly efficient in the fishery for gadoid species like cod, haddock and saithe. A new high opening design , originally developed ten years earlier get more and more popular It is basically the same design that is in use today (!!!)

1990- More than 300 vessels that are fishing with seine net, taking all or part of their quotas by this gear.

Seine net; 2009

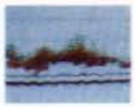


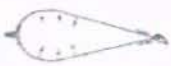
Seine net vessels; 2008

Length groups (meter)	Number
[00 - 11›	44
[11 - 15›	64
[15 - 21›	84
[21 - 28›	122
[28 - 999]	9
Total	323

Catch principle

- Searching /hunting
- Fishing does not start before good registration is found
- Shooting of rope and seine net, encircling the fish.
- Picking up the buoys, and starts fishing; (sailing slowly forward)





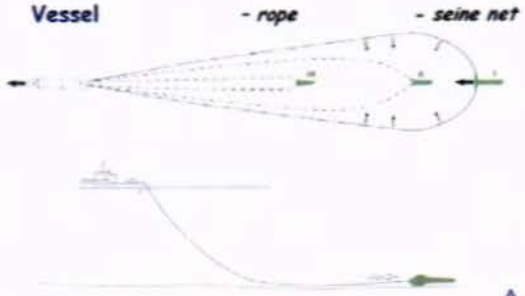
Catch princple; continued

A seine net system do change shape during the whole period from the haul starts and until it is finished (30 - 50 minutes depending of fishing conditions)

vs.

A trawl system keeps its shape more or less during the whole tow (duration of up to several hours)

Catch principle, cont:



Time spent during a normal seine net haul.

Example: 7 coils of rope, 100 m depths.

0	Throwing the buoy
1-9	Shooting the starboard rope
9-14	Shooting the seine net
14-23	Shooting the port rope
23-30	Pick up the buoy, put ropes on winch, make everything ready for towing/hauling
30-75	Slowly towing the seine net, 1.4 to 1.8 kn. Start hauling ropes in the when ropes almost closed.
75-85	Full speed hauling (approx 1.5 minutes per coil).
85- 95	Hauling of gear through triplex and/or powerblock
95-105	Lifting onboard catch, approx two bags and total 1200kg.
105-115	Make ready for another set (Starboard wing on top of port wing).

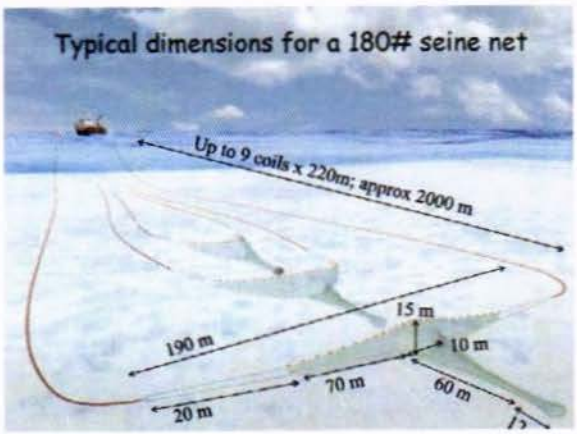
Construction of wings and "spreader"

Seine with long wings /and low opening heigth- typical flatfish seine

Seine nets with shortened wings, large opening height typical for nets used for gadoid species

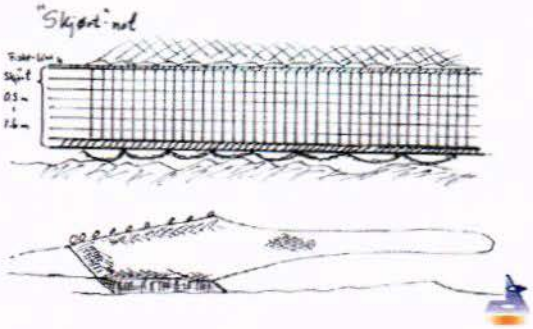
"Dan lena stick /spreader" to keep sweeps apart, and to prevent twist of sweeps

Typical dimensions for a 180# seine net



"Skirt" (1990 -)

Most used ground gear. Adjusting chain in front on both sides to work both on smooth bottom as well as rough bottom.



"Skirt seine"

Seine net rope ("STEEL BANLINE")

Only made of PP:polypropylen

4-strand rope with steel core (to make it sink fast)

Diameter 20 - 60mm

(most used 28 - 45 mm)

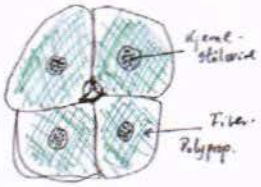
Delivered in coils of 220m.

Can be delivered in a continous length (spliced)

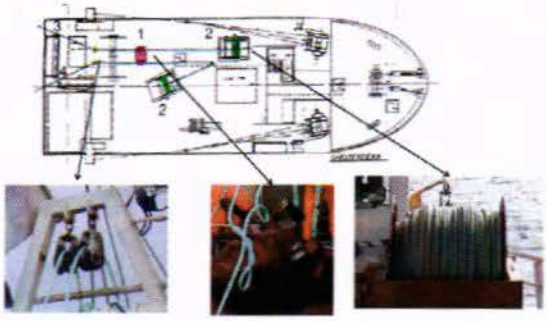
Weight in air 90-480kg pr coil.

Normal length of rope while fishing cod haddock saith in depths between 70-80 to 350 m.

Fishing for Greenland halibut 500-700 meter. 9 coils of rope on each side, pluss 250 to 400 meter of wire on each side. (Wire and rope stored on the same drum- selfhauling drums.



Rigging of vessel with winch drum for storage of rope



Block Winch Drum for rope storage

Equipment for hauling and storage og seine netrope.

I: Winch for hauling of rope, drum for storage of rope.

II: Hauling of rope directly onto drums - get more common

Block and winch for hauling of rope

Sometimes a "nice" backlash happens - espesially during too fast shooting of ropeII

Hauling of seine net through Triplex og powerblock

The seine net beeing hauled through the triplex and up through the purse seine device ("rinne")

The seine net is pulled backwards by a power block and down in the net bin. Small vessels use only power block.

Species beeing fished by seine net in Norway

COD.

Caught in depths between 50/60 and 300-350 metres.

Fished mainly jan - april,in Nordland and Troms. Late winter/ spring in April-June, Troms/ Finnmark. During summer; offshore by bigger vessels (.Bear Island)

HADDOCK

Mainly spring and summer ,Finnmarken coast. Otherwise fishing on spawning haddock , Troms Nordland, January to April.

SAITHE

Spring, summer and autumn, mainly in Nordland Troms and Finnmark.

GREENLAND HALIBUT

Caught by bigger seine vessels mai-juni, Nordland and Troms 400 - 700/800 metre.

PLAICE

Smaller catch from polar circle and nortwards. Mainly from Lofoten Island and nortwards.

HERRING

Seine net was used by smaller vessels to catch their herring quota in the late 80'ies (in the fjords)

CATFISH

Caught occasionally together with flatfish.

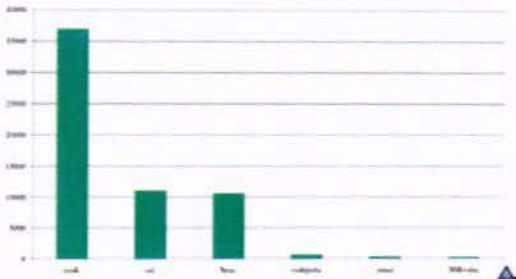
CAPELIN

In the 60'ies and 70'ies caught by small seine net, used for feeding cows/ fertilizing potato fields.

REDFISH

Occasionally catches of redfish. Directed fishing prohibited

Landings (ton) by seine net north of 62 degree, Barentshavet



Catching areas

- From Helgeland and northwards
- Inside the 4 nm line
- Off coast - Bear Island (mai-juni, [illegible])
- Continental slope (Greenland halibut)

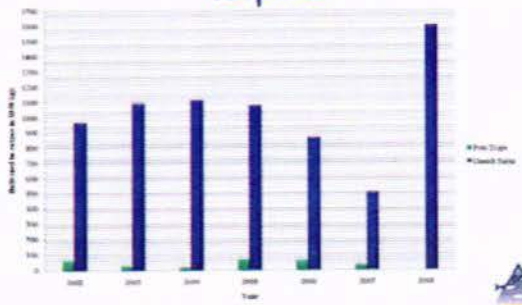
Oil consumption per kg fish Norwegian fishing fleet kg oil/kg fish

- Trawl fleet, blue whiting/Norway pout, meal production = 0,063
- Purse seine saithe, coast = 0,174
- Longline, coast = 0,205
- Seine net = 0,259
- Gill net = 0,302
- Purse seine = 0,313
- Longline, off coast ("auto" longline) = 0,380
- Trawlers, bottom (fish on ice) = 0,785
- Trawlers, Factory/freezer = 0,810
- Shrimp trawlers = 1,236
- Shrimp trawlers, off shore = 1,842

Current projects are exclusively related to Capture-based aquaculture

- ❖Availability of cod is low outside the spring fishery
- ❖Wild cod captured by Danish seine and stored in net pens in spring
- ❖Fed until autumn, doubles weight, high quality, doubles price

Live captured cod delivered to netpens



Main goal of fish welfare research:

Supply vital and healthy fish with high survival potential for aquaculture purposes:

- Explore/minimize capture stress
- Improve handling routines
- Improve sorting criterias
- Improve rearing environments

Increased transport capacity

PROBLEM

Capacity only 10-15% of conventional (100-150 kg cod per cubic metre water)

Too low since fishing grounds often are far away from fishfarms

Fuel costs and time = Money!!

SOLUTION?

- Increase (double) resting area by mounting seperating floors inside tanks
- Up 50% increase in transport capacity

Technology development for CBA (IMR, NOFIMA and SINTEF 2009-2013)

Main goals evaluate and develop:

- methods for brailing and safe handling of cod (NOFIMA)
- transportphase, surveilance of fish condition/tank environment and alternative tank design (IMR)
- CBA vessel construction for the smaller coastal fleet (SINTEF)
- pair seining and purse seine for incresaed landings of live cod (IMR)

Other challenges- catch restrictions:

- HUGE CATCHES OFTEN MEANS
- Long tow duration
- Huge pressure on fish in codend
- Time consuming brailing
- Lots of injuries to fish
- Bad quality
- Solutions?

Other challenges -bottom impact : make predictions ... Danish seine effects by combing/matching:

Lessons learned from trawl impact studies?

lifehistory

photo: MARE/ANO/IMR

Other challenges:Survival of escapees?

Lessons learned from trawl studies?

Thanks for your attention!