ICES WGFTFB REPORT 2015

ACOM/SCICOM STEERING GROUP ON INTEGRATED ECOSYSTEM OBSERVATION AND MONITORING

ICES CM 2015/SSGIEOM:22

REF. SCICOM & ACOM

Second Interim Report of ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB)

4–7 May 2015

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2015. Second Interim Report of ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB), 4-7 May 2015, Lisbon, Portugal. ICES CM 2015/SSGIEOM:22. 183 pp. https://doi.org/10.17895/ices.pub.8618

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Executive summary

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) met in Lisbon, Portugal from 4–7 May 2015 to address four Terms of Reference. The main outcomes related to the ToRs are detailed below.

Key Findings

Technical Innovation in Spreading Trawls

The topic group concluded that it made good progress toward its objectives. The group will work by correspondence over the coming year. Action items include: a) encourage R&D efforts, and b) assemble literature (grey and peer-reviewed) for distribution and sharing. The topic group will complete its tasks and submit its final report at the next WGFTFB meeting.

Non-Extractive Sampling

The first meeting of the topic group discussed scopes and assigned responsibilities for literature review on three general topics: video surveys, image and video analysis software, and modelling techniques. The topic group conveners will also establish contact with the NMFS Advanced Sampling Technology program in order to include work being done by researchers in that group and to reduce duplication of efforts.

A questionnaire will be developed and distributed during 2015 in order to identify:

- Sources of pressure to reduce the amount of fish caught during research
- What sampling methods are currently in use, and how much fish is captured
- Reasons why research catch is necessary (data collected, funding, etc.)
- How researchers are currently using optical and modelling approaches, what hardware and software they are using
- How large electronic datasets (particularly image and video) are being managed

Application of Change Management in the Fishing Industry

- No examples of the use of change management models to facilitate implementation of new gears or other fishery changes were found. Only self-developed ad-hoc models have been used by the TG members.
- Approaches to facilitate change taken by topic group members varied greatly, and had varying successes.
- Examples of rapid uptake of gears were described, including the Nordmøre grid and the twin trawl, but no clear methodology or explanation for these successes were described.
- Closing a fishery or other drastic action can be a strong motivation for uptake, but concern was raised that this type of incentive can result in unenthusiastic and superficial embrace of the change.
- The importance of incentives was identified, but a lack of clarity about the effectiveness of money or other forms of incentive was identified.

- The validity or utility of the Kotter change management model could not be adequately assessed in the time available. Therefore, a need to examine case studies using the Kotter model was identified.

Contact probability of selective devices

A more detailed investigation and discussion of contact probability between fish and selection device is essential to further improvement of existing and the development of new selective devices. This need was also reflected in the numerous contributions to this topic group. The focus of the first meeting was ToR 1 (Summarize current and past work in relation to contact probability). Existing work was presented, which was mostly related to contact in relation to net panels and grids.

During discussion, it became clear that a proper definition of contact was missing so far. Therefore, the concept of contact probability was discussed intensively.

In addition to the general investigation on the contact probability for a given selective device, the information on the contribution of different factors, influencing this contact probability are often missing. Only very few studies investigated/estimated such influencing factors.

In addition to an update of the status and outcome of ongoing work, the 2016 meeting will focus on ToR 2 and ToR 3.

1 Introduction

Directive

The directive of the WGFTFB is to initiate and review investigations of scientists and technologists concerned with all aspects of the design, planning and testing of fishing gears used in abundance estimation, selective fishing gears for bycatch and discard reduction, as well as environmentally benign fishing gears and methods with reduced impact on the seabed and other non-target ecosystem components.

The Working Group's activities shall focus on all measurements and observations pertaining to both scientific and commercial fishing gears, design and statistical methods and operations including benthic impacts, vessels and behaviour of fish in relation to fishing operations. The Working Group shall provide advice on application of these techniques to aquatic ecologists, assessment biologists, fishery managers and industry.

Chairs, Rapporteur and Venue

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Venue: Lisbon, Portugal

Date: 4– 7 May 2015

2 Terms of Reference

The **ICES-FAO Working Group on Fishing Technology and Fish Behaviour** (WGFTFB) chaired by Pingguo He, USA and Petri Suuronen, FAO, met from 4–7 May 2015 in Lisbon, Portugal to work on the following specific Terms of References that were developed from WGFTFB's multi-annual ToRs (Annex 3).

Terms of Reference (ToRs)

a) **Technical Innovation in Spreading Trawls.** A WGFTFB topic group of experts will meet at Lisbon, Portugal to document and evaluate recent technological advancements in spreading technology for mobile trawls. The group will have the following terms of reference:

- Describe and summarize new and innovative technological advancements under development (or recently developed) for spreading mobile trawls.
- Review technical challenges and obstacles for uptake by industry.
- Identify new applications for these technologies and opportunities for technology transfer.

Conveners: Paul Winger (Canada), Bob van Marlen (The Netherlands), and Antonello Sala (Italy)

b) **Non-extractive fisheries sampling**

A WGFTFB topic group of experts will meet at Lisbon, Portugal, convened by Shale Rosen, Institute of Marine Research, Norway (shale.rosen@imr.no) and Haraldur Einarsson, Marine Research Institute, Iceland (haraldur@hafro.is) will be formed in 2015 to evaluate current methods and recent technological advances applicable to sampling without physically removing organisms from the sea. The topic group will have the following terms of reference

- Summarize current needs for non-extractive sampling (e.g.. regulatory restrictions, sampling threatened or endangered species, sampling in sensitive or protected habitats)
- Inventory currently available equipment and techniques
- Identify current gaps between available technology and sampling needs

Conveners: Shale Rosen (Norway), Haraldur Einarsson (Iceland)

c) Change Management in Fisheries

A WGFTFB topic group will meet at Lisbon, Portugal to evaluate the application of change management concepts and models in a fisheries context and recommend new approaches to facilitate change in the fishing industry. The terms of reference will include:

- Evaluate the applicability of change management concepts and models in a fisheries context
- Review and evaluate fisheries case studies and initiatives to bring about change, including Knowledge networks, Environmental Management Systems, Fisheries Improvement Projects, and others
- Explore models of human behaviour that may contribute to resistance to change

- Identify and categorize circumstances and approaches that led to both the successful and unsuccessful introduction of change initiatives in fisheries.

Conveners: Steve Eayrs (USA) and Michael Pol (USA)

d) Contact Probability of Selective Devices

A WGFTFB topic group will meet at Lisbon, Portugal in 2015 to investigate, understand and improve the contact probability of specific selective devices (e.g. grids, netting). It will document and evaluate current and past work regarding the influence and improvement of contact probability. This will include studies from a wide range of scientific fields, such as selectivity, behaviour, hydrodynamics and gear design. Special attention will be given to investigating how to improve the performance of gears and selective devices with suboptimal selective properties. The terms of reference will include:

- Summarize current and past work in relation to contact probability
- Discuss and describe methods (experimental and statistical) to investigate and quantify contact probability
- Investigate and make recommendations on how to improve contact probability in selective devices, including
    - Identification of gears and selective devices with suboptimal contact probability (preferably based on current gear trials from group members)
    - Discussion on potential causes and solutions
    - Recommendations on experimental/theoretical work to understand and improve the contact probability

Conveners: Daniel Stepputtis (Germany) and Bent Herrmann (Denmark)

3 Participants

A full list of participants is given in Annex 1 and the agenda is included in Annex 2 of the report.

4 Explanatory note on meeting and report structure

The first two days of the meeting were devoted to an open session structured as a symposium where talks were presented on a range of topics of interest to WGFTFB. The third day was devoted to the topic groups and on the fourth and final day, the topic group conveners reported on their deliberations and other procedural matters were dealt with.

5 Open Session Presentations

5.1 Oral presentations

5.1.1 Recent FAO activities related to the work of the FTFB

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Recent FAO activities which relate to the FTFB were presented and included an update of the estimate of global discards; a description of the REBYC-II LAC project started in Latin America and Caribbean (Management of shrimp trawl fishing and fisheries bycatch); the role of selective fishing in Balanced Harvesting; a fuel auditing project in SE Asia; and a project on food loss and wastage in gillnet and trammelnet fisheries.

5.1.2 Introduction to Topic Group Non-extractive fisheries sampling (Non-Extractive Sampling)

Shale Rosen[1] and Haraldur Einarsson[2]

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New observation technologies and techniques are making it possible to conduct some types of fisheries investigations without taking physical samples, or to collect small-directed samples rather than the entire population encountered by the sampling. We are soliciting participants and/or reports to contribute to answering the following questions:

1) What is driving the interest and need for sampling strategies that do not result in catch / mortality?
   - Public perception of research catch as a wasted resource
   - Regulations governing the disposition of research catch / accounting for research catch under quota regimes
   - Difficulty handling large catches on research / chartered vessels
   - Investigations targeting or interacting with rare or threatened species
   - Investigations in marine protected areas / no take zones

2) What new techniques are being developed and employed?
   - Visual (baited cameras, long term moored cameras, drop cameras, video trawls, towed camera sleds)
   - Tagging for behavioural studies (technical advances, not study results)
   - Passive acoustics (we leave active acoustics to the FAST Working Group)
   - New multi-sampler equipment
   - Software for organizing and analysing large electronic datasets

- Real time transmission of data from fishing gear to vessel

3) What are the gaps between data needs and what can be provided by currently available techniques? What are the challenges to implementing non-extractive sampling?

- Need for biological samples
- Samples for physical measurements (morphometrics, meristics)
- Maintaining continuity of datasets
- Differentiation between similar species
- Access to technology (financial limitations, training samplers)
- Durability / robustness of equipment

As there have been significant recent advances in both specialized underwater camera systems and the availability of inexpensive high-resolution cameras (GoPro and similar action cameras), we expect that a significant focus will be on optical techniques, including how to analyse the large amounts of optical data generated.

5.1.3 Attitudes and approaches of FTFB Working Group members to change in the fishing industry

Steve Eayrs[1]*, and Mike Pol[2]

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The results of a questionnaire designed to understand the attitudes and approaches of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) to change in the commercial fishing industry are described in this presentation. The questionnaire was completed using the online survey tool, Survey Monkey, and was also designed to evoke consideration by WG members of i) their role in change initiatives in the fishing industry as well as that of commercial fishers and others, and ii) why many fishers are reluctant to change from the perspective of WG members. This survey is part of an investigation into the role of organizational change management theory and principles in the commercial fishing industry, including its potential application to facilitate change and improve fishery performance, which is central to the new WG topic group on change management in fisheries.

5.1.4 How many fish need to be measured in trawl selectivity studies?

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The aim of this study was to provide practitioners working with trawl selectivity with general and easily understandable guidelines regarding the fish sampling effort necessary during sea trials. Particularly, we wanted to provide guidelines on the number of fish necessary to catch and length measure in a trawl haul in order to assess the selectivity parameters within an intended maximum uncertainty level. In addition, the study investigated the dependence of this uncertainty level on the experimental method applied for the data collection and on the potential effects of factors like the size structure in the catch relative to the size selection of the gear. We based the study on simulated data created from two different fisheries: the Barents Sea cod trawl fishery and the Mediterranean Sea multispecies trawl fishery represented by the red mullet. The purpose of using these two completely different fisheries was to obtain results that can be used as general guidelines also for other fisheries. The results showed that the uncertainty in the selection parameters decreased with increasing number of fish measured and that this relationship could be described by a power model. The sampling effort needed to achieve a specific uncertainty level for the selection parameters was always lowest for the covered codend when compared to the paired gear method. In many cases, we observed that to keep a specific uncertainty level the amount of fish needed to measure with the paired gear method is around 10 times higher than with the covered codend method. The trends observed for the effect of sampling effort in the two fishery cases investigated were similar.

5.1.5 The myth of improved selectivity

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In the Baltic trawl fishery targeting cod, several changes in technical measures were implemented during the last years. In 2010, the mesh size was increased from 110 mm to 120 mm for the two legal codend-types BACOMA and T90. The adverse effects of this change in selectivity on catchability, discard rates and fishing pressure on larger individuals was already documented in 2010. Given the recent issues in Eastern Baltic cod, the known selectivity curves from the relevant gears (BACOMA 110mm, BACOMA 120 mm, T90 110 mm, T90 120 mm) were applied on BITS Q1 length structures of cod from given areas and years. The theoretical catch profile was used to estimate the effect of changed selectivity on the catch of given length classes and theoretical discard rates. The results suggest that

- The catchability of size classes up to 55 cm is reduced dramatically this causes a significant loss of commercial catch which has to be compensated by increased fishing effort; or may result in incomplete use of the TAC.
- The relative fishing pressure on larger cod increased due to the reduction of catchability for small and mid-sized fish.
- A larger mesh size does not automatically result in a lower discard-rate (in numbers). In the BACOMA codend, discard rates can even be significantly

higher with a larger mesh due to dual-selection effects; this effect increases with left- skewness of the length-structure (e.g. 2014 in Eastern Baltic cod).

These effects can help to explain some of the current changes in cod stocks and fisheries, especially in the eastern Baltic Sea: (1) TAC were not fished since 2010, (2) increasing discards in the national discard sampling programmes since 2011/12 and evidence from the fisheries for even higher discards (>50%), (3) decrease of larger cod in recent years. Consequently, the findings have implications for the assessment (e.g. commercial tuning fleets cannot be used without correction) and needs to be discussed in the fisheries management context.

5.1.6 Size selectivity of selective devices unveiled by contact probability: separator panels (grid and window) of trawl and tooth space of dredge

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This presentation will explain several examples of size selectivity of selective devices that I studied with contact probability model. First, grid separator has size selectivity on grid bar space, similar to mesh size. In Nordmøre grid separator fishing experiments carried out in the Inland Sea of Japan, some of shrimp whose body size was enough small to pass through the bar space, escaped out through the fish outlet. This suggested that only a part of shrimp contacted the grid bar space, which was defined as encounter probability (Tokai *et al.*, 1996). Moreover, the available selection of the grid with fish outlet was expressed as pr(l) + 1-p, with contact probability p and retention curve of the grid bar space for l-length shrimp, r(l). Second, in a square mesh top window tested by Aberdeen Marine Laboratory, the contact selection curves of the window panel for haddock and whiting were estimated with using probability parameter of fish contacting the window panel, and then the available selection curve (Zuur *et al.*, 2001). Third, in the windows fishing experiments with three positions of window panel: top, sides and top and sides, higher contact probabilities were provided in top and top and sides for blackthroat seaperch and in sides and top and sides for white-spotted conger (Tokai unpublished). This suggested that the fish behaviour contributed to contact probability and that gear modification can improve contact probability. Fourth, the net-mouth available selection of dredge with tooth was modelled with contact probability of a clam against the tooth and tooth space contact selection curve (Mituhasi *et al.*, 2005), for analysing the data of paired-gear test with a control dredge of 12-mm tooth spacing and four test dredges of tooth spacing 16, 20, 24 and 35 mm, based on the SELECT method. In the SELECT process, the plots of the proportion of clams caught in the test dredge to the total catch were U-shaped (Kim *et al.*, 2005). Finally, a BRD which comprised a pair of net panels and escape vents between the panels was attached at the net mouth of small beam trawl, and the available size selection was expressed with parameters of contact probability and contact selection curve for each panel (Kajikawa *et al.*, 2013). The equation expressing the available selection looked complicated. Nevertheless, no contact of animals against the panel veiled the contact selection. No retention in contact selection, e.g. too small body compared with mesh size, veiled the contact probability.

5.1.7 Escape panels in trawls – a consistent management tool?

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Selective devices are often developed in collaboration between scientists and fishers, and end with a controlled scientific test documenting the selective effect of the design. In this study, we compare two versions of a selective gear with an escape panel that was introduced into the mixed species fishery in the Skagerrak in 2013; the implemented version, which is the design used during the scientific test and subsequently documented in the legislation, and the post-implementation version, which is the version the industry is using one year after its implementation. The post-implementation version went through some relative small adjustments that resulted in a panel section with a larger vertical distance between the escape panel (upper panel) and the bottom panel compared to the implemented version. According to the legislation, both designs are legal and considered identical. However, the results showed a significantly lower selectivity for all five species examined; cod (*Gadus morhua*), saithe (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), plaice (*Pleuronectes platessa*) and Norway lobster (*Nephrops norvegicus*) in the post-implementation version currently used by the industry. The results showed that overall gear geometry in the panel section could influence the efficiency of an escape panel significantly. This is something, which is not taken into account by current legislation. It is evident that the ingenuity of fishers and their ability to adjust, or to some extent control, the selective properties in mandatory designs can reduce the expected effect of selective devices unless the management system provides adequate incentives to ensure that the intended selective effect is achieved.

5.1.8 Manoeuvrable pelagic trawl doors

John Willy Valdemarsen1*, Trond Nedrebø2, Arvid Sæstad3, Jan Tore Øvredal4 and Thor Bærhaugen[5]

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Pelagic trawl doors for which spread forces can be adjusted until 50% by changing the doors surface area of the by opening and closing of hatches inserted in the door are developed. The hatches can further be used to adjust the roll angle of the doors resulting in vertical adjustment of the doors while towing. Vertical adjustment of each door can be done independently by acoustic communication with motors that can open and close one or more hatches.

The trawl door design is described, supported by results from tests where the trawl door performance is documented both with pelagic and semi-pelagic rigged trawls. These tests include 2 m^2, 7.5 m^2 and 9 m^2 sizes of the Seaflex trawl doors. Among others,

it was demonstrated that only one of the trawl doors need to be adjusted vertically during semi-pelagic trawling when both trawl doors should have equal distances from the bottom.

5.1.9 New approaches to bycatch reduction in bottom trawling for shrimps *Pandalus borealis*

Roger B. Larsen and Ivan Tatone.

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Currently, there is a great interest in improving bycatch reduction in the Norwegian shrimp fisheries and joint efforts by the fishing fleet, the Directorate of Fisheries and science started recently. The aim is to reduce bycatches well below today's strict regulations on legal numbers of fish counted as bycatch.

Despite the compulsory Nordmöre grid (since 1991/1993) removes large quantities of fish during the catch process, the 19.0 mm bar distance allow small juveniles and slim fish in general to enter the codend, i.e. they are retained as part of the catch. Typically juveniles smaller than 15–16 cm from important species like cod, haddock, redfish, etc. are likely to be retained whenever they occur along the fishing ground.

As a first attempt in Norway, we tried a setup with green Lindgren-Pitman Electralume LED lamps along the fishing line during trials in February 2015. We attached 16 (and 20) of these LED lamps along the 52 m fishing line. We managed to get only 6 valid hauls (30 min. tows) with small shrimp catches and rather few retained fish and the interpretation of them should therefore be done with caution. For the 3 comparisons pooled numbers showed a 27% reduction by numbers of the most important and abundant bycatch species, but we found a discouraging reduction close to 9% of shrimps (by weight).

5.1.10 Can the rectangular mesh codends solve multispecies fishery selectivity problems?

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Fish morphology versus mesh size and shape is one of the main factors determining the size selection for a species in a bottom trawl. Codends made with diamond or square meshes is traditionally used for bottom trawls in many fisheries including the Mediterranean trawl fisheries. However, in these mixed fisheries, catching many different species with different body shape, it has been found very difficult to obtain an acceptable size selection with a diamond or square mesh codend construction.

Using descriptions of fish morphology based on the simulation tool FISHSELECT we demonstrate that theoretically codend meshes with a rectangular shape has a better potential to simultaneously obtain an acceptable size selection for species with different body morphology. We demonstrate this potential by theoretically investigating the

size selection of red mullet (*Mullus barbatus*) and common pandora (*Pagellus erythrinus*) in rectangular meshes of different size and shape. Further, we present size selection results from experimental trawl fishing using a codend with rectangular meshes.

5.1.11 Understanding and predicting size selection of European hake (*Merluccius merluccius*) for bottom trawl codends: a simulation-based approach

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The European hake (*Merluccius merluccius* L. 1758) is a demersal species with wide geographical distribution throughout the Atlantic Ocean and the Mediterranean. European hake is a species of great economic importance and is fished with a variety of fishing gear at depths from 50 m to more than 500 m. Bottom trawl is also one of the most important fishing method to harvest European hake. For this reason, several experimental studies have been carried to assess to codend size selectivity for European hake in bottom trawls. For this aim different mesh size, configurations, and also some grid systems were tested in order to improve European hake selectivity for the bottom trawl codends. Very limited experimental-based data exists on the size selection of European hake in trawl codends. These data needs to be supported by theoretical works, which try to understand and explain the experimental obtained results for managing the exploitation of the European hake resources. The goal of the present work is to establishment a theoretical –based framework for understanding and predicting size selection of European hake in codends with different mesh configurations and sorting grid. For this aim, we used the fish morphology and computer–based simulation method FISHSELECT and we demonstrate how results for the size selection of European hake obtained from experimental fishing can be understood based on morphological characteristics of the species and mesh geometry. This further enables us to make predictions for size selection of red mullet for the mesh configurations which has not been tested experimentally.

5.1.12 Development of concepts for reduction of flatfish catches in roundfish fisheries

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Technical measures regulating gear selectivity are often focused on single-species. Such strategy is not optimal for mixed fisheries catching species with different morphology, behaviour, as for example roundfish and flatfish. As a result, a large amount of unwanted bycatch can occur. We describe the development of different selectivity concepts aiming at reducing flatfish bycatches in fisheries targeting roundfish. The concepts have been tested in the Baltic trawl fishery targeting cod. The underlying strategy in these concepts is to establish a sequential selectivity process along the trawl and use the difference in behaviour (including altering the behaviour) and morphology between species. The developed devices include a selection device using rigid grids and a deflector to guide fish towards the grids (FRESWIND), an adaptation of FRESWIND using flexible grids (FRESWIND) and a device don't using grids (FLEX). The developed concepts could be transferred to other roundfish directed fisheries with flatfish bycatch problems.

5.1.13 Environmentally friendly fishing gear with bio resin to reduce ghost fishing and bycatch of non target species.

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The number of fishing vessels operating in the coastal and offshore waters of Korea is about 71 thousand including about 14 thousand gillnetting boats and 5,600 trap fishing boats respectively. In general, they use 500 panels per vessel in the gillnet fishery and about 50 panels (10%) of them are lost in a year. In the trap fishery, a total of 2,500 traps are used, and about 500 traps per vessel are lost during a year. Ghost fishing occurs by the lost gillnets and traps because lost synthetic net is not easily degraded under natural sea conditions. Biodegradable monofilaments for gillnet and trap were developed by NFRDI for reducing ghost fishing and protecting the marine ecosystem. It was made with PBS (polybutylene succinate) and PBAT (polybutylene succinate adipate-co-terephthalate) resin. The bio-monofilament is degraded by micro-organisms (bacteria, fungi, etc.) after two years in the sea. The fishing performance of PBS net is similar to that of PA (e.g. nylon). Representative fisheries that used biodegradable fishing gears are snow crab gillnet and swimming crab gillnet. Field experiments were conducted with commercial gillnetters to test the fishing performance of biodegradable materials. Results show that the overall catch of bio-gillnets was similar to that of commercial nets, and catch of individuals smaller than minimum landing size by bio-gillnets was less than that of commercial gillnets. Therefore, it is shown that biodegradable fishing gears are effective to reduce ghost fishing and bycatch of non-target species.

5.1.14 Danish seine – Ecosystem effects of fishing

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Although Danish seining is seen as an efficient, fuel saving fishing method with relatively low impacts on the environment, the number of seining vessels in Denmark is decreasing and the amount of scientific studies on Danish seining is rather low. At least the second point is taken up by the current study "Danish seine – Ecosystem effects of fishing", whereby the first results will be presented within this presentation. These include the outcomes of a comparison to trawls on the basis of a perennial discard dataset (1997–2012) as well as the results of a selectivity experiment from summer 2014, which represent the main part of this presentation. The trials in 2014 consisted of two parts. The first part investigated the selectivity of the codend, using the covered codend method. The second part examined the escapement characteristics of different animals in other gear parts. This was done by attaching twelve collecting bags to different parts of the gear. Both, fish and invertebrates, were included in the analyses, whereby selectivity curves and inherent selectivity parameters were used as well as other techniques like multidimensional scaling.

Furthermore, the plans for the next trials, which aim at describing the fishing process and estimating the impacts on the seabed, will be touched roughly to give an idea of the whole project.

The overall results of this study will increase the knowledge of Danish seining and its potential impacts on the environment. Consequently, it delivers profound information for future discussions in terms of spatial planning and fisheries management like setting new technical regulations.

5.1.15 Catchability of Nephrops (*Nephrops norvegicus*) in creels. A study on the effect of orientation of the creel.

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In the Kattegat and Skagerrak, more than 90% of the Nephrops catches are taken by trawl. Creels are a low-impact alternative to trawl, both with regards to impacted area and fuel demand. Increasing the fraction of the landings taken by this gear would therefore benefit the overall sustainability of the fishery. However, catch rates in creels are relatively low and the number of creels needed to make it economically viable is therefore high. Increasing the catch rates of the creels will thus strengthen the viability of this fishery and at the same time reduce the handling time and workload per kilo of Nephrops.

Previous investigations have demonstrated that Nephrops approach the creel from downstream, and that less than 10% of the Nephrops that locate a creel are captured.

One reason for this is the difficulty in locating the entrance (e.g. Bjordal 1986 and Miller 1990). In this study, we investigated the effect of changing the rigging of the creels assuming that it determines the orientation of the creel – and the entrances - relative to the current. 10 strings with a total of 240 creels were fished on known Nephrops grounds in the Swedish archipelago. Every second creel was attached to the string by a line tied to the short side of the creel (standard). On the remaining creels, the line was tied to the long side (sideways; turned 90 degrees). A total of 13.3 kilos of Nephrops were caught, which is a relatively low catch rate for the season. This is likely due to the creel design which was chosen to be as simple as possible (i.e. without a sleeping chamber). Catches of Nephrops per creel increased by 54% (95% confidence interval: 18%-89%) when turning the creels sideways.

A 54% increase in efficiency of a commercial fishing gear was higher than expected, and it is likely that it was amplified by other conditions than the location of the entrances. Data from sensors and cameras suggested that the increase in catches could be partly explained by a large number of standard creels landing on their tail. Feedback from fishers in other areas revealed that they already used the "sideways" rigging. The results illustrate two things; i) it is possible to improve catch rates of creels and ii) lack of knowledge sharing between fishers resulted in a suboptimal exploitation of the resource.

5.1.16 Recent discard survival experiments related to the EU discard ban – Technology and first findings

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The coming Discard Ban or Landing Obligation in the EU initiated studies on the survival rates of the major discarded species. IMARES is currently studying survival rates of the major discarded flatfish species (sole, plaice, dab) in the Dutch fleet. Additional to the actual survival rates the potential of improving survival through adapted deck handling is studied. The presentation will explain the techniques developed to allow a prolonged discard mortality monitoring in captive observation studies following guidelines of ICES WKMEDS. Some results of the first survival trips for three major flatfish species will be presented and discussed. The projects are ongoing this year and is financed by the Dutch fishing industry and the European Fisheries Fund.

5.1.17 Discard reduction in the Irish quad-rig Nephrops trawl fishery

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Quad-rig trawling was first adopted in the Irish Nephrops fishery in October 2012. The majority of vessels above 15m (LOA) have adopted the quad-rig by 2015 but some fishers are concerned about the effect the gear change might have on the long term sustainability of the fishery. A catch comparison trial using a hybrid twin/ quad rigged Nephrops trawl was carried out using the rigging devised by Cefas UK in 2009. The

quad rig was observed to catch more Nephrops and less fish than the twin rig which supports the findings of the previous study. Increased proportions of roundfish and Nephrops below MLS were also observed in the quad rig.

Trials of additional technical measures have been undertaken to optimize selectivity for roundfish using a 300 mm Square Mesh Panel (SMP). Trials of increased codend mesh size and square mesh codends have been undertaken to optimize selectivity for both Nephrops and fish. Reductions of 70% and 52% in haddock and whiting catch weights were observed using the 300 mm SMP. Catches by weight of Nephrops below Minimum Landing Size were down by up to 64% in the 100 mm compared with the 70 mm mesh codend.

Codend catch volumes are lower in the quad rig compared with the twin rig. The effect of reducing codend catch volumes on codend selectivity will be considered in further trials aimed at optimizing Nephrops and fish selectivity in the quad-rig.

5.1.18 Change in the catch composition in a fishing community of northern Japan over last two decades –capture fishery needs to be adaptive to change in local ecosystem?

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Sai Village is a small fishing community locating the northern end of Honshu Island (mainland) of Japan. Capture fisheries employing passive gears such as a trapnet has captured a wide range of fish of cold and warm-water species. We analysed a monthly catch data of all capture fisheries in the community over 2 decades with a change in the sea surface temperature (SST). In addition, a body fat percentage (BFP) was measured for Japanese amberjack *Seriola quinqueradiata* that is common species in the western/southern Japan, but captured by trapnets in Dec. 2014 to examine the quality as a new product in the community. Changes in catch amount of cold water species (chum salmon *Oncorhynchus keta* and Pacific cod *Gadus macrocephalus*) and the SST was not clear, but increase of catch amount of warm-water species such as Spanish mackerel *Chamaecyparis pisifera* and Japanese amberjack was apparent over last 10 years. BFP of Japanese amberjack was lower than same species captured in the southern waters or aquacultured. Passive capture techniques traditionally designed for cold-water species may be necessary to be modified to meet the change in local marine ecosystem.

5.1.19 Improving the catch efficiency for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) during bottom trawling in the Barents Sea

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Fish trawls used by the Norwegian trawl fleet has increased in size and weights gradually since the mid 1980ties. The industry claim that longer and heavier groundropes are necessary for the efficiency of the gear. We compared the escape rate below the fishing line in an Alfredo No. 3 fish trawl using the conventional 21" rock-hopper groundrope (RHG) and a 20" semicircle spreading groundrope (SCSG) along the 18 m fishing line. A retainer bag was attached to the center section of the groundrope and all fish from this bag and the codend were measured.

The trials were conducted in the Barents Sea during November 2014 (mainly large cod) and February 2015 (a mix of large cod and haddock), with rather different light and temperature conditions at fishing depth. Data analyses were made with models developed in the SELNET software for the fish size dependent escapement rate below the fishing line. The lightweight SCSG was found to be more efficient at preventing escapement under the fishing line than the conventional RHG. This difference was highly significant for cod. During November 2014 the fraction of cod >65 cm escaping below the fishing line with the RHG was 14% and below 5% with the SCSG. In February 2015 the fractions for cod > 65 cm were 5% and 2%, respectively and for haddock >62 cm the escapement was close to 7% with the RHG and 1% with the SCSG. For both species, the escapement rate under the fishing line was found to be dependent on the size of the fish with smaller fish having a higher escapement rate.

5.1.20 Possible applications of electrical pulses for a more selective fishery

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Although water and electricity are known as sworn enemies, the use of electrical pulses offers great opportunities for a more selective fishery. This is illustrated by the commercial application in beam trawlers targeting sole or shrimp. These so called 'electrotrawls' replace the traditional mechanical stimulation of the bobbin rope, tickler chains or chain mat by electrical stimulation. As a consequence, bycatches, bottom impact and fuel consumption are reduced. However, the possibility to steer the behaviour of marine organisms can also be used to separate and release unwanted bycatch without loss of commercial target species once these animals entered the net. We implemented an electrical stimulus upon a benthos release panel (BRP). This BRP was known to release great amounts of the benthos and debris caught, but it is seldom used by fishers because commercial sole was also escaping. We added an electrical field to the BRP, to prevent sole from escaping through the panel and did pairwise catch comparison with a conventional 4m beam. Our results show that this did affect the release of benthos (>70%) or debris (>60%), while the loss of commercial sole was reduced over 50%. The reduced catch volumes facilitated the sorting process and may also improve the fish quality. Moreover, several undersized commercial species were still released, which is warranted by fishers facing the upcoming discard ban.

5.1.21 The Dynamic Simulation of the Pelagic Longline Retrieving

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It is important to understand the hydrodynamic performance of pelagic longline gear retrieving and the interaction among sea current, fishing vessel, line hauler, and catches for improving the fishing gear, and increasing fishing efficiency. In this study fishing gear parameters, fishing operation parameters and three-dimensional (3D) ocean current data collected aboard the fishing vessel "Xinshiji 85" while operating in the Indian Ocean (2°S～9°S, 61°E～69°E) from September 2012 through March 2013. Taking into account the interaction among sea current, fishing vessel, line hauler, and catches, dynamic equations of pelagic longline gear retrieving were built using the lumped mass method and solved by the Euler-Trapezoidal method. The space shape, movement velocity, and tension distribution of the longline gear during the retrieving process were analysed, a model was derived, and then verified. Results indicate that: (1) pulling force of the line hauler exerted on the gear was 2800N～3600N; (2) there were no significant differences ($P > 0.05$) between the hook retrieving time measured at sea during retrieving process and the simulated hook retrieving time; (3) the absolute velocity value of representative nodes in the X, Y and Z axes ranged 0.01～24.70 m/s, 0.07～25.5m/s, and 0.07～25.1m/s, respectively; (4) variation trend of node tension showed the same trend as the hydrodynamic force, hydrodynamic force became large while the increase of node tension; (5) one tuna catch didn't produce significant effect on the shape of the gear, but three tuna catches produced certain effect on the shape of the gear. The movement velocity of the node with catch declined significantly, and the variation extent was very small. These results suggest that the dynamic model of longline fishing gear retrieving developed in the present study could be used: (1) to present the dynamic process of the retrieving of each node, the 3D shape of the longline, and the hydrodynamic performance of fishing gear under the non-uniform steady flow; (2) to serve as a reference to study the hydrodynamic performance of other fishing gears (e.g. trawl and purse-seine) during the hauling process.

5.1.22 A pilot project to audit commercial shrimp trawlers in Thailand

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This project represented the first attempt to conduct an energy audit of Thai shrimp trawlers and possibly the first of any trawl fishery in Southeast Asia. An audit protocol was applied comprising of a detailed interview of fishers followed by at sea measurement of fuel consumption by a small number of fishing trawlers. A total of 94 fishers were questioned about the operation of their trawler and fishing gear, including operational specifications, duty cycles, and catch and expenditure details. Six trawlers were then selected for further evaluation, including at-sea measurement of fuel consumption over a 10-day period. We found that the average fuel cost for all trawlers accounted for 72% of total expenditures followed by crew (13%), food (10%), ice (5%), and lubricants (1%). There was no significant difference between these proportions between the categories of small (<14m), large (14m+), or all trawlers combined ($\chi 2 = 1.296$, df = 8, p=0.9719). For each of the six trawlers fuel consumption while trawling was the dominant source of fuel consumption, accounting for 71 to 94% of total consumption. A variety of fuel saving options were then identified and a first order estimate of their suitability and fuel saving impact on the entire trawl fleet was calculated. Improved trip planning and judicious use of engine revolutions were considered simple, low-cost options that could realize significant fuel savings and provide immediate benefit. Other options were also considered, from fuel flowmeters to hydrodynamic otter boards, although many of these options are expensive, require greater education, and pay back periods extend 4 years or longer. This presentation describes the methodology applied in this project and presents a summary of results. It also critically assesses project shortcomings and provides advice for future initiatives.

5.1.23 Fishing for food: simple changes in codend design improves the quality of fish products

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Fishing gears have negative impacts on seafood quality, especially on fish in the mixed trawl fishery targeting Nephrops (*Nephrops norvegicus*). In this fishery, which is worth about €80 millions in Denmark alone, the quality of fish and Nephrops can be significantly improved by simple gear changes. In this study, a vertically divided trawl codend was designed to separate fish from Nephrops during the fishing process by encourage fish to swim into the upper part by using a frame at the entrance of the lower part. Separate codends for fish and Nephrops provide the opportunity to selectively reduce small low-value fish, which will reduce catch weight and sorting time onboard the vessel. The upper and lower part of the codend consisted of 120 mm and 60 mm square mesh netting, respectively. For this vertically divided and a standard 90 mm diamond mesh codend, in which the catch was mixed, quality assessments were performed on the same batches of fish during three steps of the value chain: i) aboard the fishing vessel; ii) at the Fishermen's Collection Central, and iii) in the production plant. Four species of fish and fillets from fish caught in the upper part of the vertically divided codend were of significantly better quality for several of the assessed parameters

compared with those caught in the standard codend: The decrease in catch-related damages in the vertically divided codend is explained by little contact between fish and animals with hard or spiny surfaces due to successful separation of fish and Nephrops into the upper and lower parts of the codend, respectively, and by lower catch weight in the upper part compared with the standard codend. The decrease in damages may also improve quality indirectly by inflicting less stress to the fish and subsequently give better texture, which offers advantages such as pre-rigor filleting and fresher products for the market. Significant improvements in fish quality can potentially increase the catch value in nationally important fisheries.

5.1.24 Trials of ruffled small-meshed inner nets to reduce loss and clogging of small organ-isms in a pelagic survey trawl

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Trials using an in-trawl camera system during a survey of young of the year fish in the Barents Sea indicated that a significant portion of the catch entered the codend when the trawl was at or near the surface during haulback (Underwood *et al.*, 2014). Combined with observations of large numbers of fish meshed in the 60 mm and 80 mm meshes in the aft portion of the trawl as it was brought on deck, this suggested that large numbers of individuals were becoming tangled in the meshes with a significant portion likely lost as the meshes are alternately pulled tight and slackened during haulback.

A system of small (8 mm) knotless mesh "ruffled" liners was tested in trials in 2013 and 2014 to reduce the loss of small organisms in the sampling trawl. The cone-shaped liner panels are constructed to match the taper of the trawl, but are attached only at the leading edge so that they are in constant motion during trawling and small objects do not become enmeshed. Results were positive: video observations showed that the nets were in constant motion during trawling. Observations of a control trawl without liner nets documented large numbers of juvenile Atlantic herring escaping through 60 mm meshes immediately ahead of the codend. Pairwise comparisons of catches with and without liner nets showed that the trawl with ruffled liners captured significantly more young of the year fish than the control net.

6 ToR a): Technical Innovation in Spreading Trawls

Conveners: Paul Winger, Bob van Marlen, and Antonello Sala

6.1 General overview

Mobile bottom trawls are known to produce ecological impacts in many fisheries. The devices used to spread these trawls (typically doors) contribute heavily to fuel consumption and seabed impacts. In response to these concerns, several countries have initiated research projects in recent years toward the development of creative and innovative approaches to spreading mobile trawls. Moving beyond basic doors and

beams, new research efforts are focused on off-bottom doors, manoeuvrable or steerable doors, kites, and hydrodynamic beam concepts. The purpose of this topic group is to provide a synthesis of these technological advancements toward the goal of stimulating innovation and creating opportunities for technology transfer.

6.2 Terms of Reference

A group of experts met initially in 2014 at the meeting in New Bedford, MA, USA. The group met again in the subsequent year in 2015 at the meeting in Lisbon, Portugal.

The goal was to document and evaluate recent technological advancements in spreading technology for mobile trawls. The terms of reference were:

1) Describe and summarize new and innovative technological advancements under development (or recently developed) for spreading mobile trawls.
2) Review technical challenges and obstacles for uptake by industry.
3) Identify new applications for these technologies and opportunities for technology transfer.

6.3 List of participants

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6.4 Individual presentations

6.4.1 Manoeuvrable Trawl Doors

John Willy Valdemarsen

A presentation was provided to give an update on the development of manoeuvrable trawl doors - part of the CRISP project led by IMR. The project is in partnership with Egersund Trawls. The vessel communicates with the doors with 2-way acoustic modem. Commands are given to open and close panels in the doors. This change in surface of the door affects its spreading power. Opening panels in the top or bottom affects the heel of the door, which changes lift. Initial results with full-scale prototypes has been encouraging.

Discussion:

Did you try modifying angle of attack? (BvM). Changing surface area is less energy intensive (JVM). Current battery can last 3 days. Is there a vessel size where this becomes uneconomical? The target is larger vessels that already use trawl monitoring equipment. The benefit is for vessels to fly-semi-pelagically on slopes or in side-currents. Another audience would be vessels that target two fisheries in the same trip. If

they have different trawls, they would normally need to sail with 2 types of doors. Now they can fish both trawls with one set of doors because these manoeuvrable doors can change their spreading power.

6.4.2 HydroRig II

Bob van Marlen

A short presentation was given on a new spreader gear in Netherlands called Hydro-Rig II. It is a wider beam (15 m instead of 12 which is the legal limit) with two wheels replacing the conventional trawl shoes with an upside wing to scope up fish. Total weight reduction is about 5.6 tonnes. The gear is used for catching plaice and the fishers reported similar catches as conventional beam trawlers fishing in the area.

Discussion:

Questions were asked about the shape and thickness and dimensions of the new beam. The beams were made wider to compensate a loss in effective spread. The wing is to produce a pressure drop to scoop flatfish up in the trawl path.

6.4.3 Jumper Door

Benoit Vincent

A presentation was given to provide an update on the development of the Jumper Door. The concept was initiated under the DEGREE project. There were difficulties with shooting (i.e. deploying) the original jumper door. A follow-up project was initiated to address this issue. The shape was based on the Suberkrub door. By utilizing a smaller shoe, the goal is to reduce contact area with the seabed as well as to reduce sediment suspension. The door was designed to roll inside and produce lift when touching the bottom. Flume tank trials were part of the project, then modelling and sea trials (on a 6 m vessel). Video was difficult to take because of turbidity. A three back-strop rigging showed better results in the flume tank. Modelling was to make performance estimation (lift and drag), and dynamic model to assess effect of adjustments and behaviour and force on the seabed. Polar diagrams were to be used for all angle. DynamiT™ simulations were shown of dynamic behaviour. The doors were less stable, but with different back-strop arrangement and position of the centre of gravity this movement can be reduced. Door movement is not the result of vessel movements, as these were not brought into the model. Time on the seabed and the time to reach seabed were also analysed. The model results were validated against measurements. Roll was overestimated, pitch and sinking speed were quite comparable. The equations were also presented. Further validation will follow. Trials were done on 15 and 25 m vessels. Door angles were recorded. A simple system to fix a GoPro camera on a cable was presented. Results of various trials were shown in detail with some video footage. The lower part of the door was made simpler. Rough seas might still provide a problem with shooting the door. Sediment resuspension was 10 x lower than with a Thyborøn door. The doors are sensitive to adjustments. Longer trials are needed.

Discussion:

How does this door affect catch rate? (IT). Catch of 25m trawler was okay, no further comparative data available (BV). Sweeps are long so effect on groundrope not important. View of fishers? They are currently not interested in bottom impact, they see it as giving more constraints. Regulation is needed. These doors are self-adjusting whereas door flown off the seabed altogether have not been. Can this work on rocky grounds? Should still be tested, they could be damaged by rocks indeed. Particle size was analysed to appraise resuspension (JWV).

6.4.4 Seine Rope Dynamics

Bent Herrmann

A presentation was given on the status of a project investigating the effect of seine rope layout pattern and haul-back procedure on fishing area in demersal seining. Since the area swept by the seine ropes defines the effective fishing area, it is of interest for the fishers to improve knowledge of its dependence on the initial pattern of rope deployment and on the applied haul-back procedure. The numerical model is still under development. Validation of the numerical model was recently done using physical models in the SINTEF flume tank. Reflective markers were attached to the ropes and their movement recorded by six stereo vision cameras. Motion tracking software was used to get exact 3D coordinates for each marker. The positions of these markers was recorded over time, with linear interpolation for times in between. "Video clips" were extracted in 2D of a top view, and a side view. Three different layout patterns (rectangular, trapezoid, and triangular) were studied. Hauling speed was varied; ropes with differing physical properties were used. Results revealed a good correlation between the model and the flume tank results. Thus, the model can be used for predictions. The model was applied for Norwegian demersal seine fishing, with these characteristics: depth 50–130 m, vessel speed over ground 2 knots, tow duration 25–40 minutes, winch speed 0.9–1.3 m/s, ropes of 36 mm thickness, 2 x 2000 m length. Effective fishing area (EFA) = Initial area on the seabed (ILA) + additional area (ASA), due to towing and hauling in. The net is yet to be modelled as additional resistance. Simulation graphics were shown for the three layouts. The winch speed was constant in this model, but this is not necessarily so. The EFA varied between 0.70–1.23 km^2, depending on layout. The square (rectangular) and diamond (trapezoid) shape showed the highest values. Longer towing times gave higher values.

6.4.5 Video Footage of Kite on Pelagic Survey Trawl

John Willy Valdemarsen

Video clips were shown of a "Russian kite" attached to the headline of a pelagic survey trawl. The effect of distortion due to the net sounder cable was shown. The kite was made of fabric canvass and attached to the headline with floats on top. The design is used a lot by Russians, hence the name. The purpose is to lift the headline as close to the surface as possible.

Discussion

Similar kites are used in Italy, if too effective the trawl stays on the surface, the lifting capacity is large (IT). The width of the kite is about 7 m the breadth 0.5 m. Floats can cause trouble on a pelagic trawl - that is why we used kites (JWV). The video was collected using IMR's towed FOCUS system.

6.5 Discussion

Following the presentations, a general conversation was held in which the group discussed technical challenges and obstacles for uptake by industry (Tor 2).

Technical Challenges:

- Numerical and physical models should be validated with field trials.
- We still lack good models of fish behaviour.
- CFD (computational fluid dynamics) modelling software (e.g. Fluent, OpenFoan, SolidWorks) sometimes produces results that disagree.

Obstacles:

- Fishers are not often concerned about seabed impacts.
- Fishing enterprises must see an economic return (financial benefit).
- Industry can take up new technology rather quickly and be the driver of adoption of innovation (e.g. Nordmøre grid in Norwegian trawling, LED's in Oregon shrimp trawls, pulse trawls in the Netherlands).
- Innovation and experimentation by industry comes at a cost to a fishing enterprise that needs to be addressed somehow e.g. by financial aid).

New applications: The New EU discard ban creates new incentive to fish selectively.

6.6 Main Outcomes

Presentations during the 2014 and 2015 meetings have described and summarized innovative technological advancements under development (or recently developed) for spreading mobile trawls – effectively satisfying objective 1.

Initial conversations during 2015 made some progress toward objective 2 and 3, but more thought and consideration is probably necessary.

6.7 Recommendations

The group feels it made good progress toward its objectives. The group will work by correspondence over the coming year. Action items include: a) encourage R&D efforts, and b) assemble literature (grey and peer-reviewed) for distribution and sharing.

7 ToR b): Non-Extractive Sampling

Conveners: Shale Rosen and Haraldur Einarsson

7.1 General overview

The topic group on Non-extractive sampling was proposed at the end of the 2014 FTFB meeting in New Bedford, USA. Participants met for the first time at the 2015 meeting in Lisbon, Portugal. In addition to those participating, researchers from NOAA Fisheries (which had no representation at the 2015 FTFB meeting) have expressed interest in contributing and remaining informed about the group's work.

7.2 List of participants

NAME	INSTITUTION	E-MAIL
Shale Rosen (convener)	Institute of Marine Research, Norway	shale.rosen@imr.no
Haraldur Einarsson (convener)	Marine Research Institute, Iceland	haraldur@hafro.is
Junita Karlsen	DTU Aqua, Denmark	juka@aqua.dtu.dk
Bart Verschueren	Institute for Agricultural and Fisheries Research, Belgium	bart.verschueren@ilvo.vlaanderen.be
Paulo Correia	Instituto Superior Técnico, Universidade de Lisboa, Portugal	plc@lx.it.pt

7.3 Terms of reference

1) Summarize current needs for non-extractive sampling (e.g.. regulatory restrictions, sampling threatened or endangered species, sampling in sensitive or protected habitats)

2) Inventory currently available equipment and techniques

3) Identify current gaps between available technology and sampling needs

7.4 Main Outcomes

Responsibilities were assigned for literature review on three general topics: video surveys, image and video analysis software, and modelling techniques. The topic group conveners will also establish contact with the NMFS Advanced Sampling Technology program in order to both include work being done and reduce duplication of efforts.

A questionnaire will be developed and distributed during 2015 in order to identify:

- Sources of pressure to reduce the amount of fish caught during research
- What sampling methods are currently in use, and how much fish is captured
- Reasons why research catch is necessary (data collected, funding, etc.)
- How people are currently using optical and modelling approaches, what hardware and software they are using
- How people are managing large electronic datasets (particularly image and video)

7.5 Recommendations

It is recommended that the Topic Group work via correspondence during 2015, with a short meeting during the 2016 FTFB meeting to discuss preparation of a final report during 2016.

8 ToR c): Application of Change Management in the Fishing Industry

Conveners: Steve Eayrs and Michael Pol

8.1 General overview

The topic group (TG) on Change Management in Fisheries met for the first time in Lisbon on Wednesday, 6 May 2015. Fourteen people participated for part or all of the meeting. Participants represented a wide range of experience, ranging from newly employed to greater than 40 years, and included work in large and small-scale fisheries globally. In plenary, results from a survey of WGFTFB listserv members eliciting experience and attitudes toward change management in fishing technology were presented as a general invitation to the WG. In the TG, the agenda, purposes, scope and objectives of the TG were introduced, followed by a presentation on types of change, discussion about factors affecting change in the fishing industry, an introduction to some models of change, and discussion about the challenges of facilitating change in the fishing industry.

To set a foundation for the TG, S. Eayrs presented the Kotter model for change management. This model has been globally used in the business world and is considered applicable to the fishing industry. The presentation of this model provided an opportunity to review and comment on its applicability. Three formal presentations were also heard regarding individual or group experience with change, followed by individual brief examples of experience facilitating change by participants.

The group discussed the applicability of the Kotter change management model and any other models or frameworks that had been used to facilitate change; the group was unable to conclude that any particular model fit better than the others did. No experience was found where change in fishing fleets was managed with any change management model other than ad hoc ones derived from experience. Examples were cited of very rapid change by fishers, but no clear or consistent drivers for rapid uptake could be discerned. It was clear that banning of gear or closure of fisheries can incentivize change, but the enthusiasm and cost efficiency of change in these situations was questioned. The role of incentives, particularly but not exclusively, money, was also discussed. Examples were provided where financial incentives to fishers had not facilitated change or encouraged adoption of fishing gear. A need was identified to assess the utility of the Kotter model to known examples of success. A plan was developed for the intersession and for next year, whereby individuals would evaluate the performance of a change initiative they were involved in against the Kotter model. It was proposed that the topic of change management in fisheries be considered for a mini-symposium topic for the FAO section of the 2016 meeting.

8.2 List of participants

NAME	INSTITUTION	COUNTRY
Steve Eayrs	Gulf of Maine Research Institute	USA
Michael Pol	Massachusetts Division of Marine Fisheries	USA
Ulrik Jes Hansen	Catch-Fish	Denmark
Pingguo He	School for Marine Science and Technology, Univ. of Massachusetts-Dartmouth	USA
Aida Campos	IPMA	Portugal

NAME	INSTITUTION	COUNTRY
Thomas Moth-Poulsen	FAO	Turkey
Petri Suuronen	FAO	Italy
Rikke Frandsen	DTU-Aqua	Denmark
Thomas Noack	DTU-Aqua	Denmark
Ismet Saygu	Cukurova University	Turkey
Arne Kinds	ILVO	Belgium
Daniel Aguilar	INAPESCA	Mexico
John Willy Valdemarsen	IMR	Norway
Tereza Fonseca	Southwest Western Atlantic Advisory Council	Portugal
Leela Edwin (by e-mail)	Central Institute of Fisheries Technology	India

8.3 Terms of reference

A WGFTFB TG convened by Steve Eayrs (USA) and Michael Pol (USA) will be formed in 2015 to evaluate the application of organizational change management concepts and models in a fisheries context and recommend new approaches to overcome resistance to change in the fishing industry.

The terms of reference will include:

1) Evaluate the applicability of organizational change management concepts and models in a fisheries context

2) Review and evaluate fisheries case studies and initiatives to bring about change

3) Explore models of human behaviour that may contribute to resistance to change

4) Identify and categorize circumstances and approaches that led to both the successful and unsuccessful introduction of change initiatives in fisheries.

Justification:

Despite efforts by fishing technologists, conservation engineers, and others to increase fishing efficiency and reduce environmental impacts, commercial fishers are often highly resistant to changing their fishing gear and practice. In the business world, responses to change are increasingly being guided by organizational change management concepts and models; however, their application to the fishing industry has been scant, piecemeal, and incomplete. These concepts and models provide greater understanding of resistance to change and could provide an insight into new approaches to facilitate change in the fishing industry. By reviewing organizational change management literature, as well as past efforts to facilitate change in fisheries, we hope to identify circumstances, models, techniques, and approaches that will result in smoother, cost-effective, and successful change initiatives in the fishing industry in future.

8.4 Individual presentations

8.4.1 Questionnaire Results

S. Eayrs

Prior to the meeting in Lisbon members of the Working Group were invited to complete a brief questionnaire in order to learn about their attitudes and approaches to change in the commercial fishing industry. The online survey tool Survey Monkey was used to administer the questionnaire and each member was provided an online link to questions.

Over a period of 6 weeks a total of 48 responses were received. At the time of this presentation in Lisbon 31 members had responded, however, as the tool was open until 22 May, the following results are based on responses received up to 22 May. For the sake of brevity, written comments are not included in this summary.

A total of 32 respondents (66.7%) considered themselves to be fishing technologists, while the remainder were fisheries biologists, ecologists, or held other positions. Most respondents were employed by the government (44%), followed by academia (28%), non-governmental (8%), and intergovernmental (6%). Just over a quarter of respondents had been employed in their current position for 5 – 10 years (27%) while a quarter had been employed for 21 years or longer. Approximately 21% of respondents had been employed for less than five years in their current position and 21% had been employed for 11 – 15 years. In contrast, almost 38% of respondents had been employed for over 21 years in any capacity in the fishing industry. Most of the remaining respondents had been employed for 15 years or less.

Just over 83% of all respondents indicated it is one of their current roles or duties to work with fishers and assist their adoption and use of new or modified fishing gear due to *regulation or mandatory* change. Only 73% of respondents thought it was their role or duty to help fishers *voluntarily* adopt and use new or modified fishing gear. Over 80% of respondents felt it was the duty of fishers, fishing industry organizations and the government to help fishers adopt and use new or modified fishing gear due to *regulation or mandatory* change and to facilitate their voluntary adoption of and use new or modified fishing gear. Despite a large proportion of respondents feeling it was their duty to work with fishers to facilitate change, 50% of them do not use a formal or recognized organizational change model and almost one-third felt it was not applicable in their current position. Only 6% of respondents indicated they have had formal training to develop their strategy for facilitating organizational change, while just over 30% indicated they apply a trial and error approach to facilitating change in the fishing industry and another 30% felt it was not applicable or did not have a strategy.

Just over 56% of respondents indicated they sometime embrace and accept significant change in their position and almost 30% indicated they do not like or accept significant change in their position. In contrast, 48% felt fishers do not like or accept significant change and 46% indicated they sometimes embrace and accept significant change.

Over 80% of respondents indicated they use face-to-face communication with fishers and industry meetings and workshops to bring about change in the fishing industry. Around half of the respondents indicate they use project reports, fishing industry publications and literature, at-sea training, technology transfer and incentives to bring about change. Only 13% of respondents indicating using social media to bring about change.

In response to the question regarding why they thought fishers were generally resistant to significant change, respondents most commonly selected: *Concerns that change will be costly or painful*; *Perceived lack of incentives to offset catch loss*; *Perceived lack of control over their fishing operation or business*; *Uncertainty about the future and how they might be affected by change*; and *Perceived lack of opportunity, benefit, or reward from change* as the primary reasons for their resistance. *Concerns by individuals that they will appear incompetent in the face of change*, and *Insufficient time to become adjusted to the idea of change* were the least commonly selected responses.

In conclusion, the questionnaire has confirmed that most respondents were fishing technologists that have been involved in the fishing industry for a long time. The application of formal change management models is virtually non-existent and we have had little or no training in this topic. We feel that fishers, fishing industry groups, government should play a leading role facilitating change with fishers, both in response to regulation or voluntarily. We prefer face-to-face contact with fishers including meetings and workshops to facilitate change, and we feel concerns over increased expenses, loss catch and control, uncertainty, and lack of reward are core drivers for the resistance by fishers to change.

8.4.2 Setting the Scene: Can a new approach to change in commercial fisheries provide additional benefit to fishers and others?

S. Eayrs

A key goal of conservation engineering research is to encourage significant or revolutionary change in a fishery, such as fishers using new fishing gear, their compliance to seafood certification requirements, and the introduction of new regulations pertaining to fishing gear design and operation. However, in many instances, such changes are resisted by fishers (and other stakeholders) and their appetite for change is low.

This resistance is somewhat paradoxical considering commercial fishers operate daily in an environment that is highly variable and often unpredictable. They literally work in an environment that is perpetually changing, and their fishing success requires them to respond and adapt to changes in this environment. Their success also depends on an ability to adapt to variation in catch volume and composition, fishing costs, market prices, and numerous fishery regulations and amendments. Despite a plethora of influencing variables, and their persistence and their influence on fishing success, change is seldom embraced by fishers. This contradiction in behaviour, where fishers respond to change but also resist change, can be called The Paradox of Fishermen.

The rationale for this paradox is not well understood. However, it does challenge the ability of researchers, managers, and others to work with fishers and facilitate needed change in the fishery. To better understand The Paradox of Fishermen and foster a more dynamic and receptive environment for change, a new way of thinking about fishers and change seems necessary, one that is underpinned by an understanding of the theory and principles of organizational change management.

At a fundamental level, organizational change management is about ensuring the survival of an organization that is surrounded and influenced by a variable, discontinuous, capricious, and often-unpredictable external environment. It is often focused on people, structure, processes, or technology, and aims to bring about significant cultural change within an organization. For those attempting to facilitate organizational change, a variety of change management models exist to facilitate, guide, and manage the process of instituting desired change.

Change management models often strive to distinguish between two types of change, one that has a significant effect on an organization and the other having a lesser effect. Change that has significant impact on an organization is often referred to as revolutionary change. This type of change is planned to revolutionize or transform an entire business or organization and improve performance. Revolutionary change is radical, intense, episodic in nature, and strategically applied. In the fishing industry, revolutionary change occurs when fishers are required to alter fishing practice to comply with significant change in fishery regulations, for example, the replacement of input controls with output controls. In this instance, the change may require fishers to significantly modify or replace their fishing gear or behaviour, especially if 'choke' species limit access to other quota species, and is planned to significantly influence most or all participants in the fishery. Usually this change is associated with turmoil, and although it can occur quickly, its effects are long lasting because the ultimate goal is irrevocable change.

Change that has a lesser effect on an organization is referred to as evolutionary change. This type of change occurs relatively continuously, in increments, and gradually over a period of time. Evolutionary change is also characteristic of most change efforts, including those designed to improve performance or efficiency, and while it does not normally set out to change the culture or fundamental nature of an organization or business, it can eventually provide broad and lasting changes with little disturbance. Most change that has occurred in the fishing industry can be considered evolutionary.

The Kotter model of change management was then presented. The Kotter model is an eight-step process that has been used to guide many corporations both nationally and internationally through the process of introducing and cementing revolutionary change (Figure 8.1). The Kotter model is a response to eight commonly observed errors to establish permanent change. The first and biggest error is to attempt change without establishing a sense of urgency. This results in lack of enthusiasm and complacency, and always leads to a failure in bringing about hoped-for change to the fullest extent practicable. For example, a lack of buy-in by fishers for new fishery regulations means they will reluctantly acquiesce to change and not fully apply themselves. The second error is to create an insufficiently powerful guiding team or coalition that lacks credibility, expertise, and leadership to create a climate for change. Individuals alone seldom have the competency and charisma to sufficiently create long-lasting change and a powerful coalition is essential. In many fisheries, fishing fleets are poorly organized and there is little collaboration between fishers to optimize outcomes. The independent nature of fishers is a substantial contributor to poor collaboration. Ideally, the guiding coalition should comprise a diversity of fishers affected by a proposed change, preferably including representatives of all fishing methods, boat sizes and types, and old hands and new. The identification and engagement of early adopters is essential at this point. The third error is underestimating the power of vision to guide and inspire individuals to change. The vision must be clear, concise, and easily articulated. Failure to overcome any of these three errors almost always leads to failure because the appropriate climate for change has not been established.

The fourth error is under communicating the vision. Change will not occur if people do not believe the benefits of change are attractive and that revolutionary transformation is possible. Communication, both verbally and through actions, is vital and requires a committed, sustained, and coordinated effort. Fishers are sometimes parochial in their communication and beliefs, and so gaining their support for change requires a substantial undertaking. Failure to do so risks rumour and innuendo spreading throughout the fleet. Furthermore, if fishers are witnessed ignoring or circumventing

the change initiative the enthusiasm of other fishers will be challenged and the initiative is likely to fail. The fifth error is permitting obstacles to block the new vision. These obstacles may be based on perception, emotion such as fear or anxiety, parochialism, or, due to business structure, practice, or culture. Again, the nature of some fishers may make it very difficult to overcome this error (although in many instances regulatory complexity and rigidity of many fishery management systems is also a major obstacle to change), and a key challenge is overcoming how these obstacles influence radio or dockside conversation between fishers. Therefore, a major role of the guiding coalition is to turn around this negative 'chatter' and increase the frequency of positive communication.

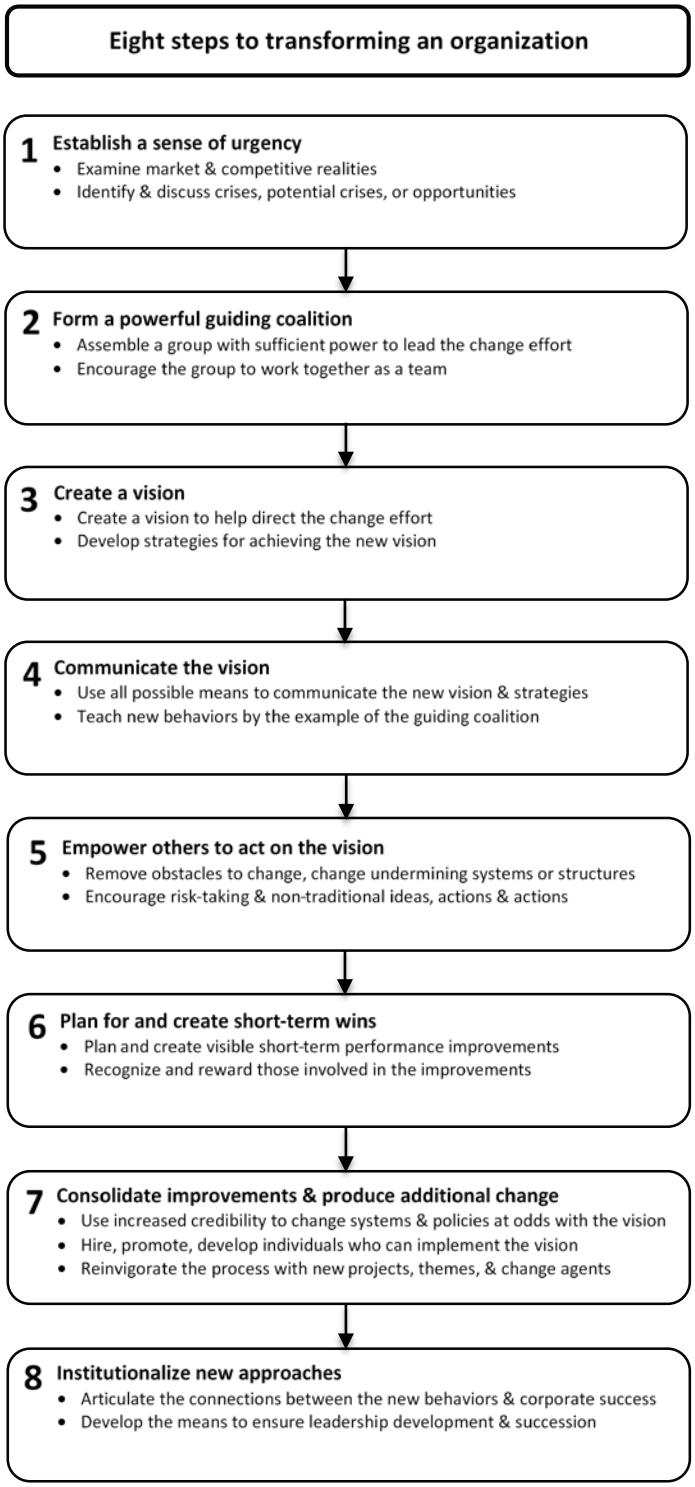

Figure 8.1. Kotter's eight-step change management model. (Adapted from Kotter, 1996).

The sixth error is failing to produce short-term wins early in the change process. These wins may be in the form of increased salary, profit, or reward, and are essential because they serve to encourage individuals to stay the course and maintain momentum. In a fishery this success might be in the form of increased landings or catch value, reduced fuel consumption (although in the New England groundfish fishery some fishers deem

this of lesser importance than other factors), or increased access to fishing grounds or fish stocks. Such success is also likely to lead to better buy-in, communication, and participation by fishers. Committing errors four, five, or six risks an inadequately engaged or enabled individual or organization and will compromise potential for change.

Error seven is to declare victory too soon and lose momentum. This occurs when change initiatives are successful and resources are then redirected elsewhere prior to the change being fully embedded into the culture of an individual or organization. The final error is to actually fail to deeply embed changes into the culture of an individual or organization; only when a new behaviour becomes a norm is it likely to be cemented in place and prevent regression. In a fishery, this may require providing fishers adequate time and opportunity to learn and become comfortable using new or modified fishing gear over a range of operating conditions, and to pass on their findings to other fishers.

The core challenge in all eight stages of Kotter's model is changing people's behaviour. An underlying premise underpinning the model is that people change because they are shown a truth that influences their feelings and less so because they are given analysis that influences their thinking. Strong leadership rather than management is key. Kotter argues the mantra of '*See*, *Feel*, and *Change*' must be applied within each of the steps to bring about effective change, and that this is significantly more powerful than the traditionally applied, '*Analyse*, *Think*, and *Change*' approach.

Comments:

How does FAO experience with TEDs in Nigeria fit or not fit the Kotter model? The group had some disagreement on the success level of this effort and current usage by Nigerian fishers remained unclear.

8.4.3 Tracking the Evolution of Ring seine Fishing System of India and Interventions to ensure sustainability of the fishery

L. Edwin (India), presented by M. Pol

The adoption and proliferation of ring seine (mini-purse-seine) among the traditional fishers is considered as the most significant change in the post motorization era of fisheries of the southwest coast of India. In 2012, this fishery contributed 18.3% of the marine fish landings of the country. The ring seine gear was first introduced by the Central Institute of Fisheries Technology (CIFT), Cochin in the mid -1980s as a new gear for the traditional sector, which was marginalized by the emerging mechanized sector. At the time of introduction, the size of ring seine was 250m in length and 33m in depth, and was designed for operation from the traditional plank built canoes. Fishers welcomed the new fishing method as it assured them a large quantity of catch compared to their conventional fishing methods. Widespread adoption of this technology resulted in substantial increase in the landings of small pelagic species like oil sardine, mackerel and anchovies by the traditional sector. By the end of the eighties, ring seine became the principal gear for the exploitation of pelagic fish resources along the coast of the state of Kerala and it later spread along the entire southwest coast of the country. A recent survey conducted by CIFT in 2012–13 on the marine fishing systems of India show that this technology has spread along the west and east coast of the country except in the state of West Bengal. The same study revealed that the dimensions of this gear has increased at least three to four times to about 1000m in length and 100m in depth. The success of this fishing method attracted more fishing units to this fishery. In order to accommodate the huge gears the fishing vessels also increased in size and

number of craft forming a single fishing unit increased to as many as four. The uncontrolled growth in the size of the fishing unit (from 6m to 24m LOA), increased number of units (>2500 in place of 300) and large crew (12 to 60) onboard, questions the continued sustenance of this fishing method. The horsepower of the engines increased from 9.9hp to >600hp in tune with the increasing size of craft and gear, larger crew size and bulky catch. The huge capital investment, high operational costs, increased number of non-fishing days and excess labour have forced many units to limit fishing to peak season alone. Studies revealed that 90% of the operational expenditure of the larger units is on fossil fuel, which also increases carbon emissions. Scientific advisories and government regulations to curb the unbridled growth of the fishing system did not have any effect on the management of this fishery.

In this context, an optimized ring seine was designed by downsizing the gear, in consultation with the fishers, and demonstrated by CIFT on an experimental basis but adoption was restricted to three districts only. The operational efficiency of the gear with respect to sinking speed, durability has been studied and through substitution by an alternate material, a further improved design is proposed by the institute. Meanwhile, realizing the non - viability of the large units the fishers themselves have come up with a miniature model of the large encircling gear, of about 100m in length, which is being operated from small canoes and is gaining fast acceptance. It is reported that 60% of the ring seine fishermen of Chellanam fishing village, have turned back to the small fishing units. The Life Cycle Assessment and Carbon footprint of the new gears compared with the larger conventional ring seines is also discussed in this communication. Theoretical calculations shows that the Life Cycle Assessment (Global Warming Potential for 100 years) for the design proposed by CIFT is 60% lesser than the conventional large ring seine. The tracking of the growth and evolution of this gear has once again proved that the success of scientific interventions depend solely on the 'bottom up' approach.

Comments

A group member noted that top–down approaches to change are not always effective and carry special risk.

8.4.4 VALDUVIS: integrated sustainability assessment by a cost-effective use of existing data and science-based indicators, affordable to any scale of fishery

A. Kinds

Numerous seafood guides, labels and certification schemes have emerged over the past decades, and their number is still growing. Although with the best intentions to inform consumers about sustainable seafood choices, this excess has often resulted in consumer confusion (Jacquet and Pauly, 2006). Since recently, however, considerable effort is being put into aligning and benchmarking these initiatives (e.g. Vos *et al.*, 2010; Food & Water Europe 2011, Sys, 2013; Melissant *et al.*, 2014). Pressure groups are lobbying for a European standard for sustainable seafood based upon the FAO guidelines for aquaculture and fisheries certification, instead of leaving it to private labels (e.g. Food & Water Europe, Brot für die Welt).

On top of the need for aligning and benchmarking existing certification schemes, the Institute for Agricultural and Fisheries Research (ILVO) calls for a rethinking of data gathering and a broader reach of these schemes. Certification schemes either focus on consumers (e.g. Friend of the Sea, the Marine Stewardship Council) or on businesses

(e.g. Label Rouge, GLOBALG.A.P.), but hardly ever the same standards are used to inform both.

There is a growing demand for sustainably caught fish on the Belgian market. However, retailers are now importing sustainable (labelled) fish from Iceland or Norway, as sustainability information for Belgian fisheries is lacking. Sustainable seafood guides (e.g. de VISwijzer) offer a handy tool for the environmentally conscious consumer, but are not accepted by the Belgian fishing sector because they use generalized information to score fishing techniques. On the sector's demand, we have developed a set of indicators and a scoring system (called VALDUVIS) that takes into account local characteristics and uses of fishing gears, gear adaptations and socio-economic aspects of the fishery. The system is developed in such a way that it is ready for use in other European member states.

The VALDUVIS method (Valorisation of Sustainably Caught Fish) constitutes a holistic and cheap approach to assess the sustainability of a fishing trip. Under EU legislation, fisheries data collection is organized. As such, fishermen use an electronic logbook system to report their catches to their local governments. VALDUVIS uses these data sources to automatically generate sustainability scores, which are available to fish mongers soon after landing the catch. Socio-economic indicators are calculated on a quarterly or yearly basis. By using an existing and reliable data sources, VALDUVIS goes past the issue of the high audit costs of most schemes. VALDUVIS thus generates an invaluable source of information that can be used by fishermen, researchers, policy-makers, retailers, certification bodies, etc. to communicate about sustainability in the same standardized way. VALDUVIS is an information tool that can be used in various ways, depending on the needs of the users. Great emphasis is placed on stakeholder participation and most notably feedback to and from fishermen.

ILVO wants to take a lead in aligning sustainability standards and in making reliable sustainability information accessible throughout the production chain. The aim of the sustainable seafood movement goes beyond demonstrating best practices to obtain a better price or improved market access. The ultimate goal is a worldwide shift towards sustainability, which cannot come from private initiatives alone (Kaiser and Jones; 2006, Jacquet *et al.*, 2009).

8.4.5 Confessions of a developer

U. J. Hansen

This presentation served as a personal retrospective covering a long and storied history working with fishermen and developing fishing gear. It was noted that Ulrich's perspective is relatively unique, as it is from a commercial angle, someone who makes a living from working closely with fishermen, and who has tried every promotional means. Yet, despite his long experience, and substantial promotion of innovations, uptake has been spotty and unpredictable (Table 1). Reasons for this lack of uptake are unclear and never been fully understood.

Table 1: Key developmental activities with fishermen, outreach type, and outcome.

ACTIVITY	OUTREACH/PROMOTION	OUTCOME
Twin trawl development	Flume tank demonstrations Instructional pamphlets with measurements Papers, magazine articles Report	Most Danish fishermen converted within first year
Twin trawl development	Seafood NZ magazine Newspaper/media Annual Seafood Conference Report Word of mouth	Not adopted by New Zealand fishermen
Y trawl development	Full-scale trials Flume tank demonstrations Training courses and lectures Fishing papers and magazines Fishing exhibition Report	Not adopted. Too complicated, few understood
Flume tank courses by video link	Fishing exhibitions Fishing News International Tank demonstrations to Norweigians, Icelanders, and Americans	No interest; participants wanted to travel to tank facility
Energy efficient trawl development (flying doors, net redesign, drop meshes, T90 in belly and codend	Fishing News International Magazine articles in Denmark, Norway, Poland, Iceland, Argentina, Australia, etc. Conferences in FTFB, Denmark, Spain, Iceland, Bangladesh, Mexico	Limited uptake; too complicated, few understood
T90	Full-scale trials Flume tank demonstrations Training courses and lectures Fishing papers and magazines Reports (refereed) Pamphlets, brochures Conferences	Limited adoption
Plate gear	Full-scale trials Flume tank demonstrations Fisheries exhibitions Fishing papers and magazines Video (free) Conferences	Limited adoption; too complicated, too early?
Oyster dredge	Full-scale trials Flume tank demonstrations Reports	Too cumbersome? No! Negative attitude from users despite threats of closure

8.5 Discussion

It was commonly observed that long experience working with the fishing industry has not provided any easy answers to facilitating change with fishermen. It was estimated that the cumulative experience with the fishing industry exceeded 200 years, yet almost universally, TG participants cited experiences where fishermen had strongly resisted change.

Several core themes, conclusions, or points for future consideration were identified:

1) Consideration should be given to differences in the type of change i.e. revolutionary (transformational) change or evolutionary (incremental) change and those types of change should be considered from the perspective of the change recipient.

2) The relative validity and utility of bottom–up, fishermen-driven models and top–down scientist/manager driven change initiatives was discussed. It was pointed out that a risk of bottom–up initiatives is that an initial, bad, experience by fishermen may deter future efforts by the same fishermen to facilitate refinement of the gear, testing of new gear, or involvement in another change initiative. These outcomes clearly present a risk to the success of projects working with fishermen. The unpredictability of timing and the capacity for fishermen to accept change was also cited.

3) Incentives, particularly money, were cited as necessary for uptake, including understanding the motivation of fishermen. The proper alignment of these incentives was seen as key, but counter examples were also cited whereby seemingly significant financial incentives were larger ignored by fishermen and the hope-for change did not occur. Examples were also cited where the benefits of a new gear were not seen to be harvested by those that bore the costs (reduced catch, for example) of the gear. Further, along these lines, the necessity to understand who the stakeholders are was cited: targeting owners when they are not captains, for example. Also, noting that representatives of fishing groups sometimes make decisions for fleets than are not acceptable to fishermen.

4) The requirement and tendency toward economic privacy may inhibit development of an appropriate economic incentive. Since access to economic data are restricted, it is difficult to find out or to verify if a change would be profitable or not.

5) The role of trust or lack of trust, with fishermen was cited. Management systems erode trust by endorsing schemes and regulations that seem absurd to fishermen or undercut their sustainability. Where historical sacrifices by fishermen are unrecognized by change agents or have gone unrewarded, further change may be impeded by these same fishermen.

6) The self-image (or imposed image) of fishermen as experts was discussed. It was questioned whether fishermen bear a social cost if they are open to change, and examples were identified where the economic viability of fishermen was admitted privately but not publicly.

7) It was noted that in an unpredictable environment, doing nothing or waiting might be an excellent strategy for fishermen to adopt to resist change, in the hope that it might go away. In addition, the unpredictable nature of fishing (tow-to-tow, or year-to-year) might imply that rewards for uptake might need to be much higher than previously thought. It was noted that where ecosystem productivity is high, the impact of over exploitation or the benefits of gear uptake might be obscured, as shifts to other species were easy.

8) The expected time-scale and frequency of change was discussed. Is five years too short a time-scale? Is change generational – does it only really happen, or most commonly, with new entrants to the fishery? What frequency of success should be expected for change efforts?

9) GAP2 and ECOFISHMAN were cited as big EU projects that might have considered a change management system. These projects should be explored in readiness for the meeting next year, and consideration given to inviting speakers from these projects

8.6 Main Outcomes

1) No examples of the use of change management models to facilitate implementation of new gears or other fishery changes were found. Only self-developed ad-hoc models have been used by the TG.

2) Approaches to facilitate change taken by TG individuals varied greatly, and varied in success.

3) Examples of rapid uptake of gears were described, including the Nordmore grid and the twin trawl, but no clear methodology or explanation for these examples was described.

4) Closing a fishery or other drastic action can be a strong motivation for uptake, but concern was raised that this type of incentive can result in unenthusiastic and superficial embrace of the change.

5) The importance of incentives was identified, but a lack of clarity about the effectiveness of money or other forms of incentive was identified.

6) The validity or utility of the Kotter change management model could not be adequately assessed in the time available. Therefore, a need to examine case studies using the Kotter model was identified.

8.7 Recommendations

1) The group will work intersessionally applying the Kotter model to examples of change in fisheries that they have personal familiarity with. Individual members volunteered to take on this task.

   a) GEARNET (Eayrs)

   b) Raised footrope trawl (Pol)

   c) Grids in Denmark (Frandsen)

   d) Twin trawling (Hansen)

   e) Nordmore grid (He, Valdemarsen)

   f) VALDUVIS (Kinds)

   g) To be determined (Saygu)

2) The VALDUVIS project is underway, and Kinds will consider the application of the Kotter model to this project. Saygu will create a theoretical plan for implementation of the Kotter model based on a current project.

3) The topic will be put forth as a possible theme for the mini-symposium in 2016.

4) In 2016, the group will continue to work, including attempting to validate the Kotter model based on results of the intersession and any experiences described in the mini-symposium.

5) The group will consider ways to incorporate fishermen's perspectives.

6) The group will solicit expertise from experts in social sciences, and explore their potential involvement in the 2016 meeting. Two candidates were identified: Alyne Delany from the Institute for Innovative Management (University of Aalborg); Marloes Kraan from IMARES.

9 ToR d): Contact probability of selective devices

Conveners: Daniel Stepputtis, Bent Herrmann

9.1 Introduction

Over the past decades, numerous selective devices have been developed and tested. Many of them did not fulfil expectations and even those that are now being used can probably be improved.

A key factor influencing the effectiveness of selectivity devices is the probability of a given specimen to contact the specific selection device. Nevertheless, this factor is often not sufficiently considered when developing selective devices. Additionally, few selectivity studies have quantified the contact probability of these devices although it underpins how they perform and how they can be improved.

This Topic Group is highly relevant to the further development of sustainable fisheries, especially in the light of discard ban, single and multispecies selectivity and potentially also for balanced harvesting – in a wider sense. Therefore, a WGFTFB topic group of experts was established in 2015 to investigate, understand and improve the contact probability of specific selective devices (e.g. grids, netting). The TG will document and evaluate current and past work regarding the influence and improvement of contact probability. This will include studies from a wide range of scientific fields, such as selectivity, behaviour, hydrodynamics and gear design. Special attention will be given to investigating how to improve the performance of gears and selective devices with suboptimal selective properties.

9.2 Terms of reference

1) Summarize current and past work in relation to contact probability

2) Discuss and describe methods (experimental and statistical) to investigate and quantify contact probability

3) Investigate and make recommendations on how to improve contact probability in selective devices, including:

   a) Identification of gears and selective devices with suboptimal contact probability (preferably based on current gear trials from group members)

   b) Discussion on potential causes and solutions

   c) Recommendations on experimental/theoretical work to understand and improve the contact probability.

9.3 Discussion

The first meeting of the TG was held on 06 May 2015. The focus of this first meeting was to review the current status of research. Therefore, participants presented their past and current work related to this topic. A total of 14 abstracts were submitted for presentations to be given within this topic group, whereas some are given during the

WGFTFB plenary session. Each of the presentations was followed by stimulating discussion.

During the discussions, it became clear that there is no agreed understanding of the general concept and definition of "contact" (including "effective contact" and "qualitative contact"). Therefore, the general discussion in this TG tried to set a basis and common understanding.

As a first attempt for a definition, the contact leads to a size dependent size escape probability through the device which is relevant and for which we can estimate the value. With this definition, a fish that makes physical contact with the device but does it with a very poor orientation for escapement through the device will be accounted as not making contact (contact = 0).

This basic definition did lead to the discussion about specific examples for reason for lack of contact. For example:

1) Fish get in (physical) contact with the grid, but due to some reasons (not selective properties of the selection device) it is not able use the device, e.g. due to
    a) wrong orientation to the selective device, e.g. sliding along a grid, and
    b) high water flow, reducing the time of escapement trials
2) Fish try to use the selective device but is able to swim out and in (and out and in and out and in)

Both examples show that the basic definition (and the methods we use to calculate contact does not take into account the complex structure of processes which can result in the final contact probability (e.g. in-out-in-(out) is measured as binomial event). Therefore, an improved knowledge of contributing processes can lead to a better understanding of the entire process as basis for the improvement of the gear. Additionally, this process can be potentially influenced by a number of parameters, which are seldom taken into account in gear selectivity investigations. These parameters include:

1) Gear related
    a) Design of gear / selection device
2) Movement of codend/selection device (e.g. important for T90 vs. T0)
3) Fishing process
    a) Depth
4) Catch volume
5) Water flow
6) Environment
    a) Seasonal effects (see below abstract from O'Neill *et al.*,)
    b) Temperature
    c) Biology of fish (e.g. condition, maturity status)
7) Turbidity
8) Light
9) Behaviour of specimen in relation to the gear

9.4 Individual Presentations

9.4.1 Can square mesh panels inserted in front of the codend improve size and species selectivity in Mediterranean trawl fishery?

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3. University of Tromsø, Breivika, N-9037 Tromsø, Norway.
4. National Research Council, Institute of Marine Sciences (CNR-ISMAR), Fisheries Section. Largo Fiera della Pesca, 60125 Ancona (Italy).

The size selection of Atlantic horse mackerel (*Trachurus trachurus*), european hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), poor cod (*Trisopterus minutus*), broadtail shortfin squid (*Illex coindetti*) and deep water rose shrimp (*Parapaeneus longirostris*) has been evaluated for a typical Mediterranean bottom trawlnet equipped with the 50 mm square mesh panel placed in front of the 50 mm diamond mesh codend. The purpose of this study was to investigate if a square mesh panel mounted in the upper panel in front of the codend could improve size and species selectivity in the fishery. The results showed very poor release efficiency through the square mesh panel. When the selectivity of the experimental gear was compared with the estimated selectivity for the "codend alone" setup, no significant difference in selectivity between the two setups was found. The low release efficiency of the square mesh panel was caused by the lack of fish making contact with the panel during their drift toward the codend. Insufficient contact with the selection device was thus found to represent a major challenge for obtaining improved size selection by integrating a square mesh panel in the upper panel ahead of the codend.

9.4.2 Contact efficiency for lateral square mesh panels in a Spanish otter trawl: Does the lateral position enhance the fish contact probability?

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Square Mesh Panels (SMP) are often integrated into trawl sections ahead of a diamond mesh codend in an attempt to improve release efficiency of undersized individuals of some species. Often these release panels are integrated in the upper panel of the trawl. This is the case for some trawl mixed fisheries in western European Atlantic waters, where a diamond mesh codend with 70 mm mesh size can be applied conditioned that

a SMP with at least 100 mm mesh size is integrated into the upper panel ahead of the codend. One of the main purposes of this SMP configuration is to avoid catches of undersized hake for which the 70 mm diamond mesh codend is known to have insufficient release potential. The main requirement for these SMP's to work efficiently it that a large fraction of fish i) notice the presence of the selection device in the top panel, and ii) react to the presence of the SMP altering their swimming direction upwards to encounter it. However, experimental fishing studies testing the mentioned SMP configuration has shown very low release efficiency for different species, such as hake (*Merluccius merluccius*). Some of those studies have shown that most of the hake simply do not make contact with the square mesh panel in this position during their drift towards the codend. Based on these poor results we designed and tested a new selective device named SLEP (Side Long Escapement Panels). The novelty of the new gear design is the position of the SMPs as they are fitted into the lateral sides of the aft part of the belly section. This position for the SMP's was selected based on information provided by fishers collaborating in the design stage, who in their normal fishing activities observed that a large proportion of fish meshed in the netting when they pull the gear up are found in the sides of the gear. Such observations indirectly indicate that many fish come into contact with the netting at the position the SLEP was finally positioned. Contrary to inserting SMP´s in the top panel, the effectiveness of this device does not rely on changes in fish swimming direction under the presence of the SMP's, but on using the longitudinal swimming path towards the codend expected in normal catch process. The SLEP concept is completed by the insertion of two net pieces forming a V-shaped panel in the belly section, with the aim of guiding fish to the sides to increase the fish contact likelihood with SLEP further.

SLEP was mounted and tested in a Demersal Otter Trawl commonly used in the trawl fishery operating in Divisions VIIIc-West and IXa-North (OTB_DEF_55), targeting a mixture of demersal species including Anglerfish (*Lophius* spp.), Hake, Megrim (*Lepidorhombus boscii*) and Nephrops (*Nephrops novergicus*). The fishery is known to present high discard rates, estimated to be between 30%-60% of the total catch. By species, the high discard values for Hake juveniles have been identified as a key factor causing the failure of this species recovery plan (COM (2011) 260; UE 2005). The experimental sea trials were carried out from May 21th to 25th onboard the vessel "Nuevo San Cibrán", a 27.9m, 490HP otter trawler; chosen for being a representative vessel of the fishery. Two 5m long PE netting covers with 40 mm mesh size were attached to the sides of the belly where to retain all fish escaping trough SLEP, while the codend selectivity was avoided by using a small mesh cover. The sea trials resulted in 13 valid hauls, and the two compartment collected data were analysed using a structural model implemented in SELNET. Based on the data collected we quantified the contact probability, the fraction of individual fish, which during their drift towards the codend came into contact with the square mesh panels. The analysis revealed that 81% Hake, 61% Norwegian lobster, 26% Four-spot Megrim and 38% Blackmouth catshark (*Galeus melastomus*) contacted SLEP. Thus, the contact probability for the square mesh panels when integrated in the side panels by far exceeded that found by others when integrated in the top panel. This study was carried within the project "Desarrollo y experimentación en campaña de un arte selectivo para la pesquería de arrastre de litoral Cantábrico noroeste" funded by the Spanish Ministerio de Medio Ambiente y Medio Rural y Marino.

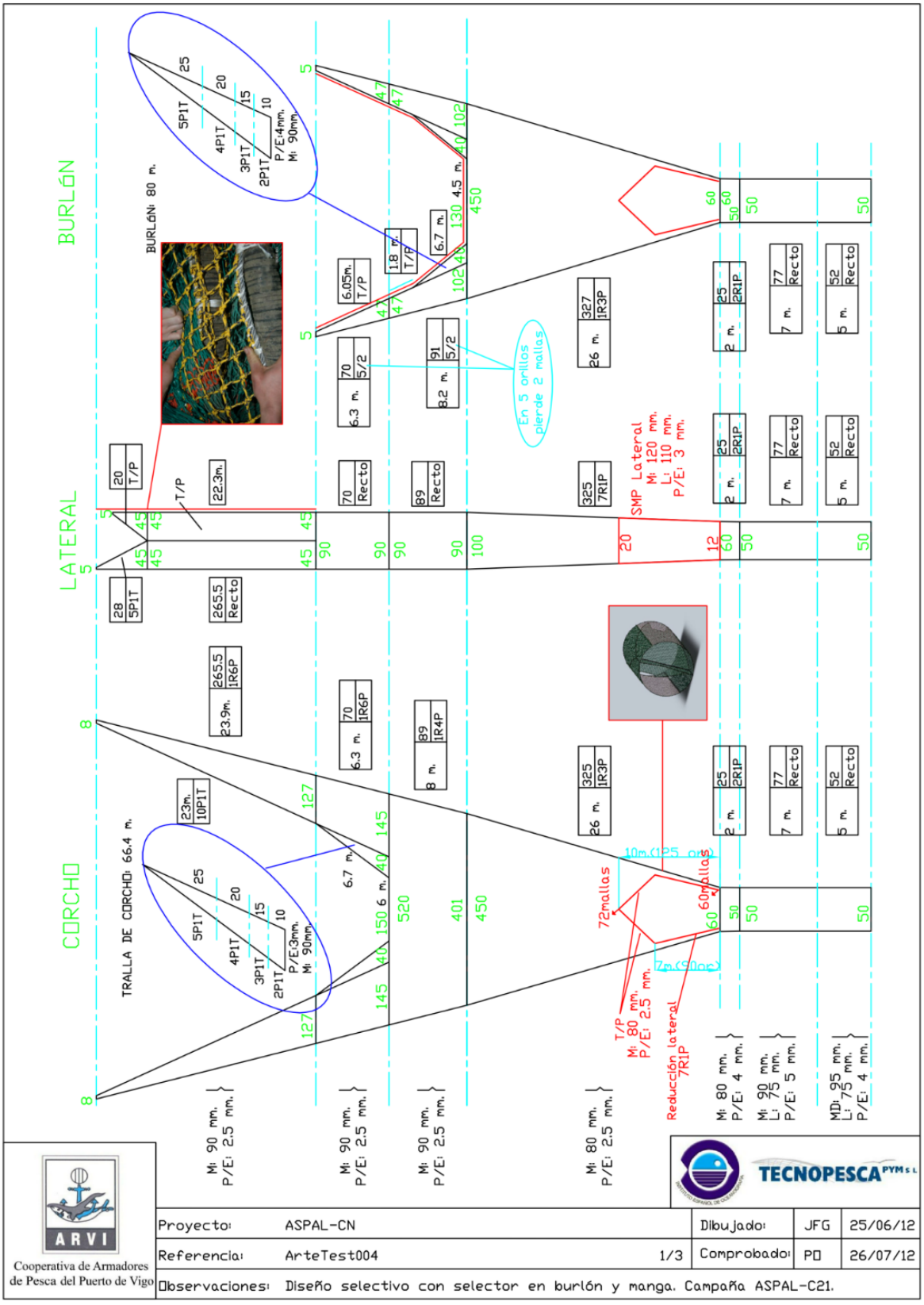

Figure 9.1. Drawing of net including of SLEP.

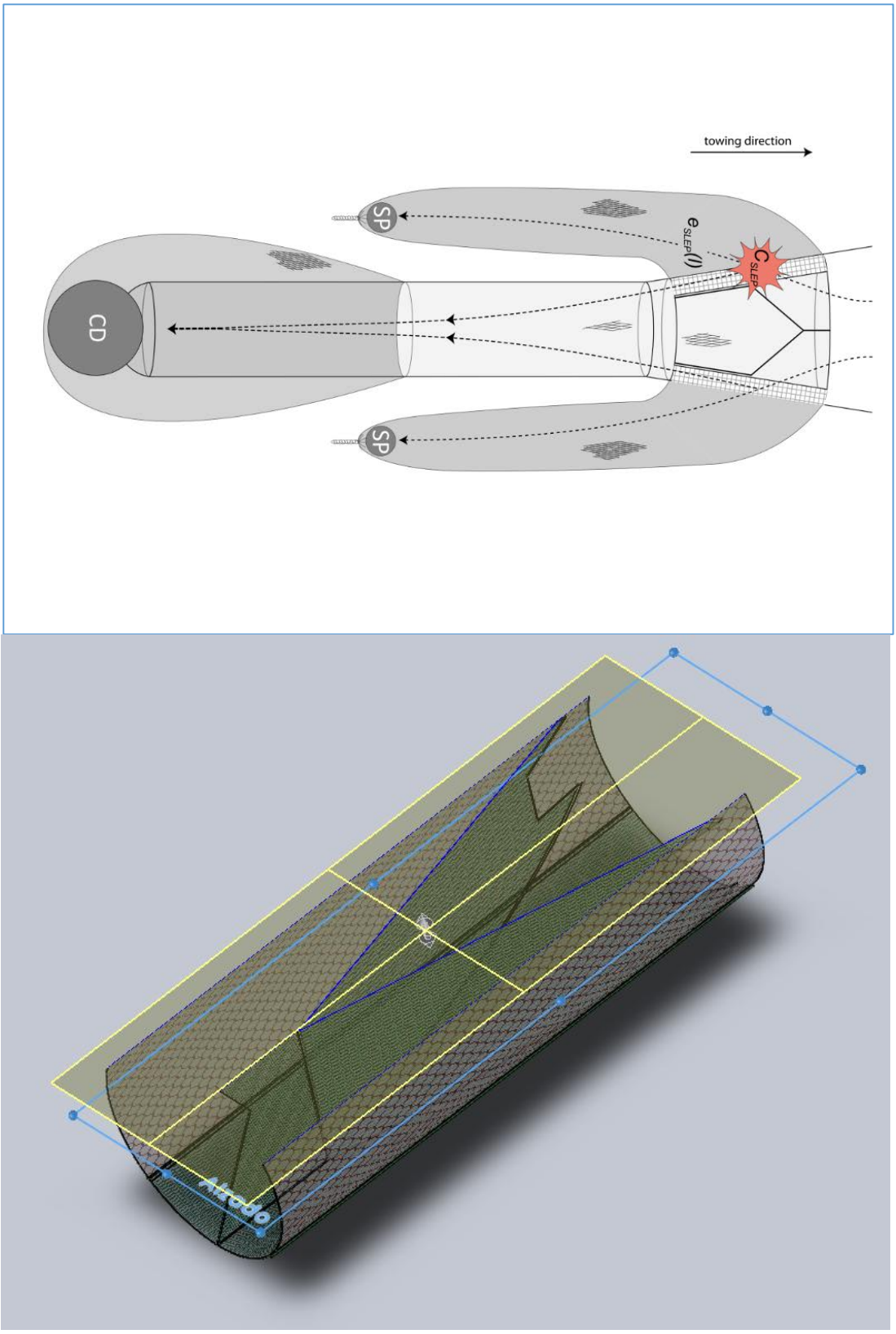

Figure 9.2. Schematic drawings of SLEP.

9.4.3 Contact probability of square mesh panels: Evidence of a seasonal effect for haddock.

F.G. O'Neill, R.J. Fryer and A. Edridge

Marine Scotland Science, Aberdeen, Scotland.

A recent meta-analysis of haddock selectivity developed a structural model of the dual process of square mesh panel and codend selectivity. The model takes into account the codend selection, panel selection and the contact probability of haddock with the codend. Individual-haul estimates of the 50% retention length (L50) and the selection range (SR) from 40 sets of trials were related to explanatory variables such as mesh size, twine thickness, panel position etc. The results show that panel contact probability has a seasonal component and is greatest during November and January and least between May and July, periods, which broadly coincide with peak and poor haddock condition.

Here we explore these results further and consider the implications these may have for fisheries management.

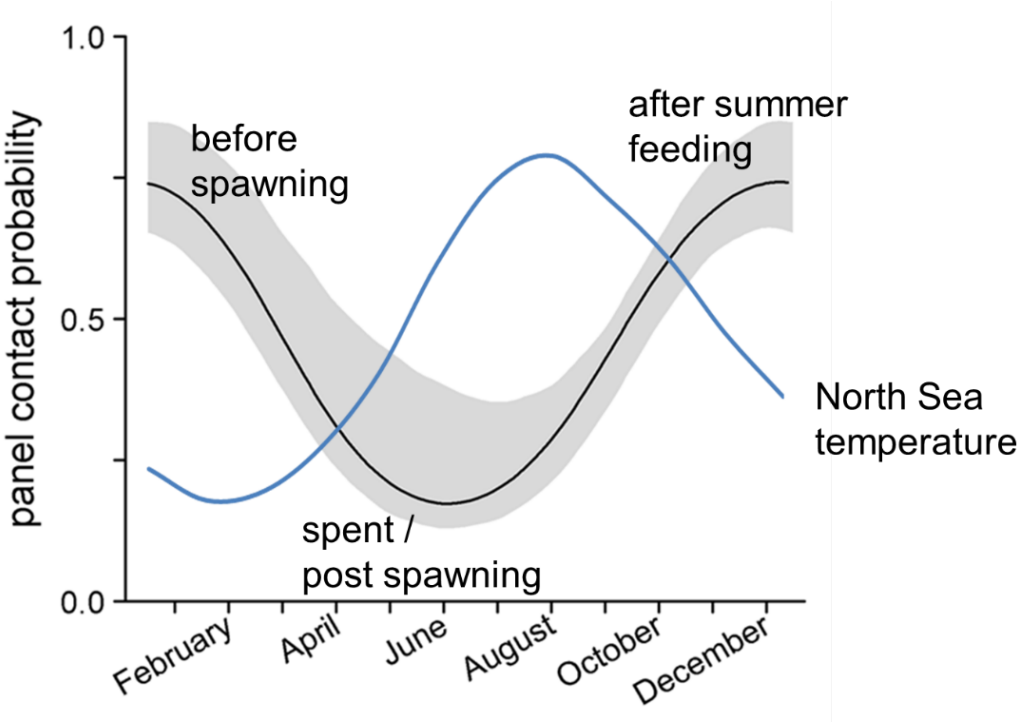

Figure 9.3. Seasonable effect of contact probability of haddock.

9.4.4 Improving escape panel selectivity by active stimulation of fish behaviour

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The efficiency of escape panels inserted in trawls relies on fish actively attempting to escape through the panel. Several studies however indicate that most fish drift towards the codend, passing beneath the escape panel through which they easily could have escaped, without making contact with the panel. For such panels to be efficient, the contact probability needs to be improved. In this study, we investigate to what extent we can improve the panel efficiency by actively stimulating the escape behaviour of fish. We compare the performance of two identical panel sections using the covered codend method in a twin trawl system, one with and one without a stimulation device. We took full advantage of the experimental setup using a new-coupled analysis method to explicitly quantify the improvements in contact probability and release efficiency for the escape panel. The results demonstrate that active stimulation can significantly improve the contact probability and release efficiency for cod (*Gadus morhua*), hake (*Merluccius merluccius*), saithe (*Pollachius virens*), whereas no effect was found for plaice (*Pleuronectes platessa*) and Norway lobster (*Nephrops norvgicus*).

9.4.5 Could T90 be the solution for size selectivity in the Belgian beam trawl fishery?

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In an effort to improve the selectivity of beam trawls targeting flatfish, codend size selectivity of three flatfish and two roundfish species were compared testing 80 mm diamond-shaped mesh (T0), vs. 80 mm mesh turned 90^0 (T90). The results demonstrate that the T90 codend significantly increased size selectivity for the two roundfish investigated, whiting (*Merlangius merlangus*) and pouting (*Trisopterus luscus*), and significantly decreased size selectivity of the three flatfish, sole (*Solea solea*), plaice (*Pleuronectes platessa*), and dab (*Limanda limanda*). Models that considered contact probability, the fraction of fish that make sufficient contact with meshes required for size based selection, provided the best model for four of the species with T90, and one species with T0. Lack of adequate contact with the T90 meshes could be a result of the combined effects of increased flow through the T90 codend due to T90 meshes remaining more open than T0 meshes during towing, and the relative high towing speeds of beam trawls. The advantages of using a T90 codend in a beam trawl are discussed for the Belgian beam trawl fishery.

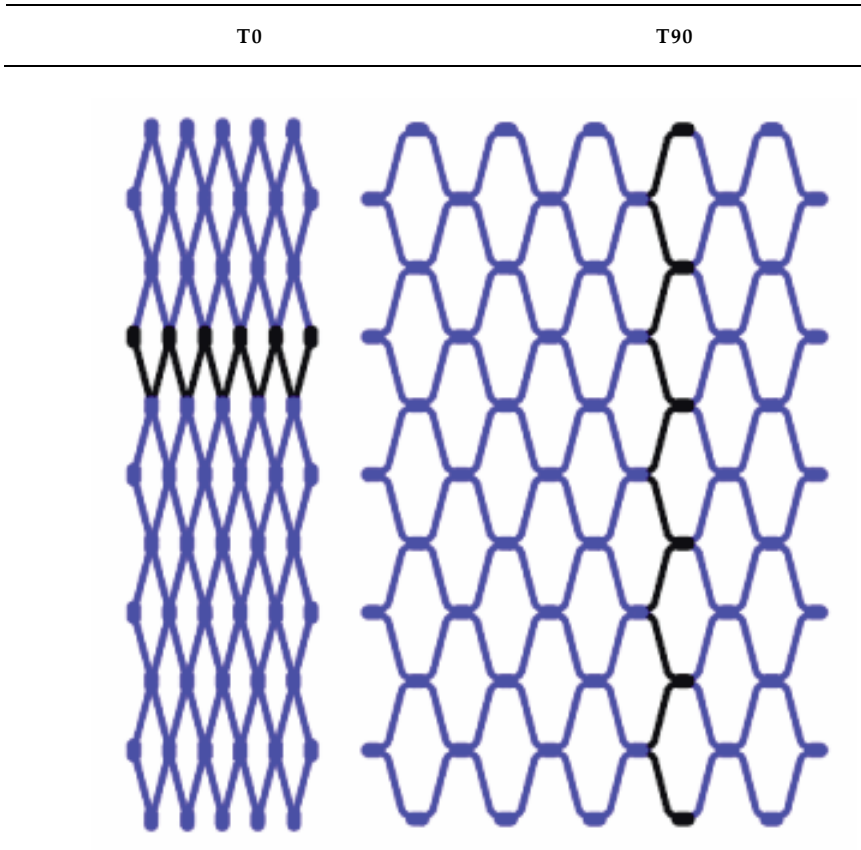

Figure 9.4. Illustration of T0 and T90 netting.

Table 9.1. Overview of catch data.

	Sole		Plaice		Dab		Whiting		Pouting	
Codend	T0	T90	T0	T90	T0	T90	T0	T90	T0	T90
No. of hauls	15	15	15	15	15	15	14	13	14	14
No. in codend	783	911	473	580	764	779	1007	131	361	129
No. in cover	1159	1043	134	52	353	227	102	788	74	327
Min. length (cm)	8	4	9	7	6	6	12	11	9	9
Max. length (cm)	39	39	42	51	39	35	40	41	30	29

Table 9.2. AIC values for fit of models (equation 1).

		LOGIT	PROBIT	GOMPERTZ	RICHARD	CLOGIT	CPROBIT	CGOMPERTZ	CRICHARD
Sole	T0	2197.08	2204.22	2247.56	2177.55	2164.19	2161.49	**2157.47**	2160.08
	T90	1938.38	1965.01	2073.15	1922.54	1890.78	1898.08	**1874.92**	1877.66
Plaice	T0	**439.98**	443.33	444.93	441.12	441.65	445.33	443.98	443.12
	T90	189.34	191.33	215.41	186.78	183.95	185.50	**183.88**	185.74
Dab	T0	1108.15	1116.82	**1106.87**	1108.24	1110.15	1118.82	1108.25	1110.20
	T90	469.95	478.57	557.47	442.51	436.58	**435.33**	440.30	437.74
Whiting	T0	**611.48**	612.05	611.67	613.43	613.43	614.05	613.45	615.43
	T90	**568.19**	569.99	579.38	569.95	569.46	568.39	569.24	570.89
Pouting	T0	**315.01**	315.28	315.25	317.01	317.01	317.28	317.12	319.01
	T90	391.49	393.15	395.97	393.44	393.38	394.68	**391.46**	393.48

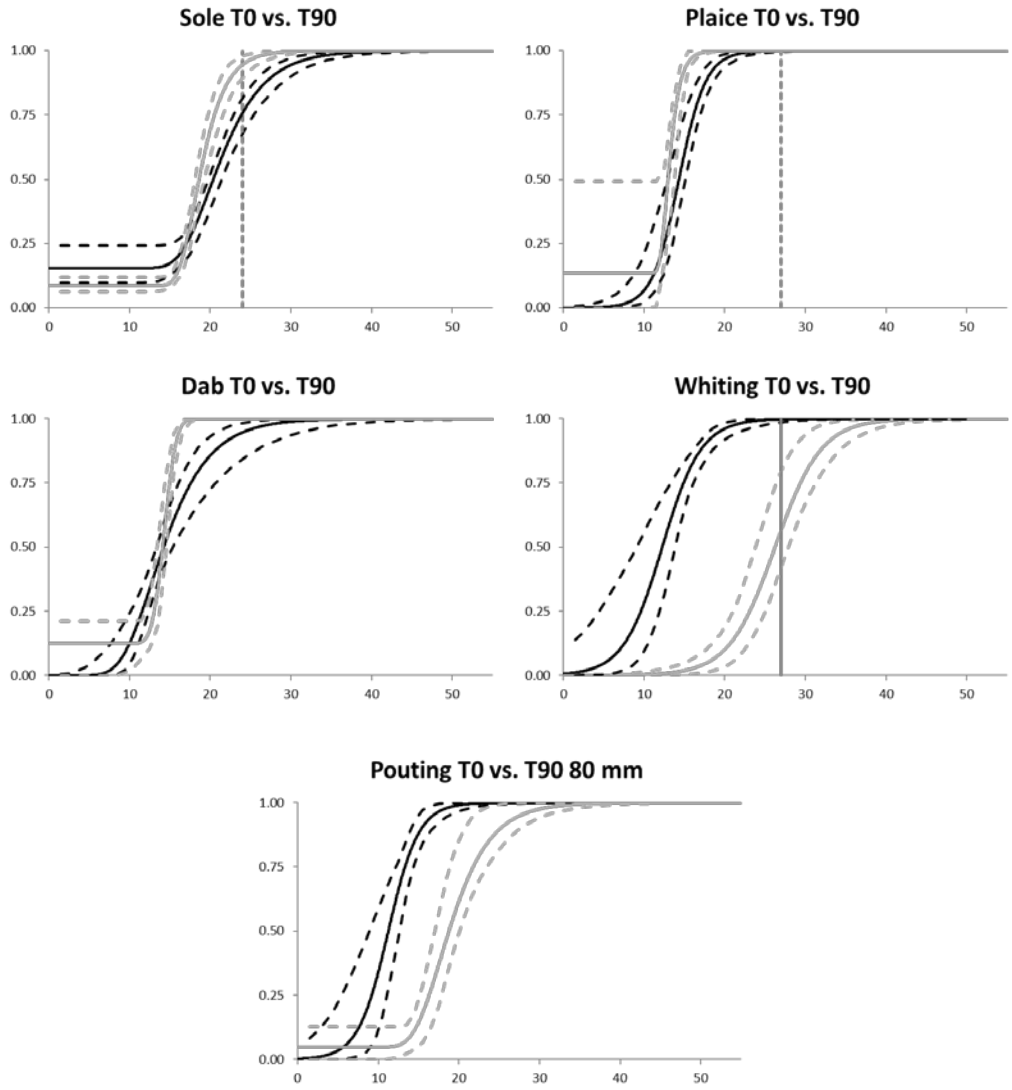

Figure 9.5. Comparison of selection curves for T0 (black) and T90 (grey) codends. Stippled curves represent 95% confidence bands for the selection curves.

Table 9.3. Results for selected models. Values in () represent 95% confidence limits. * not applicable.

	Sole		Plaice		Dab	
Codend	T0	T90	T0	T90	T0	T90
Model	CGompertz	CGompertz	Logit	CGompertz	Gompertz	CProbit
L50 (cm)	20.4 (19.8–21.4)	18.6 (18.1–19.3)	14.3 (12.9–15.1)	13.0 (12.0–14.3)	14.2 (13.3–15.4)	14.1 (13.4–14.6)
SR (cm)	6.8 (5.3–8.6)	3.5 (2.7–4.4)	3.7 (2.8–5.2)	1.6 (**-2.1)	6.1 (4.3–9.9)	1.9 (1.2–2.5)
C	84.5 (75.8–90.2)	91.2 (87.8–93.6)	*	86.4 (50.9–100.0)	*	87.6 (78.8–100.0)
L501 (cm)	21.3 (20.6–22.5)	18.9 (18.4–19.6)	*	13.2 (12.5–14.5)	*	14.3 (13.5–14.8)
SR1 (cm)	5.9 (4.6–7.0)	3.3 (2.5–4.2)	*	1.4 (0.1–1.8)	*	1.6 (1.0–2.2)
nP-	29.2 (20.3–38.2)	30.7 (19.9–41.4)	76.2 (65.4–87.8)	90.1 (87.4–94.1)	65.7 (57.7–72.9)	75.1 (71.5–78.4)
nP+	89.0 (81.9–96.1)	99.0 (95.0–100.0)	100.0 (100.0–100.0)	100.0 (100.0–100.0)	91.5 (70.0–100.0)	100.0 (100.0–100.0)
p-value	0.001	0.258	0.757	1.000	0.030	1.000
Deviance	56.83	34.60	21.61	9.25	42.36	8.37
DOF	28	30	27	29	27	26

*** not applicable; ** undefined – see text**

	Whiting		Pouting	
Codend	T0	T90	T0	T90
Model	Logit	Logit	Logit	CGompertz
L50 (cm)	12.3 (9.0–13.8)	26.2 (23.8–27.9)	11.2 (8.8–12.6)	18.7 (17.0–20.1)
SR (cm)	5.3 (3.5–9.0)	6.3 (4.1–8.3)	4.1 (2.2–6.8)	5.5 (2.3–7.0)
C	*	*	*	95.2 (87.3–100.0)
L501 (cm)	*	*	*	19.0 (17.1–20.3)
SR1 (cm)	*	*	*	5.3 (2.2–6.8)
nP-	90.3 (86.3–93.0)	9.1 (4.1–16.3)	*	*
nP+	100.0 (100.0–100.0)	70.5 (55.4–94.3)	*	*
p-value	0.999	0.016	0.991	0.333
Deviance	7.54	41.29	7.49	20.00
DOF	24	24	19	18

Conclusion:

Our analysis indicates that a T90 codend can increase the selectivity of roundfish, something that is desired within the fishery, and decrease the selectivity of flatfish, which is a conflicting point. Sole, a flatfish, was shown to have a lower selectivity with T90, which is a result that is likely in favour of fishermen targeting sole, but these results conflict with management goals seeking a decrease in the discards of flatfish, particularly plaice. Therefore, a T90 codend is not the panacea for beam trawl selectivity, but it does function to improve selectivity for roundfish. Additionally, though plaice selectivity is decreased, the result is the same for both T0 and T90, 100% of fish under MLS being retained.

The Dutch flatfish fishery is the major beam trawl nation in Europe. Many of the Dutch vessels have changed to pulse trawling with reduced catches of plaice (Van Marlen *et al.*, 2014 – Fish Res). Catches of plaice may be further reduced by the T90, as pulse gear still catches the plaice. So, then there is a combination of the selectivity of the gear stimulus (tickler vs. pulse) and the codend (T0 vs. T90). In the light of the landing obligation this could seriously improve selectivity, especially of plaice.

9.4.6 Questioning the effectiveness of implemented technical measures under the EU landings obligation: the Basque Otter Bottom Trawl fishery case study

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Three experiments were carried out on board two commercial trawlers in the Bay of Biscay area for the period 2011–2013 to study the effectiveness of the implemented top square mesh panel (SMP) selective device. "Fall-through" experiments with netting and fish demonstrate the potential size selection of the SMP for hake (*Merluccius merluccius*), red mullet (*Mullus surmulletus*) and bib (*Trisopterus* spp.), which should enable escape of immature and undersized fish. However, this was contrasted by the results from the experimental fishing with the SMP, which showed very limited escapement through the SMP also for immature and undersized fish. Analysis of the data collected during the experimental fishing showed that the poor escape effectiveness of the SMP was caused by that only a very small fraction of the fish entering the trawl did attempt to escape through the SMP during their drift towards the codend. This attempt probability was quantified by the "SMP contact probability" (CSMP) whereas the size selective potential for the SMP was described by the parameter L50SMP. The analysis resulted in L50SMP values above the length-at-maturity, documenting that the panel have the potential to function well regarding release of immature fish. However, the CSMP values for all three species suggest that the panel contribution to the selectivity is small, as on average less than 15% of the bib and less than 4% of the hake and red mullet were predicted to attempt to escape through the device. For all three species, the release potential for the diamond mesh codend, quantified by the parameter L50codend, was found to be significantly lower than the length-at-maturity and the minimum landing size (MLS), resulting in an average retention of 45% of the undersized hake and underweight red mullet entering the gear. Overall, the results show that the studied fishery remains somewhat unselective in the face of the EU landings obligation.

9.4.7 Some do, some don't, and some do hesitate: estimating species contact-probability with grids. The Portuguese experience

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*Presenting author.

The use of selective gears has proven to successfully reduce, in many situations, the amounts of bycatch otherwise discarded. In some cases, survival rates were found to be high for individuals escaping through these devices, thus justifying the adoption of gear-based management measures in a number of fisheries.

Different types of sorting devices have long been used to sort out bycatch taking advantage of the differences in behaviour and/or size between species, such as escape windows, sorting panels or sorting grid systems. The latter in particular, provide escapement while ensuring higher survival rates for escapees. However, a key factor influencing the effectiveness of these devices is the probability of a given individual to contact the specific selection device. Few selectivity studies have quantified this probability for the species in study.

In this presentation, we will show a few examples on how escape behavioural responses can be elicited by the use of sorting grid systems, and the probability of contact with the grids estimated, for a number of species captured in Portuguese bottom trawl fisheries.

9.4.8 Performance of a new double grid design: quantification of grid contacts

Manu Sistiaga[1]*, Jesse Brinckoff[2], Bent Herrmann[2,3], Lise Langård[4], Dagfinn Lilleng[4] and Eduardo Grimaldo[1]

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*Presenting author.

The flexigrid is a double grid design and is one of the mandatory selection devices used in the northeast Arctic cod and haddock fishery. The aim of this study was to investigate the selective performance of a new 4-panel flexigrid design for this fishery. Specifically, we wanted to evaluate if this new design increases the chances for a fish to make contact with at least one of the two grids in the design. Therefore, in addition to the selectivity parameters L50 and SR, we quantified the parameter "grid contact" for both grids independently and combined for both the mandatory 2-panel and the new 4-panel designs.

In a direct comparison carried out using a twin trawl, the 4-panel flexigrid design showed higher L50 values and lowers SR values than the 2-panel design. Underwater

recordings revealed that the cause for this difference between the designs might be that the 4-panel section holds a more correct shape than the 2-panel section while fishing. The mean values estimated for the grid contact were always higher for the new design. The results also showed that undersized cod escapes mostly through the lower grid of the section whereas haddock utilizes in general the upper grid. This is in good agreement with the behavioural differences expected between these two species.

9.4.9 Some French experience to improve the contact probability of selective devices

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* Presenting author

This presentation summarizes several French studies carried out to improve the probability of contact of fish and Nephrops with various selective devices or meshes in trawlnets. Three examples of interaction are presented:

- The influence of a "scaring bowl" on the escape of fish, in interaction with a square mesh panel or cylinder.
- The implementation of a separator panel in a Nephrops trawl, which allows to separate Nephrops from fish but also to increase the contact either with the net or the selective devices.
- Combination of a semi-rigid grid with a square mesh panel tested in the Channel and North Sea, which increased the contact of whiting with the square mesh panel.

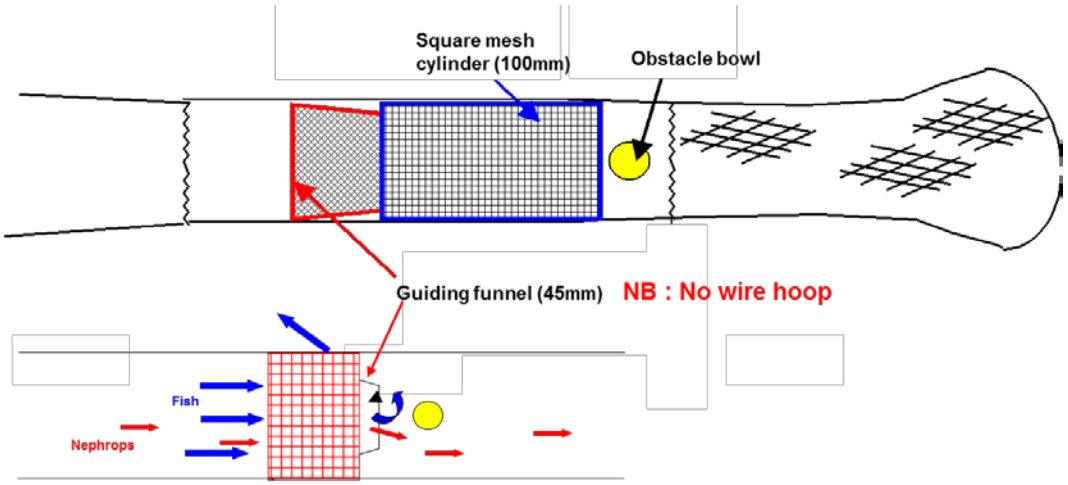
Some short video footages were screened for these three devices.

1) Interaction « scaring bowl » / square mesh cylinder[1], Bay of Biscay, 2009

This device was tested in the Bay of Biscay.

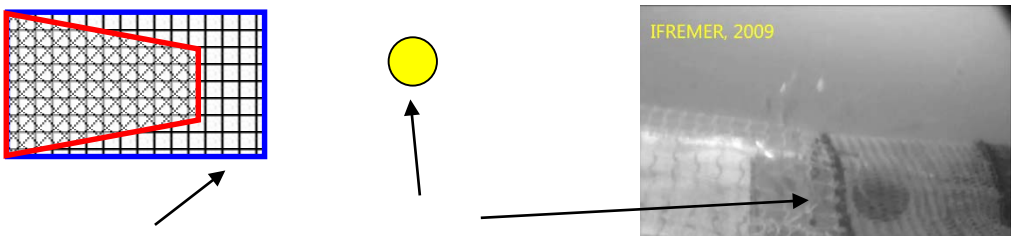
A Radial Escape Section, already tested with success in 2007 in French Guyana, in shrimp fishery was tested in the Bay of Biscay in 2009 in the mixed -*Nephrops*/hake and other fish- fishery.

[1] M. Meillat, S. Méhault, F. Morandeau, J.P. Vacherot, E. Marc. Etude de dispositifs sélectifs. Pêcherie crustacés-poissons du Golfe de Gascogne. R.INT.STH/LTH 11-01, 2011



Scheme of the RES with "scaring" bowl tested in the bay of Biscay in 2009.

The escapement of hake through a very short square mesh cylinder shifted with the guiding funnel (5 meshes long / 100 mm mesh size), was improved by its interaction with a "scaring bowl". 65% escapement of hake under the minimum landing size was observed, as well as high commercial loss on hake and Nephrops.

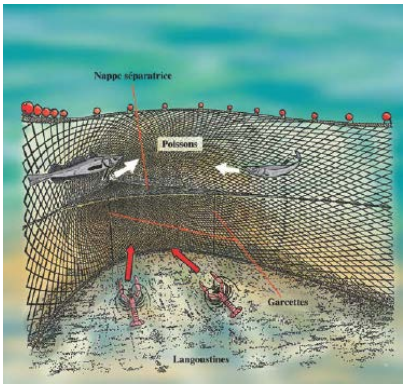


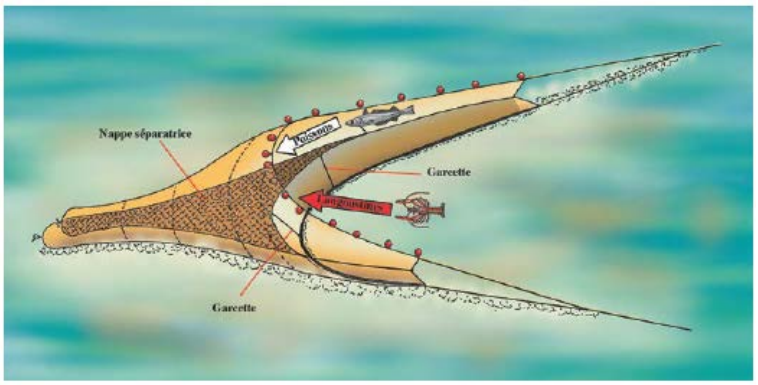
square mesh cylinder « scaring bowl »

2) Interaction separator panel /square mesh panels (Bay of Biscay), 2014–2015

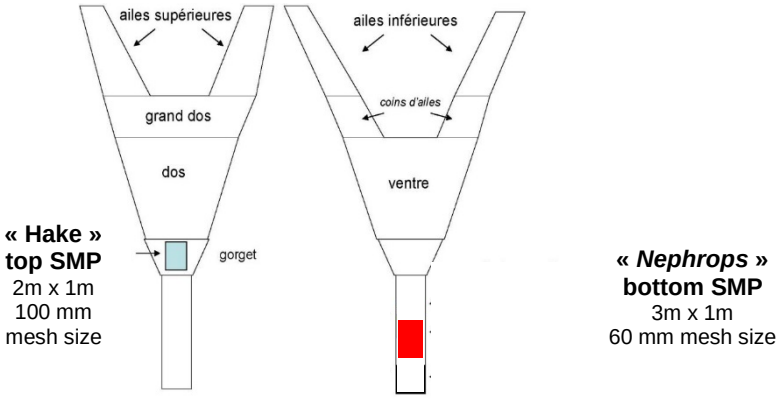
This panel already tested in the seventies and eighties in the Bay of Biscay was tested again in the national REDRESSE project[2] carried out since the end of 2013 in the context of landing obligation. The objective is to separate as well as possible *Nephrops* from hake and other fish, in order to implement, in a second step, adapted selective devices.

[2] REDRESSE project, carried out by AGLIA in partnership with IFREMER, granted by France Filière Pêche and Atlantic Regional Councils.





Principle of the separator panel



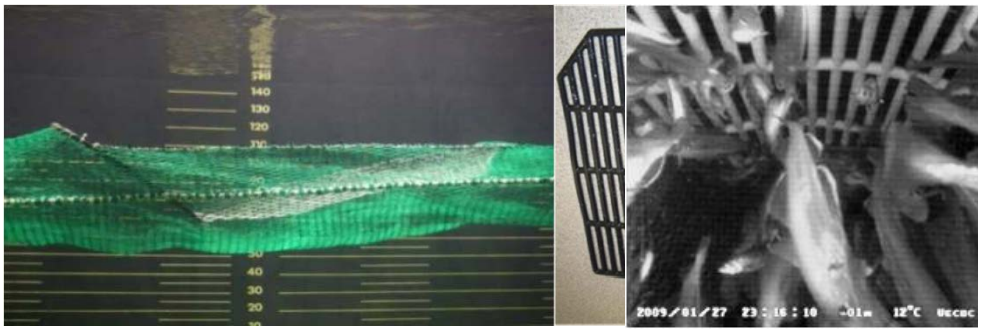
Test trawl AND reference trawl equipped with mandatory SMPs in the Bay of Biscay

The preliminary results showed that the separator panel decreases the Nephrops discards by 48% and hake discards by 18% (in weight). An explanation can be the increased contact of Nephrops with the bottom SMP and hake with the top SMP (and with standard meshes), thanks to the separator. These preliminary results also showed a good separation with 80% of hake on the top part and 72% of Nephrops on the bottom part. Trials are going on in 2015 with a longer separator panel, aiming to improve these percentages, to check long-term feasibility and to add selective devices, as T90 on the top for example.

3) Interaction semi-rigid whiting grid / square mesh panels (Eastern Channel), 2009–2010

One objective of these trials, carried out in SELECMER/SELECCAB projects[3] in 2009 and 2010 was to decrease whiting discards. A 23 mm bar spacing whiting grid used alone showed an important "clogging" of the grid, although 30% small whiting (under 20cm) were able to escape in number.

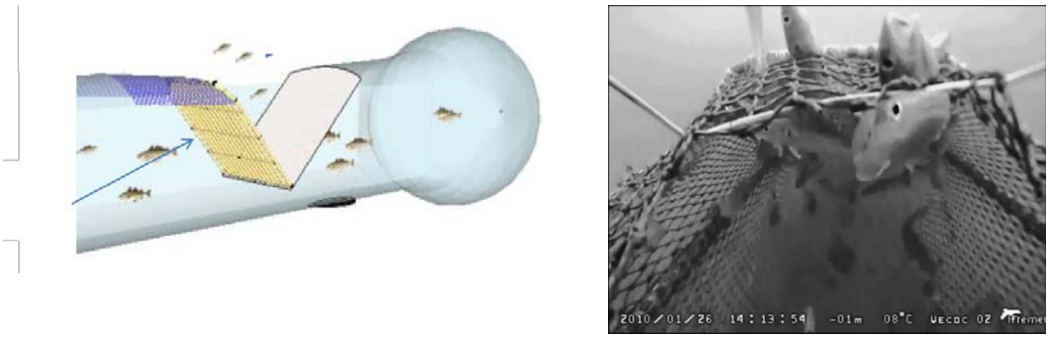
3 Projects holded by the Nord Pas de Calais-Picardie Regional Committee and the French National Fisheries Committee in partnership with IFREMER, funded by the Fisheries and Aquaculture French Administration and European Union.



23 mm bar spacing semi-rigid grid

"Clogging" of the grid used alone

When a small square mesh panel (1m x 1m SMP / 60 mm mesh size) was added before the grid, no clogging was observed anymore, with 52% escapement of whiting but with commercial loss of whiting and mackerel (weight).



23 mm bar spacing semi-rigid grid + 1m x 1m SMP/60 mm mesh size

No "Clogging" of the grid used with SMP

9.4.10 Guide fish to the selective device as a measure to improve the contact probability. Experiences with Argentine hake (*Merluccius hubbsi*)

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2. Mathematical Ecology Group, Department of Mathematics, School of Natural Sciences, National University of Mar del Plata. Funes 3350, 7600 Mar del Plata, Argentina. aaubone@mdp.edu.ar

* Presentation not given due to logistic reasons.

This presentation will show some results in contact probability on hake (*Merluccius hubbsi*) selective devices tested in the Argentine Sea. Contact probability is defined as the proportion of the fish that encounter the selective device. Trials were carried out with the following devices:

DEJUPA: single sorting grid device with a guide funnel. FLEXIGRID: double sorting grid and a guide panel over the second one. ARSEL: a single sorting grid turned upside

down compared to DEJUPA and with a lifting panel. SMD: Square mesh device, is a square mesh window in the upper panel, with lifting-guiding panel. The data were collected with a three-compartment setup, and the devices own selectivity was considered.

ARSEL and SMD did not show increasing retention. This situation is postulated to be necessarily correlated to a variation in the probability of a fish contact the selective device. Both DEJUPA and FLEXIGRID showed a logistic retention relationship. This is associated with a practically constant contact probability. A simple theoretical model helps to explain these results of retention (observed), correlated to the variation or not in the contact probability. We model the contact probability as a function of length. Both retention function of the fishing gear and contact probability are estimated. The estimation is considered suitable under the knowledge of the low escape reaction of the argentine hake against the selective device. We conclude the importance of the high contact probability in the selective device in order to obtain a more knife edge selectivity of the fishing gear.

9.4.11 Size selection of redfish (Sebastes spp.) in a double grid system: quantifying the escapement through individual grids and comparisons with former grid trials in Norway.

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Rigid sorting grids have been mandatory in the northern gadoid fisheries since 1997. Over the last years, the Norwegian fleet has reported problems related to the sorting capacity of the sorting grids as fish accumulates before the grid section. Currently the commercial fleet seek simple, practical solutions to improve the water flow through the system and help the fish move faster through the grid section and finally to the codend.

At present we have limited information on how increasing water flow can affect selectivity of various species of fish through grids, i.e. how increased flow can affect contact rate. In an attempt to improve the release efficiency for undersized fish in a rigid grid system, we tested a new double steel grid system consisting of first a lower grid followed by an upper grid. The grid system was inserted in a 4-panel section. The trials were made during February-March 2015 along fishing grounds in the Barents Sea using a conventional bottom trawl. We concentrated this study on a typical bycatch species in the cod and haddock directed fishery, i.e. redfish (Sebastes spp.). Redfish were available in most of the hauls and had a good length distribution for selectivity studies. Therefore, all fish from the codend and the upper and lower retainer bags were length measured (nearest cm). The data were modelled in the SELNET software including quantification of the probability for the fish making contact with each of the two grids. The results showed that most of the redfish escaping did it through the second (upper) grid. The release efficiency of the first (lower) grid was significantly smaller. The low efficiency of the first grid was caused by a significant smaller fraction of the redfish entering the grid zone that was making contact with it compared with the second grid. It was estimated that 80% of the redfish did make contact with at least one of the two grids. Further, the release efficiency for redfish in the new double grid system was

compared to earlier results obtained with the grid systems used in the fishery today. However, this comparison did reveal that the new double grid system did not increase size selection of redfish compared the existing grid systems. Moreover, we found that that existing Sort-V single grid system released significantly more redfish than the new double grid system.

9.4.12 Understanding and quantifying the size selection of Brown Shrimps (*Crangon crangon*) in Trawls based on net-frame experiments in laboratory

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2. SINTEF Fisheries and Aquaculture, Fishing Gear Technology, Willemoesvej 2, 9850 Hirtshals, Denmark
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Very little is known about the size selectivity process of Brown shrimps (*Crangon crangon*) in trawl codends. Due to limitations in shrimp swimming ability compared to the towing speed it could be expected that their contact with the codend meshes is a complex process. It may involve many different shrimp orientations, so called contact modes, making the size selection complicated. In an attempt to learn more about the size selection of Brown shrimps and to enable predicting it, we carried out a series of laboratory experiments with netting frames. We collected a set of artificial size selection data for shrimps for a range of meshes with different size and openness for each of 14 different potential modes of contact. Supported by underwater recordings, and assuming different contributions from the different contact modes and mesh openness's, it was possible to reproduce accurately size selection curves obtained during experimental fishing. Based on this we were able to identify the modes of contact most likely defining codend size selection. Specifically we found that three very different modes of contact probably are the most important and that it is unlikely that any of the shrimps are able to make contact with meshes in a mode optimal for escapement. These findings confirm that the codend size selection of Brown shrimps is more complex than previously found for many fish species having better swimming capability. Our findings enable predictions, based on our laboratory experiments, of size selection for other codend mesh sizes than tested at sea. Our approach could potentially be applied for other species as well.

9.5 Main outcomes

A more detailed investigation and discussion of contact probability between fish and selection device is essential to further improvement of existing and the development of new selective devices. This is also reflected in the numerous contributions to this topic group. The focus of the first meeting was ToR 1 (Summarize current and past work in relation to contact probability). Existing work was presented, which was mostly related to contact in relation to net panels and grids.

During discussion, it became clear that a proper definition of contact was missing so far. Therefore, the concept of contact probability was discussed intensively.

In addition to the general investigation on the contact probability for a given selective device, the information on the contribution of different factors, influencing this contact probability are often missing. Only very few studies investigated/estimated such influencing factors.

9.6 Recommendations

The work of this topic group needs to be continued. In addition to an update of the status and outcome of ongoing work, the 2016 meeting should focus on ToR 2 and ToR 3.

10 Final report of ToR "Innovative dynamic catch control devices in fishing

Conveners: Eduardo Grimaldo, Pingguo He, Mike Pol

This ToR has been completed with the full-text final report attached as Annex 4. The background, terms of reference, and main outcomes are provided below.

10.1 Background

Current activities within the institutes of several members of WGFTFB suggest that dynamic catch controls are important for several fisheries worldwide. Excessive catches are an acknowledged problem that results in increased mortality from high discard rates, reduced fish quality from the high densities creating crowding and additional compression, and minimized fishing opportunities. Solutions pertaining to catch control are often required by the regulating authorities and fishers of different countries.

Several countries have conducted or are currently underway in catch controls studies but better solutions are still needed. An international group dedicated towards researching and sharing methods and findings of catch controls will improve the overall quality of data, reduce redundant studies, foster cooperation between countries and institutes, and would act as a nexus for the progress in the field.

Excessive catches are a problem, especially when they exceed the processing capacity of the vessel increasing handling time and affecting the quality of the fish delivered. Also, unwanted catch is often discarded with high associated discard mortality rates. Live fish supplied to aquaculture purposes are also adversely affected by the overly high catch densities. In addition, excessive catch amount can lead to serious health, safety, and environmental (H.S.E) concerns and significantly add to the workload for fishers. In individual or group quota fisheries, excessively large catch of limited quota single species can lead to diminished fishing opportunity (early trip or season termination) for other species.

Excessive catches occur most often in trawls, Danish seines and purse-seines, which are methods used in global fisheries. Therefore, global solutions will contribute to more responsible fisheries worldwide and reduced unaccounted fishing mortality through the reduction of discards.

10.2 Terms of Reference

This report was produced by WGFTFB members as required by the terms of reference for a topic item adopted at the WGFTFB meeting in Lorient, France, April 2012. The Terms of Reference include:

1) Review the fisheries, conditions, and impact on mortality where dynamic catch control can be an advantage and consider/share recent improvements towards commercial fisheries.

2) Provide improvements/solutions for the challenges related to excessive catches that are encountered in the different fisheries and gears worldwide.

3) Produce a report including a review of the status of knowledge and technology on the subject, with identification of technology gaps, and recommendations for future research on the technology for the different fisheries and fishing gears.

The group agreed that only trawls, seines and purse-seines would be investigated for catch control methods as they risk higher unintentional catches than other fishing methods. The group also agreed not to include separator trawl techniques (separator panels, separator ropes, eliminator trawl, etc.) as dynamic catch controls systems since they are designed to improve selection but not limit quantity.

Size selectivity devices are not considered as dynamic catch control in this report.

The group defined dynamic catch controls as systems that change the structure and functioning of the gear during the fishing operation so that the gear stops collecting fish when the desired amount of fish has been retained by the gear and actively release excess fish.

The group identified the drivers for using dynamic catch controls. Some of the most relevant are: control of catch size; release of excessive catch without harm; keep fish alive for freshness; quality and pricing; safety.

The group met for first time in Bangkok, Thailand (9 May 2013). The group was attended by 14 people from nine countries, and four oral presentations were hold.

The group met for second time in in New Bedford, USA (7 May 2014). The group was attended by 12 people from four countries, and five oral presentations were hold.

10.3 Main Outcomes

1) A preliminary definition of dynamic catch controls was made: "Dynamic catch controls are systems that change the structure and functioning of the gear during the fishing operation so that the gear stops collecting fish when the desired amount of fish has been retained by the gear and actively release excess fish".

2) The group identified the drivers for using dynamic catch controls. Some of the most relevant are: control of catch size; release of excessive catch without harm; keeping fish alive for freshness; quality and pricing; and safety.

3) The group reviewed the fisheries, conditions, and impact on mortality where dynamic catch control can be an advantage.

4) The group provided an overview of a series of techniques that has been used in different fisheries around the world. Special attention was put on dynamic catch controls that are currently been tested (or recently has been

tested) in the Barents Sea demersal fishery, and in the mixed groundfishery in the USA.

5) We defined the scope to specifically include only trawls, seines and purse-seines. In other than these gears the group did not identify a need for dynamic catch control. The group agreed on not including separator trawl techniques (separator panels, separator ropes, eliminator trawl, etc.) as dynamic catch controls systems.

6) The group will try to recruit expertise on purse-seine work with regard to releasing of undersized fish.

7) The group recruited expertise on seine net fisheries in regard to control of big catches.

8) The group reviewed a series of techniques for controlling the catch in seine net fisheries for cod and haddock. Differences in fish behaviour in respect to fish escape through the catch control device were found to be important when designing such devices. The group discussed implications of cod escape from the seine net during the haul back operation, often associated with decompression stimulus, and its implications to fish survival.

9) The group recruited expertise on purse-seine work with regard to identifying species and releasing unwanted species and undersized fish.

10) The group reviewed several techniques that have been tested in the Norwegian purse-seine fisheries for catch controls of mackerel and herring. These techniques have focused on three main areas of research: 1) acoustic instrumentation for improved pre-catch identification of fish schools (in terms of species, quantity and fish size) to prevent catching unwanted fish; 2) methods and equipment to estimate the catch volume, fish size and quality at an early stage of pursing while slipping is still acceptable; 3) seine net designs and techniques that minimize the mortality associated with slipping.

11) The group identified technology gaps and weaknesses which include identification of codend catch volume, image/video wireless transmission; automated codend closing device reliability and resetting time, cost of devices (not technically a technology gap), and catch sampling of purse-seines.

10.4 Conclusions and recommendations

Pelagic schooling species, like mackerel and herring, experience elevated levels of stress and considerable mortality after dense crowding in purse-seine nets (Huse and Vold, 2010; Tenningen *et al.*, 2012). Slipping from purse-seines in the late stages of hauling may therefore produce unacceptably high rates of unaccounted fishing mortality.

The group has reviewed a range of potential technical solutions, including a new generation of acoustic instrumentation, as well as new fishing gear designs. They indicate that by relatively simple modifications to the purse-seine net, the survival of the slipped fish may be improved. The white buoy technique is a good example of this, and can be easily implemented in any small pelagic purse-seine fishery around the world. Acoustic and physical sampling techniques show promising results that may ultimately lead to the development of an integrated suite of technologies that can provide fishermen with the information they need to make rational decisions about the selection of their catch before they have any detrimental impact upon the target school.

In purse-seines, continued progress in sonar technology is expected to eventually provide reasonable composition estimates to determine if catch should be brought onboard in purse-seines. Development of other sampling methods must continue.

In the pelagic and bottom trawl fisheries, acoustic catch sensors and motorized devises are generally found to be too slow to control catch volume. That is, by the time the device either alerts the crew that the codend is full or stops the gear from fishing, the codend may have exceeded the desired capacity. As a result, simpler, alternative designs using weak links, springs, or changes in water pressure have been tried to quickly halt fishing while under-tow. However, these alternatives require further or continuous fine-tuning concerning operation and/or reliability. Other methods, also tested in seine fisheries, which create sufficient escape openings past a catch volume threshold, show promising results but have been limited in use due to restrictive regulations and under-testing. Openings provide an opportunity for fish to escape but they still must navigate the gear, adding to stress and unobserved mortality, a problem in the seine fisheries as well as trawl fisheries. Additionally, none of these methods assess the species lengths or compositions prior to escape or capture. Techniques that image fish moving into the codend using live video or acoustics are both complex and expensive. As technology improves and prices reduce, imaging techniques can provide the most straight-forward indication of what and how much enters the net near the mouth and fishing can be halted as desired. The simpler solutions provide great promise and we recommend more testing in a wider variety of situations, with input from fishermen and scientists to refine the designs.

Catch control devices for trawls and seines have the potential for reducing unaccounted mortality by releasing smaller fish before they reach the codend and fish of all sizes before crowding. This reduction is an assumption based on reducing fatigue and preventing injury. However, Escape-mortality studies have been done for a limited number of species, in a limited number of conditions, and in only a few fisheries. We recommend extending investigations to other fisheries and quantifying this issue for a larger number of species to improve assessment of impacts of dynamic catch controls on mortality of escapes.

11 National Reports

11.1 General Overview

Participants were asked prior to the meeting to prepare summaries of current and expected research related to the activities of the WG within their country. Thirteen National reports were received: Canada, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Scotland, Sweden, and the United States. The full text of these reports is inserted below, by country. A summary of some of the major themes across nations was prepared during the meeting. A word cloud was produced from the full text of the National Reports as a means of simply illustrating the main areas of interest in the reporting countries (Figure 11.1). The word cloud displays words in font sizes proportional to their frequency within the text – the bigger the word, the more frequently it appeared in the reports. Not surprisingly, words such as "codend", "fishing", "fishery", "contact" and "selectivity" were common.

Figure 11.1. Word cloud of the text of all national reports. Word size is proportional to its frequency.

The contents of the individual national reports are NOT discussed fully by the group, and as such, they **do not necessarily reflect the views of the WGFTFB**. The reports are randomly ordered.

To provide a brief overview of the research being carried out the projects described in the National reports were classified as being related to:

a) towed gears,
b) static gears,
c) fuel efficiency,
d) behaviour and physiology,
e) seabed impact,
f) survival studies,

g) management, fishing strategies, outreach,
h) modelling, analysis, instrument development, and
i) catch and discard handling.

It is recognized that projects can belong to more than one classification and that the classification are not necessarily independent. Figure 11.2 portrays the proportion of projects in each classification.

Projects related to towed gears predominate (~ 36%), with about a third as many static gear projects reported (~ 13%). There were approximately equal proportions (7 - 10%) of projects related to fuel efficiency; behaviour and physiology; seabed impact; survival studies; management, fishing strategies and outreach; and modelling, analysis and instrument development. The main difference to last year is the increase in the number of survival studies and the in projects dealing with catch and discard handling, both of which can be explained by the landing obligation that is being introduced in Europe.

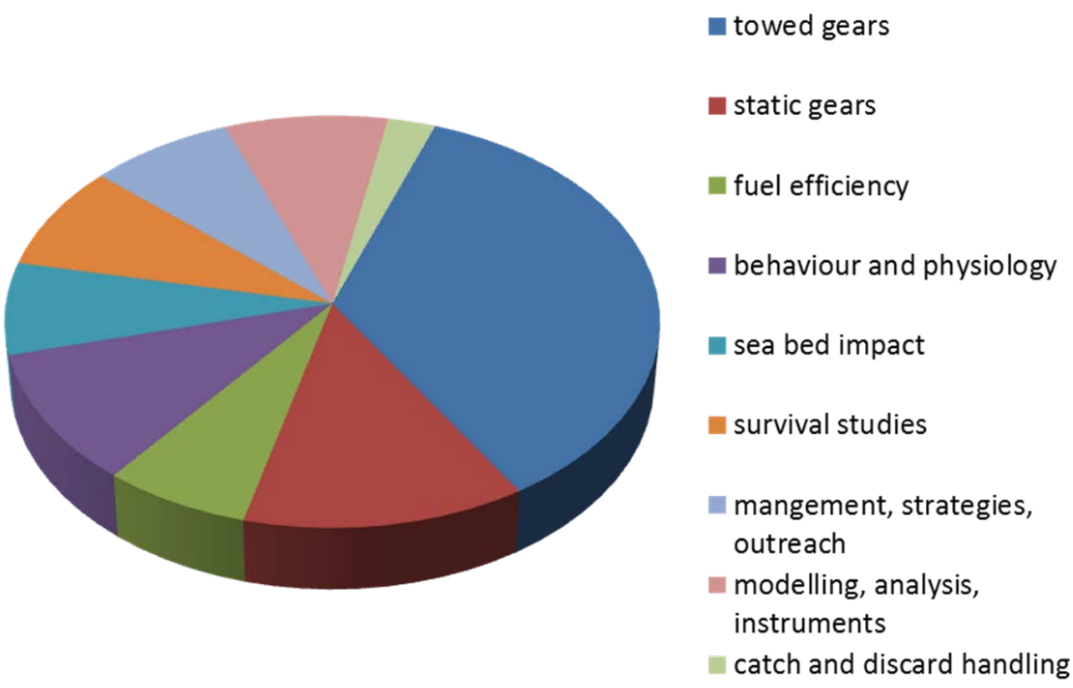


Figure 11.2. The proportion of projects from the national reports allocated in each classification.

11.2 ICELAND

11.2.1 Marine Research Institute

Contact: Haraldur Arnar Einarsson (haraldur@hafro.is); Einar Hreinsson (eihreins@hafro.is); Hjalti Karlsson (hjalti@hafro.is).

Codend size selectivity for different trawl designs- gadoids

One short survey was conducted on a commercial trawler last November (2014) where four panel codend with 135 mm mesh was tested with cover. Two methods of mounting the four panel codend to two panel trawl was tested. Three species was measured; cod, haddock and redfish. There was no significant difference between the methods of

mounting the codend on the trawl. Cod was measured near 40 cm in L50, haddock just under 44 cm but redfish was surprisingly high in L50 or 40.5 cm (~1 kg). Further investigations are planned but not on this year's schedule. (HAE).

Shrimp trawls

For many years, shrimp (*Pandalus borealis*) quotas have been low for ocean fishery and almost zero for inshore fishery. As the shrimp quota has increased lately, old problems connected to this fishery have reappeared. A survey with three boats towing parallel, each with one version of shrimp trawl was conducted in March 2014 and March-April 2015. The three compared trawls where a regular shrimp trawl, shrimp trawl with 19 mm sorting grid and topless trawl. The topless trawl was also equipped with light on the footrope meant to lower the amount of fish bycatch. The results are in processing but topless trawl with light look promising. Further tests on measuring selectivity on different mesh sizes and grid for small shrimps are planned later this year also the effect of using the light as method to decreasing fish bycatch in shrimp fishery. (HK and HAE).

Nephrops fishery

A short survey was conducted in April on commercial Nephrops-boat where the purpose was to test the effect of using vertically divided codend similar as have been performed successfully in Denmark. Last year large proportion of fish was landed in Nephrops fishery, from boats using 90 mm in codends. That raised worries of bycatch of juvenile fish. First results show that a vertically divided codend collect most of the Nephrops in the lower codend (~90%) and the fish in the upper codend. When this is written most of the data are not analysed, but further trials are planned. (HAE).

11.3 GERMANY

11.3.1 Thünen-Institute for Baltic Sea fisheries (TI-OF), Rostock

Working group on fisheries and survey technology

Contact: Daniel Stepputtis (daniel.stepputtis@ti.bund.de)

http://www.ti.bund.de/en/of/fields-of-activity/research/fisheries-and-survey-technology/

Project CRANNET: Optimized codends for an ecologically and economically sustainable brown shrimp fishery in the North Sea

Contact person: Project leader: Gerd Kraus (gerd.kraus@ti.bund.de); experimental selectivity: Juan Santos (juan.santos@ti.bund.de), Daniel Stepputtis (daniel.stepputtis@ti.bund.de); FISHSELECT: Bente Limmer (bente.limmer@ti.bund.de), Bent Herrmann (bent.herrmann@sintef.no)

CRANNET is a joint research project of the Thünen-Institute of Sea Fisheries, Thünen-Institute of Baltic Sea Fisheries and the Institute for Hydrobiology and Fishery Science at the University of Hamburg. Project duration: 01/2013–06/2015.

Brown shrimp fishery in the North Sea is an important economic factor in German coastal areas of Schleswig-Holstein and Lower Saxony, where approx. 200 vessels are involved. As for other fisheries, shrimp fishery is criticized for its seasonal large amount of discards of small shrimp and fish. This discussion is amplified since fishing is often conducted in the Wadden Sea National Park. Consequently, it is agreed between stakeholders that discards in this fishery have to be reduced.

The main aim of the CRANNET project is to determine the codend size selection for brown shrimp (*Crangon crangon*) and selected bycatch species, for a variety of experimental codends with different mesh orientation (T0, T45 (square mesh), T90) and mesh sizes (14 to 34 mm (mesh opening)). Sea trials involved four different cruises onboard the German FRV"SOLEA". In all cases, the paired gear method was used for data collection. The resulting selectivity curves from the experimental sea trials were subsequently combined used in population models to identify codends with the best prospects of sustainability for the shrimp fishery, in terms of increasing brown shrimp stocks and economic revenue.

In addition to the work, as described above additional investigations were carried out within the CRANNET-project:

a) Understanding and quantifying the size selection of brown shrimps using FISHSELECT

Very little is known about the size selectivity process of brown shrimps in trawl codends. Due to limitations in shrimp, swimming ability compared to the towing speed it could be expected that their contact with the codend meshes is a complex process. It may involve many different shrimp orientations, so called contact modes, influencing the size selection. In an attempt to learn more about the size selection of Brown shrimps and to enable predicting it, we carried out a series of laboratory experiments with netting frames. We collected a set of artificial size selection data for shrimps for a range of meshes with different size and openness for each of 14 different potential modes of contact. Supported by underwater recordings, and assuming different contributions from the different contact modes and mesh openness's, it was possible to reproduce accurately size selection curves obtained during experimental fishing. Our findings enable predictions, based on our laboratory experiments, of size selection for other codend mesh sizes than tested at sea.

b) Theoretical studies on the effect of catch size, mesh geometry and mesh size on codends from the Crangon beam trawl fisheries

The mechanical dynamics of a set of experimental codends (differing in mesh size (20 m, 24 mm 28 mm) and mesh orientations (T0, T45, T90)) were also investigated within the CRANNET project. In particular, we investigated the differences in codend shape, drag forces and flow dynamics under different catch weights (ranging 0–200kg). These investigations were carried out in collaboration with the University of Rostock, using the wind tunnel facilities provided by the later partner.

Assessing the efficiency of inserting square mesh windows ahead of the codend in North Sea bottom trawl fisheries (Cruise SO693 with FRV "Solea"; 09/2014)

Contact person: Bernd Mieske (bernd.mieske@ti.bund.de)

During the last decades, an active research has been carried out to develop gear technologies to supplement codend selectivity. Among others, Square Mesh Panels (SMPs) fitted to the top panel ahead of the codend are one of the most tested alternatives, being in some cases introduced into European regional legislations. The SMP functioning relies on utilizing escape behaviour and assisting escape by maintaining an open mesh structure in a certain area of the gear. For these SMPs to work efficiently it is required that a large fraction of fish do come into contact with the top panel of the gear at the location of the SMP during capture process. For some species this requirement might not be satisfied given the natural behaviour for many fish species to stay clear of the netting on their travel towards the codend. In previous cruises, which were conducted

in the Baltic Sea, we have developed and tested a concept using fluttering ropes (STIPED). A number of positive-buoyancy ropes attached to the bottom panel below the SMP to force fish to alter their natural swimming behaviour upwards. The SMP mesh size netting was chosen sufficiently large (400 mm) to allow all length classes to escape once they contacted, therefore the experimental setup also addressed potential interaction between fish length and contact likelihood.

During cruise SO693 (FRV "Solea" 09/2014), we have tested the STIPED – concept in the Skagerrak to estimate its potential to reduce roundfish bycatch in North Sea-Nephrops fishery. A significant bycatch reduction was found for cod, blue whiting and haddock, whereas no effect was found for target species Nephrops.

Prior to tests of STIPED, we have tested a newly developed double-belly trawl to allow catch comparison studies on FRV "Solea".

The effect of increasing the mesh size in standard Baltic trawl gear on catch and energy efficiency (CLU288)

Contact person: Bernd Mieske (bernd.mieske@ti.bund.de)

This investigation addressed the research question on what extent an increase of the mesh size in the trawl body could reduce the hydrodynamic resistance and therefore the energy demand during towing. The sea trials carried out in the Baltic Sea onboard the German FRV"CLUPEA" involved twin trawling, with a trawl made of netting with 60 mm mesh size on one side and an experimental trawl made of trawl made of netting with 80 mm on the other side. This results in a reduction of the twine area by 20%. The results indicates that the longitudinal drag was reduced only by ~2% for the experimental 80 mm-trawl, compared to the 60 mm trawl. In addition, we observed a mean reduction in catches of ~20% for cod, flounder and turbot (in weight). Contrary, no catch reduction was observed for dab and flounder.

Development and testing of flatfish species selection devices using flexi-windows made of rubber material devices (follow up from FRESWIND).

Contact person: Juan Santos (juan.santos@ti.bund.de)

In 2013 we developed and tested the FRESWIND (Flatfish Rigid EScape WINDows), a new selection device originally proposed by the industry to reduce flatfish catches without loss of commercial cod catches. The FRESWIND concept consists of mounting rigid windows made of steel on each side of a four-panel extension piece in front of the codend. Additional research efforts were invested in re-designing the original FRESWIND concept. The re-design basically consisted on replacing the original 470 x 900 mm steel windows by flexi-windows made of rubber material with different sizes. A total of 3 alternative designs were developed and tested besides the original FRESWIND during research cruises CLU277 (December 2013) and CLU278 (January 2014), onboard the German FRV "CLUPEA". The best performance in terms of flatfish catch reduction was observed for the alternative FRESWIND using the flexi-windows with same dimensions of the steel windows from the original device.

A fourth alternative device using a horizontal flexi-window was tested in December 2014 onboard FRV"CLUPEA" (CLU287 cruise). The flexi-window was mounted in the lower panel of the extension piece with 30° degrees inclination upwards-backwards. This device yielded similar results in terms of flatfish bycatch reduction as the other alternative devices tested, but it did not improve the performance of the original FRESWIND.

FLEX (FLatfish EXcluder) a new flatfish bycatch reduction device in Baltic Sea cod-directed trawl fishery (CLU278, SO696, CLU287)

Contact person: Juan Santos (juan.santos@ti.bund.de)

Flatfish bycatch is an issue in many demersal trawl fisheries around the world. Under the recent implementation of discard ban for quota species in European fisheries, in the Baltic Sea there is a concern that the bycatch of these species -for which a country or vessel has no or little quota- could choke the normal fishing strategy on the targeted cod. In 2013, we started a new research area to develop a toolbox of selection systems specifically designed to reduce flatfish bycatches in roundfish fisheries (see above, FRESWIND). The FLEX is one of the concepts for a selection device resulted from this research study. The FLEX conceptual basis takes advantage of differences in vertical swimming preferences from flatfish and roundfish during towing, to exclude flatfish catches independent to their length size. The concept was developed during CLU278 sea trials in October 2014 onboard the German FRV"CLUPEA" , and tested in different fishing conditions during two additional sea trials onboard FRV"SOLEA" (SO696) and FRV"CLUPEA" (CLU287). The preliminary analysis from the experimental fishing demonstrated that inserting FLEX in front of the codend reduces flatfish catches ranging from ~70% to ~80% with limited losses in marketable cod catches (<5%). However, UW observations demonstrated that an update of the current design is required to avoid cod losses during the haul back process.

A study on the influence of flatfish bycatch on the roundfish selectivity in T90 codends (Cruise SO702 with FRV "Solea"; 04/2015).

Contact person: Juan Santos (juan.santos@ti.bund.de), Daniel Stepputtis (daniel.stepputtis@ti.bund.de)

It is known that several factors (acting alone or interacting each other) can influence the codend selectivity; for example, sea state, catch volume or catch composition. In this study, we have investigated the influence of flatfish catch volume on size selection of roundfish. The hypothesized mechanisms of action can be a change in drag forces acting on the codend due to higher catch volumes (and therefore changing the geometry of the codend and the meshes), and/or the reduction of open meshes available for roundfish selectivity (based on earlier UW-recordings where it was observed that flatfish block the meshes when contacting the codend net, due to their body shape).

With one of the flatfish-escapement devices recently developed by the Thünen-Institute (FLEX), it was possible to directly influence the amount of flatfish in the catch and hence to have a controlled experimental setup. The experiments were successfully conducted. Data analysis is pending.

11.4 CANADA

11.4.1 Fisheries and Marine Institute of Memorial University of Newfoundland

Drop Chain Footgear:

This study compared the effectiveness of a low seabed impact footgear vs. a traditional rock-hopper footgear on identical bottom trawls targeting Northern shrimp (*Pandalus borealis*) in Newfoundland and Labrador, Canada. The experimental trawl used in this study was designed to be low seabed impact through the reduction of contact area of the footgear by replacing traditional heavy rock-hopper footgear with only a few drop chains lightly in contact with the seabed (i.e. drop chain footgear). Two comparative fishing experiments were conducted to evaluate two variants of the experimental

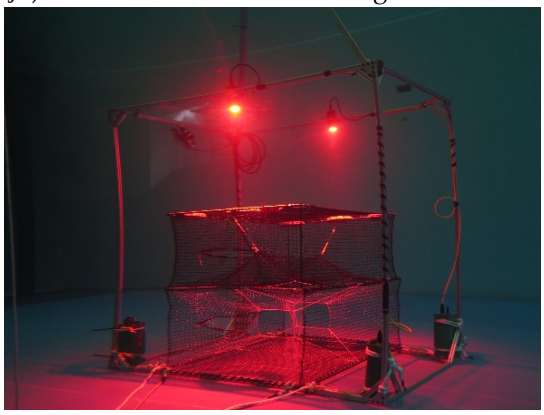
drop chain footgear (9-drop chain and 5-drop chain) against the traditional footgear. Results revealed that the 9-drop chain footgear trawl is able to catch comparable quantities of shrimp, but with substantially reduced seabed contact area compared to traditional trawling systems (i.e. rock-hopper footgear). Underwater video observations demonstrated that the drop chain trawling system, with greatly reduced bottom contact on the seabed, could help reduce potential disturbance of marine ecosystems, in particular minimizing encounters with snow crab. Contact PhD student Truong Nguyen (**Truong.Nguyen@mi.mun.ca**).

Emerging Fishery – Porcupine Crab:

In the spring of 2014, a research study team joined a 30.5 m commercial gillnet fishing vessel (*FV Arluk II*) for a three week fishing trip in NAFO Division 0B as the crew targeted Turbot (a.k.a., Greenland halibut, *Reinhardtius hippoglossoides*). The primary focus during this multiyear study (i.e. 2014–17) is to collect information on the Porcupine Crab (*Neolithodes grimaldii*), a species commonly captured incidentally in Turbot gillnet fisheries in Atlantic Canada. The objectives of the study included 1) development of fishing gear that targets Porcupine Crab, 2) examine factors influencing bycatch of Porcupine Crab in the Turbot gillnet fishery, 3) assess key biological features of Porcupine Crab, 4) assess health status, shell condition, rhizocephalan parasitic infestation, and post-capture survival of Porcupine Crab, and 5) investigate the stomach contents and feeding behaviour of wild and captive Porcupine Crab. Contact Scott Grant (Scott.Grant@mi.mun.ca).

Behaviour of Northern Stone Crab Using Deep water Video:

In 2014, we used deep-sea underwater cameras with red LED lighting to observe the behaviour of Northern stone crab (*Lithodes maja*) in relation to baited Norwegian cod pots. Using these videos, we obtained precise estimates of the rate at which crabs approached, entered, and exited pots, as well as interactions with other species at depth. We found that the rate at which stone crabs approached pots was low. Less than half of crabs that attempted entries successfully made it into the pot. However, once caught, crabs rarely exited pots, and the final catch rate was comparable to other studies. In addition, we found that white hake were caught at high rates in these pots. In addition, we have found that current direction is strongly associated with approaches and entry attempts, with the vast majority occurring in a direction against the current. This study has demonstrated that potting gear could be a viable technique for a multispecies fishery targeting both hake and crab, provided the stocks can sustain commercial levels of exploitation. Contact Philip Walsh (Philip.Walsh@mi.mun.ca).



Reducing Seabed Impacts of Bottom Trawls:

A five-year project is currently underway with Vónin Canada Ltd. to develop bottom trawl technology capable of catching commercial quantities of finfish and shellfish with reduced seabed contact compared to traditional systems, thereby reducing significant environmental impact on the seabed. The objectives of the project are to conduct computer simulation of innovative fishing systems; evaluate physical models using the flume tank; and construct and evaluate full-scale prototypes. 2015 is the final year of the project. Contact Paul Winger (Paul.Winger@mi.mun.ca).

Invasive Green Crab – Optimizing Capture Efficiency:

European green crab (*Carcinus maenas*) is a notorious invader on the east and west coasts of Canada, and was discovered in Newfoundland waters in 2007. This two-year study (2015–16) will use stationary underwater video cameras attached to Fukui traps to study parameters critical to informing the design of an optimal removal program, including rate of crab accumulation in traps, length of time to saturation, the mechanism of saturation, and whether there are differences in these parameters across distinct populations. These findings will inform the optimization of soak times, and will identify whether bottlenecks exist in the capture process that could be addressed with modifications to the trap design. In addition, we propose to employ underwater filming to examine how a green crab invasion affects the performance of lobster and eel traps, two fisheries that occur within the invaded sites. Contact Brett Favaro (Brett.Favaro@mi.mun.ca).

Evaluation of Different Beam Designs for the Northern Shrimp Beam Trawl Fishery:

Persistent problems exist with beam trawls used off the coast of Newfoundland and Labrador, Canada. The beams being used are continuously breaking or being damaged and when the beams are reduced in length (to prevent breakage), the catch rates attained are not economically sufficient for harvesters. This study investigated 3 different types of beams to gain insight into whether beam type plays a role in reducing damage. We compared a standard welded aluminium beam to two experimental designs (continuous aluminium and carbon fibre). Trawl tension, hook-ups, catch rates, material, and cost were compared for the different beams. Contact Philip Walsh (Philip.Walsh@mi.mun.ca).

Hake Potting:

A study was recently initiated to develop baited pots for white hake (*Urophycis tenuis)*. Comparative fishing experiments using Newfoundland and Norwegian pots designs were conducted on the Southwestern edge of NAFO Division 3Ps and 3O, near the Laurentian Channel. Experiments were conducted onboard the 16.8m (55') *F.V. Burin Tradition*. Results showed that the Norwegian pot performed very well in catching white hake and crab species. The Newfoundland pot without triggers also performed well, but the research team speculates that this pot may perform even better if some minor modification were made to incorporate lighter materials with monofilament netting entrances. Contact Philip Walsh (Philip.Walsh@mi.mun.ca).

Laser Scanning of Model Trawls:

In partnership with 2G Robotics Inc., this project evaluated the use of underwater laser scanning as a method of characterizing fishing gear in a flume tank. 3D images of trawls and traps were collected in the form of point-cloud data (non-optical images). Results showed that laser scanning improved the accuracy and precision of measurements compared to traditional optical technology used in a flume tank. However the

most intriguing output is a long-term "data product" that can be interrogated (i.e. queried) for useful information long after tank testing has been conducted. Contact George Legge (George.Legge@mi.mun.ca).

11.4.2 Fisheries and Oceans Canada Central and Arctic Region

Greenland Shark and Arctic Skate Bycatch Reduction – Longline modifications:

A multiyear experiment was initiated by Fisheries and Oceans Canada and the Memorial University of Newfoundland in 2011 to test the effectiveness of longline modifications for reducing shark and skate bycatch in the Cumberland Sound Greenland Halibut fishery. Currently, the fishery exclusively uses bottom-set longlines and primarily catches Greenland Shark and Arctic skate as bycatch. Several modifications to current commercial longlines have been tested. Gangion length and spacing were tested in 2011. Gangion material (multifilament vs. monofilament) and breaking strength (22.7–90.7 kg) were tested in 2012–2014. Contact Kevin Hedges (Kevin.Hedges@dfo-mpo.gc.ca).

Movement patterns and habitat use of Greenland Halibut, Greenland Shark and Arctic Skate:

Fisheries and Oceans Canada, the Ocean Tracking Network and the University of Windsor have been using acoustic telemetry and satellite tracking to assess regular movement patterns and habitat use in Greenland Halibut, Greenland Shark and Arctic Skate along the east coast of Baffin Island since 2010. Acoustic and satellite tags and moored monitors have been deployed in Cumberland Sound and at Scott Inlet, Nunavut to record individual movement patterns. The objectives of the project are to: 1) examine connectivity among fishing areas; 2) determine seasonal changes in habitat use; 3) evaluate interspecies interactions; and 4) determine if regular patterns in habitat use can be used to reduce bycatch rates of sharks and skates in commercial fisheries. Contact Kevin Hedges (Kevin.Hedges@dfo-mpo.gc.ca).

11.4.3 Merinov Centre d'Innovation de l'Aquaculture et des Pêches du Québec

Controlling bait costs in the American Lobster and Snow Crab fisheries in Quebec:

For Québec trap (pot) fisheries, bait represents significant costs. It could reach up to 15% of the daily revenues. Another challenge: populations of wild-caught finfish (Atlantic mackerel and herring) in the Gulf of St-Lawrence (NAFO 4RST), used traditionally as baits, are less available thus becoming too expensive. Therefore, we are working to develop processes to improve their use. The goal is to reduce by 15% the amount of bait used by the fishermen while maintaining catch per unit of effort. In addition, we will test other options like the use of artificial light or alternative attractants which diffuse a similar mixture of molecules like the ones previously isolated in some wild-caught fish. Finally, Merinov is assessing the potential of using grey seal by-products to reduce dependence on finfish. Contact Jean-François Laplante (jean-francois.laplante@merinov.ca).

Kite Sail on a Shrimp Trawler:

This project consists of installing a kite sail on a shrimp fishing vessel to reduce the fuel consumption. The first step of this two-year project will be related only to the installation and the optimization of the kite system onboard. Launching and recovering operations and security tests will be performed. During the second year, comparative at-sea trials will be performed to quantify energy savings. In addition, navigational data

(fuel consumption, RPM, boat speed, etc.) and environmental data (wind force and direction), will be recorded the entire fishing season. Specific care will be given to safety and security. Contact Damien Grelon (damien.grelon@merinov.ca).

Codend development: enhancing filter efficiency and shrimp quality:

A project will be carried out in 2014 to compare traditional and experimental codends for shrimp trawls, using the twin-trawling approach. The goal is to reduce net drag and enhance shrimp selectivity. A combination of numerical modelling, flume tank trials, and at-sea demonstrations are planned. Contact Damien Grelon (damien.grelon@merinov.ca).

Modification of Rock Crab Pots to Increase Selectivity:

Rock crab is harvested using conical pots that are not very selective and in some areas a noticeable bycatch or lobster occurs. In 2012, a study was carried out to study the performance of a selecting device in rock crab pots. This one is made of a disk with two slots through which rock crabs can enter the cage but not commercial size lobster. The device is installed at the base of the entrance cone and is hinged. Thus, it is easy to add bait. The goal of the project was to assess the impact of the modification on on-board work time, compare the number of crabs caught in modified traps to catches using conventional traps, and compare the effect on bycatch. Contact Damien Grelon (damien.grelon@merinov.ca).

Development and introduction of a lobster sliding guide device:

Female lobsters with eggs need more care when they are thrown overboard. Loss of eggs may be very important depending on how lobsters fall in the water. The freeboard of lobster vessels is sometimes high (up to 1 m) and the workable area is far from the seawater surface. The objective of this study is to work with fishermen to develop a sliding guide device that allows the safe return of female lobster to the sea. Some sea trials will be done during the 2015 lobster fishing season on a commercial vessel. Contact Damien Grelon (damien.grelon@merinov.ca).

PDG 2: Reducing impact of Scallop Dredges on seafloor:

The aim of this study was to respond to a request from Magdalen Island scallop's fishermen. This need was expressed during a 2010 workshop with scallop's fishermen and scientists from Quebec, United States and France, The main objective was to observe the scallops swimming behaviour escaping off a Digby dredge, as well as gear dragging on the rocky seabed. During spring and summer of 2014, we did approximately six fishing trips with two scallop's fishermen. A HD trawl cam was attached on the bridle just in front of the dredge and a GO PRO cam was fixed directly on the dredge. The images are still under analysis. A movie with the best images will be presented to the fishermen in summer 2015. Contact Lisandre Solomon (lisandre.solomon@merinov.ca).

Development of a multi-level trawl for the study of bycatch and northern shrimp vertical distribution for the optimization of the shrimp trawl in Quebec's fleet:

The main objective of this project is to develop a multi-level trawl in order to collect data on the vertical distribution of problematic bycatch species and northern shrimp in the commercial trawl. The study includes three steps: 1) the conception of a multi-level trawl subdivided in three vertical sections; 2) the sea trials (adjustments of the device and sampling methodology); 3) a workshop with the industry. The results obtained will ensure the success of a second phase for large-scale sampling, and to further

develop an innovative commercial trawl (phase 3), aiming to reduce the vertical opening and develop exclusion devices for bycatch. This project will be profitable both in scientific (fish and shrimp vertical distribution data) and economic terms. In fact, it is considered that ultimately, the profitability and competitiveness of the industry will be increased (fuel savings, reduction of bycatch and seabed impacts). Contact Marie-Claude Côté-Laurin (marie-claude.cote-laurin@merinov.ca).

Experimental fishery of Sculptured shrimp (Sclerocrangon boreas): Feasibility assessment of this new fishery:

Fisheries diversification is one of the main challenges of the Gulf of Saint-Lawrence North Shore and developing new fisheries is a key factor. The goal of this project is to assess if harvesting the sculptured shrimp might be economically feasible regarding to available biomass, fishing technology and environmental conditions. The first step of the project has been completed in 2014 and allowed to describe the spatial distribution, the available biomass as well as biometrics of the population sampled in this area. The second step of the project (currently in progress) aimed to design efficient traps for this species. Afterwards, there will be comparative efficiency and selectivity at-sea tests in experimental as well as commercial conditions. Contact Marie Lionard (marie.lionard@merinov.ca).

11.5 THE UNITED STATES OF AMERICA

11.5.1 Massachusetts Division of Marine Fisheries – Conservation Engineering Program

Michael Pol (Report compiler) (mike.pol@state.ma.us), David Chosid and Mark Szymanski

A Network to Redevelop a Sustainable Redfish (*Sebastes fasciatus*) Trawl Fishery in the Gulf of Maine

This multiyear project is a collaboration among netmakers, gear researchers and other scientists, fishermen, processors and regulators to increase exploitation of a fully rebuilt stock of redfish once nearly unfishable due to small numbers. The project has multiple components including exploratory fishing, codend selectivity, bycatch reduction, marketing, and outreach. In the past year, activity centred on design and execution of a component examining timing of escape of undersized redfish using underwater cameras, and testing of a double grid (modified Sort-X) system to encourage the escape of small fish when a trawl is on bottom. The purpose of this research is to improve the sustainability of the fishery by protecting juvenile redfish. Data were successfully collected and are currently being analysed. Two manuscripts from the 2013 codend selectivity data were submitted. In collaboration with Pingguo He and Bent Herrmann and others.

CEMFIN/GEARNET: Conservation Engineering Marine Fisheries Initiative

The goal of this collaborative network was to assist industry in transition to output controls by identifying short-term technology transfer and pilot gear projects, based on existing knowledge and experience that could quickly reduce bycatch and avoid weaker stocks. Over 35 projects were funded through this initiative. Overall, more than 96 individual fishermen and others participated in these projects, spanning six themes of research: saving fuel (11 projects), trawl selectivity (9), seabed impact (2); gillnet selectivity (7); alternative gear (4) and education (1).

Specific outcome highlights included the adoption of small-diameter large-mesh trawlnetting, semi-pelagic doors, and fuel flowmeters to reduce fuel consumption (and seabed contact, in the case of the doors), the invention of an innovative self-closing codend that allows fishermen to limit catches to predetermined levels, and distribution of harbour-porpoise reducing, easier-compliant gillnet pingers at minimal cost. Intriguing research included the possibility for species separation using raised footrope gillnets, reinforcement of the cod-avoiding properties of topless nets, and the possibility that topless nets could reduce bycatch of white hake *Urophycis tenuis*. Left for further development were the possibility of a fuel-saving paravanes and the economic viability of cod pots. The value of bringing fishermen to a flume tank was once again reinforced, with the highest level of participation yet from the region. More details on this project, including reports on the individual projects, can be found at www.gearnet.org. Collaboration with Steve Eayrs of GMRI, Pingguo He of SMAST, and others.

11.5.2 NOAA Fisheries, Northeast Fisheries Science Center – Ecosystems Surveys Branch, Woods Hole, Massachusetts

Philip Politis (philip.politis@noaa.gov) and Michael Martin (michael.martin@noaa.gov)

Bridle Herding Efficiency of a Survey Bottom Trawl

An experiment aimed at quantifying the herding efficiency of flatfish for the Northeast Fisheries Science Center's survey trawl bridles was conducted during autumn 2014 aboard a commercial fishing vessel. Using a blocked design, the standard survey bridle length, 36.6 m, was compared to two longer bridle lengths, 58.5m and 80.5m. One tow of each bridle length was conducted per block at equal towing speed and duration. Bridle angle and net width were held constant at approximately 12° and 13m, respectively, at each bridle length in an effort to maintain equal bridle efficiency, equal area swept by the net width and equal net efficiency for each length configuration. Restrictor ropes made of positively buoyant, 9/16" braided rope, were connected between the trawl doors to define and maintain proper door spread at each bridle configuration for the duration of the study. A total of 77 blocks were sampled on eastern Georges Bank and south of Martha's Vineyard, producing data for 5 species of flatfish: yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus*) and fourspot flounder (*Hippoglossina oblonga*). Underwater video observations were recorded from 20 tows at various positions on the trawlnet, doors and bridles. Data analyses are focused on estimating species and length specific bridle efficiencies, particularly with regard to differences between day and night and to understand bridle bottom contact in relation to flatfish herding efficiency. This project was conducted in collaboration with Pingguo He.

11.5.3 NOAA Fisheries, Northeast Fisheries Science Center – Protected Species Branch, Woods Hole, Massachusetts

Henry Milliken (Henry.Milliken@noaa.gov) and Eric Matzen (eric.matzen@noaa.gov)

More info: http://www.nefsc.noaa.gov/read/protspp/PR_gear_research/

Development and Testing of a Tow Time Data Logger to Monitor and Enforce Tow Time Restrictions in Trawl Fisheries

Tow time restrictions have been discussed as a viable alternative in fisheries where Turtle Excluder Devices (TEDs) are likely to significantly reduce targeted catch. Although the length of time a turtle can remain submerged in a trawl is still being evaluated, tows less than an hour are expected to result in a negligible number of sea turtle mortalities. Discussion about the feasibility of tow time restrictions often results in concerns about the feasibility of monitoring and compliance with any limit on tow times. We solicited a contractor to develop and construct a robust, simple, and inexpensive data logger that can be used to enforce tow-time restrictions on commercial bottom trawl fishing vessels. These loggers, which are attached to the trawlnet or the trawl doors, record the amount of time the units are below a certain predetermined depth and have a signal (light) alarm that can inform enforcement when the unit has triggered this alarm. Additionally, the units have a battery life of approximately four years and can store up to four months' worth of data with the option to overwrite oldest memory. The units were tested for their ability to reliably record trawl fishing times and detect when a tow has exceeded a time threshold. The loggers have been tested on eight vessels operating in six fisheries and have held up to the abuses of the salt environment and the shock and vibration of commercial fishing practices. Additionally, because these loggers are programmable, they may have applications in other fisheries where there is a need to monitor, record, or enforce soak durations. A report on this project should be published before summer of 2015.

A Feasibility Test of the NMFS Flounder Turtle Excluder Device (TED) With Large Opening in the US Mid-Atlantic Scallop Trawl Fishery

The NEFSC is conducting a study to provide data on the operational feasibility of using Turtle Excluder Devices [TEDs] on trawl vessels targeting Atlantic sea scallops (*Placopecten magellanicus*) and to provide a comparative study on the catch rates between the trawls with TEDs vs. trawls without TEDs in the scallop trawl fishery. Previous studies comparing catch rates of Turtle Excluder Device (TED)-equipped trawls and standard scallop trawls indicated a 7 to 14% loss in scallop catch in the TED equipped trawl. To date, this study has examined the feasibility of using a NMFS-certified flounder TED-equipped trawl to capture scallops in the limited access general category trawl fishery. The study has documented operational issues as well as catch comparison data. At this time, a 10% average loss of scallops was observed, though this is not a significant difference (n=13). During the initial field-testing, TEDs consistently showed many problems related to haul back operations and storage on the net reel. During the course of the research, two TEDs were destroyed while being hauled back under average scallop catches. Captains involved in the study indicated the need for a different TED design. Since this work was initiated and with the help of the SEFSC, we have constructed a hinged TED that will be tested. The hope is that this hinged design will resolve the operational issues experienced when using the rigid TED. We anticipate several more trips using this new TED design in the spring and summer of 2015.

11.5.4 University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST) – Department of Fisheries Oceanography, New Bedford, MA

Marine Fisheries Research Group

Kevin Stokesbury (kstokesbury@umassd.edu), Erin Adams, Travis Lowery, David Bethoney, Greg DeCelles

A Video Trawl Survey System to Monitor Groundfish Abundance and Distribution on Georges Bank

Beginning in April of 2013, scientists at the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) partnered with engineers at Simrad (Norway) and net manufacturing specialists at Reidar's Manufacturing (Fairhaven, MA) to develop a video trawl survey system that could be used to investigate the abundance and distribution of groundfish on Georges Bank. A Simrad FX80 camera system was used to record fish as they passed through the extension of the survey trawlnet. The Simrad FX80 system uses a high-density LED light and a high resolution underwater camera that are produced by Kongsberg Marine. The video is sent from the camera to the FX80 Communication Hub, which uses a standard third wire cable to relay the video image to a Bridge Control Unit located in the wheelhouse. The objective of the survey is to enhance the spatial resolution of survey data for groundfish species on Georges Bank, with a particular focus on yellowtail flounder. The advanced survey technology allows us to increase the amount of time that the net can sample on the seabed, while minimizing the ecological impact of the survey.

Fish Behavior and Conservation Engineering

Pingguo He (phe@umassd.edu)

Testing of modified otter trawl groundgears to reduce the catch of juvenile cod and flounders

Two variations of modified Rubber Riser groundergear with different sized escape windows were tested on Georges Bank and Southern New England with the aim to reduce overfished flounders while targeting Atlantic cod and haddock. Sea trials were completed in April 2014. While significant reductions of flounders were observed, there was also a large reduction in the catch of targeted species. Further fine tuning of window size and groundgear geometry will be needed.

Redfish codend escape and size selectivity

In collaboration with Massachusetts Division of Marine Fisheries, we tested a Sort-X style grid with the aim to reduce small redfish (*Sebastes fasciatus*) in the Acadian redfish fishery in Gulf of Maine. Video cameras were installed at the codend to reveal when redfish was escaping from the codend – during towing, hauling or at surface to gauge potential mortality of escapees. Sea trials have completed with data analysis continuing.

Testing of a topless shrimp trawl for brown and pink shrimp in the North Carolina's Pamlico Sound shrimp fishery

A new project has started in collaboration with North Carolina Division of Marine Fisheries to test a topless shrimp trawl for the Sound fishery that targets brown shrimp (*Farfantepenaeus aztecus*) and pink shrimp (*F. duorarum*) to reduce finfish bycatch, primarily weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*) and Atlantic croaker (*Micropogonias undulatus*). Both commercial trawl and the experimental topless trawl were tested in full-scale in the flume tank at the Fisheries and Marine Institute in Newfoundland Canada. Sea trials will be carried out in the coming summer.

Semi-pelagic trawling for haddock to reduce flounders

A new project has started this spring in collaboration with Massachusetts Division of Marine Fisheries to test a semi-pelagic rigging of a typical groundfish trawl to target

haddock on Georges Bank with the aim to reduce yellowtail flounder (*Limanda ferruginea*) and windowpane flounder (*Scophthalmus aquosus*). The experiment rigging uses a set of pelagic trawl doors fishing with doors off bottom, while the commercial rigging use a bottom door fishing with doors on bottom. A floating sweep is used in the experimental rigging. Fuel consumption is also monitored and compared between two rigs.

Scallop dredge

A project to re-design the New Bedford-style scallop dredge to reduce yellowtail flounder bycatch and to reduce fuel costs and seabed impact during dredging has just completed. The dredge incorporates wheels and hydrodynamic pressure plates. Sea trials have been completed with data being analysed.

11.5.5 Gulf of Maine Research Institute (GMRI), Portland, Maine

Steve Eayrs (steve@gmri.org)

Commercial fishing vessel electronic trip reporting pilot study

(Steve Eayrs, Adam Baukus, Croy Carlin – GMRI)

The goal of this project is to facilitate the use of electronic logbook software by New England groundfish fishermen and their transmission of electronic vessel trip reports (eVTRs). The scope of work includes i) working with software providers, sector managers, and NMFS staff to identify and overcome outstanding challenges and limitations to effective transmission of VTR data, and ii) facilitating the use of electronic logbook software by New England groundfish fishermen. We have now equipped 37 groundfishing vessels (up from 32 last year) with the new eVTR software, although only 27 are currently reporting electronically. These vessels have together transmitted over 500 trip reports over the past year. All vessels are using the FLDRS software. We have also recently introduced electronic reporting to three charter boats, and we expect to increase this number substantially base on considerable interest by the charter boat fleet to transmit logbook data electronically. This project is funded by the National Marine Fisheries Service.

FAO Fishing Vessel Energy Audit Pilot Project: A pilot project to audit commercial shrimp trawlers in Thailand

(Steve Eayrs – GMRI; Worawit Wanchana - SEAFDEC, Petri Suuronen – FAO)

This project represented the first attempt to conduct an energy audit of Thai shrimp trawlers. An audit protocol was applied comprising of a detailed interview of fishing captains followed by at sea measurement of fuel consumption by a small number of fishing trawlers. A total of 94 fishermen were questioned about the operation of their trawler and fishing gear, including operational specifications, duty cycles, and catch and expenditure details. Six trawlers were then selected for further evaluation, including at-sea measurement of fuel consumption over a 10 day period. The average fuel cost for all trawlers accounted for 72% of total expenditures followed by crew (13%), food (10%), ice (5%), and lubricants (1%). There was no significant difference between these proportions between the categories of small (<14m), large (14m+), or all trawlers combined ($\chi 2 = 1.296$, df = 8, p=0.9719).

For each trawler fuel consumption while trawling was the dominant source of fuel consumption, accounting for 71 to 94% of total consumption. A variety of fuel saving options were then identified and a first order estimate of their suitability and fuel sav-

ing impact on the entire trawl fleet was calculated. Improved trip planning and judicious use of engine rpms were considered simple, low-cost options that could realize significant fuel savings and provide immediate benefit. Other options were also considered, from fuel flowmeters to hydrodynamic otter boards although many of these options are expensive, require greater education, and pay back periods extend 4 years or longer. Further analysis of the project data are ongoing, including accurate costs associated with each fuel saving option. This project was administered by the FAO.

An evaluation of target and discard catch rates using a bottom tending trawl in the GOM Grate Raised Footrope Exemption Area

(Adam Baukus – GMRI, Vincent Balzano – Commercial fisherman)

This pilot study examined the catch and discard rates in a small mesh whiting fishery using a bottom tending trawl in an exemption area currently regulated for use of a raised footrope trawl. Industry members indicated the raised footrope trawl was inefficient at this particular habitat, leading to poor performance and reduced participation in the fishery. This project utilized a variety of methods to alter the bottom tending trawl system in response to bycatch levels, in an effort to remain under the 5% legal limit for regulated groundfish bycatch. Gear alterations included lengthening of the sweep, increasing the vertical spread, changing trawl door style, and increasing codend mesh size. These changes, in addition to temporal and spatial adjustments of fishing operations, successfully targeted commercial quantities of whiting while remaining under the 5% limit. We performed 77 sample tows, with a total catch weight of over 23,000 kg and a regulated bycatch level of 2.7%. This work is a first step towards better understanding the limiting factors of a fishery that is not currently fully utilizing the available resource, but has the potential to reduce the fishing pressure on other depleted fish stocks. This project was funded by the Nature Conservancy.

Maine Inshore Acoustic Herring Survey

Dr Graham Sherwood, Adam Baukus, Curt Brown - GMRI, Mike Jech -NMFS

This industry based collaborative effort utilizes ten lobster boats to perform an acoustic survey targeting herring in the coastal Maine waters. There are strong economic ties between the herring and lobster industries, through the supply of fresh and affordable bait. This incentive, combined with the globally recognized conservation ethic of the Maine lobster industry has engaged project participants to collect data that addresses gaps in the herring stock assessment. Each vessel is fitted with a scientific echosounder and conducts weekly transects (60 mile survey per boat) from September to November. We have currently analysed over 4,200 miles of acoustic data from coastal waters that are inaccessible to larger federal survey vessels. The first year's data suggests the timing and duration of herring spawning may be more variable than previously thought, with direct implications for the current management scheme of spawning closures. This project leverages funds from multiple sources (Saltonstall Kennedy, Northeast Consortium, Maine Technology Asset Fund, NOAA) to maintain the momentum of industry participation and a community-based approach to responsible ecological and economic stewardship of Maine and New England's herring resource.

11.5.6 Oregon Department of Fish and Wildlife, Marine Resources Program, Newport, Oregon

Bob Hannah (bob.w.hannah@state.or.us), Steve Jones, Mark Lomeli (PSMFC), Polly Rankin, and Matthew Blume

Tests of artificial light for bycatch reduction in an ocean shrimp trawl

A field study investigated how the addition of artificial light in the vicinity of the rigid-grate bycatch reduction device (BRD) and along the fishing line of an ocean shrimp trawl altered fish bycatch and shrimp catch. Contrary to expectations, the addition of artificial light around the rigid-grate increased the bycatch of eulachon by 104% (P=0.0005) and slender sole by 77% (P=0.0082), with no effect on shrimp catch. The addition of 10 LED lights along the fishing line reduced the bycatch of most fish well beyond the reduction already achieved via BRDs, with no effect on shrimp catch. Bycatch of eulachon was reduced by 91% (P=0.0001), slender sole and other small flatfish were each reduced by 69% (P<0.0005). Bycatch of darkblotched rockfish was reduced by 82% (P=0.0001) while the bycatch of other juvenile rockfish was reduced by 56% (P=0.0001). In both experiments, the addition of artificial light appears to have greatly increased the passage of fish through restricted spaces that they typically would not pass through under normal seabed ambient light conditions. A manuscript describing these results is "in review".

Delayed recovery and behavioural competency of recompressed yelloweye rockfish

We conducted two studies designed to evaluate delayed mortality, physical condition, and behavioural competency of recompressed yelloweye rockfish following capture-related barotrauma. We used sea cage and laboratory holding to evaluate fish condition at 15 and 30-days post-capture from 140–150 m depth. All external barotrauma signs resolved upon recompression, but fish that survived (10/12) had compromised buoyancy, swimbladder injuries, blood clots and/or active haemorrhaging in the body cavity. For the second study, we used a submersible aquarium to observe fish orientation, swimming competency, and visual capability for one hour following recompression and return to the seabed. Trials were conducted with 24 fish captured from 54–199 m water depth. All fish survived, but 50% of fish from the deepest depth ranges showed impairment in their ability to vertically orient. Most deep fish did not exhibit "exploration" behaviour and appeared unable to visually discern the difference between an opaque and transparent barrier. These studies suggest physical injuries and behavioural impairment may compromise yelloweye rockfish in the hours and weeks following recompression and release. A manuscript is being prepared describing these results.

Quantitative evaluation of the efficiency of visual fish surveys as a function of near-seabed water clarity and ambient light levels

We are conducting a field study using a stereo-video lander to evaluate how varying conditions of seabed water clarity and ambient light alter the areal efficiency of visual surveys. We have deployed the stereo lander into fish schools (target-rich environments) and calculated ranges to identifiable and unidentifiable fish using the stereo calibration parameters and the computer program Sebastes (National Marine Fisheries Service). At each station, ambient light was measured using a Wildlife Computers MK9 and water clarity was measured using a WetLabs EcoBB scattering meter. Logistic regression was used to estimate the range (cm) of 50% identification (ID50) at each station. Variation in ID50 will be related statistically to variation in water clarity and ambient light. Data on temporal and spatial variation in water clarity and seabed ambient light levels are also being collected on a nearshore rocky reef. Together, these data may be useful to better understand how to efficiently conduct visual surveys on temperate rocky reefs.

Future work:

- An evaluation of the use of semi-circle barbless hooks in the nearshore recreational bottomfish fishery to reduce size-related discard and associated hooking injuries.
- We hope to develop and test a stero-video drift camera system as a tool for estimating the species and size composition of suspended rockfish schools.

Recent publications that may interest FTFB:

Hannah, R. W., and M. T. O. Blume. 2014. The influence of bait and stereo video on the performance of a video lander as a survey tool for marine demersal reef fish in Oregon waters. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science, 6:181–189.

Hannah, R. W. 2014. Evaluating the population-level impact of the ocean shrimp (*Pandalus jordani*) trawl fishery on the southern distinct population segment of eulachon (*Thaleichthys pacificus*). Oregon Dept. Fish Wildl., Information Rept. Ser., Fish. No. 2014–06. 20 p.

Hannah, R. W., P. S. Rankin and M. T. O. Blume. 2014. The divergent effect of capture depth and associated barotrauma on post-recompression survival of canary (*Sebastes pinniger*) and yelloweye rockfish (*S. ruberrimus*). Fisheries Research, 157: 106–112.

11.5.7 NOAA Fisheries, Alaska Fisheries Science Center (AFSC), Conservation Engineering Group, Seattle, Washington

Carwyn Hammond (carwyn.hammond@noaa.gov), Scott McEntire (scott.mcentire@noaa.gov)

Salmon Excluders-RACE MACE

We continued our collaboration with industry on new designs for salmon excluders. Efforts have focused on testing and improving a new design that would allow escape from both above and below, resulting from a previous flume tank workshop. We began by participating in a model testing/development workshop at the flume tank in St. Johns, Newfoundland. The North Pacific Fisheries Research Foundation placed a technician aboard Gulf of Alaska vessels to demonstrate correct tuning and operation of the new excluder design to promote transfer of this technology to that fleet. The AFSC provided the camera systems used by this technician from our CE "loaner pool." This work was conducted both in the Bering Sea and the Gulf of Alaska Pollock trawl fisheries. Tests in 2013 and 2014 of the new over/under design in the Gulf of Alaska trawl fleet show escapement rates for salmon between 35–54%. Pollock escape was insignificant at less than 1%. Because the new excluder system includes more and larger escape portals, escapes are being monitored with video instead of the more cumbersome recapture nets. The CE program developed a much more compact camera system for this work and up to six of these have been used during the same tow. This new camera system is expected to see wide use on Alaska fishing vessels. The most recent design is currently being tested in 2015 in the Bering Sea.

Develop alternative trawl designs to effectively capture pollock concentrated against the seabed while reducing bycatch and damage to benthic fauna

The Alaska pollock fishery requires the use of pelagic trawls for all tows targeting that species. During some periods of the pollock fishery, these fish concentrate against the seabed and, to capture them, fishermen have to put nets designed for midwater capture onto the seabed. We are developing footropes raised slightly off the seabed to have less effect on seabed habitats than the continuous, heavy footropes (generally chains) currently required on pelagic trawls. We have held several workshops with 20+ participants, including captains of pollock trawlers and industry representatives, as well as federal and university scientists to come up with ideas for alternative footropes to test.

In May 2014, we began exploring these possibilities with experiments to compare the seabed effects of the different alternative footropes. Preliminary results show that we reduced footrope contact with the seabed by at least 90%. We are still working on analysing the data to determine impacts to benthic structure forming organisms. CE cooperative research moving forward includes work with industry to adapt the prototype footropes tested in 2014 for regular commercial use and full-scale tests of the resulting designs to confirm commercial effectiveness.

Provide underwater video systems to fishermen and other researchers to facilitate development of fishing gear improvements

We have continued to provide underwater video systems to be used by the fishing industry to allow them to directly evaluate their own modifications to fishing gear. Beyond their direct use, exposure to NMFS systems has motivated many companies to procure similar systems for dedicated use on their vessels. Either way, the goal of better understanding of fishing gear operation and quicker development of improvements is being realized. While the existing camera systems have been maintained, a significant advance in this area has been the development and testing of much more compact and inexpensive camera systems for use on commercial fishing gear. All camera system components are enclosed in a single 3.5 inch diameter acrylic tube mounted on a plastic plate. The entire system measures 21 x 9 x 5 inches and is of nearly neutral buoyancy in water. These systems have been in use for about 2 years now and have proven to be very easy to use, durable and flexible. Six new systems will be built for our use and as replacements of the older loaner systems. While this design is so inexpensive and functional that many vessels have acquired their own systems, there is still a need for loaner systems.

11.6 SWEDEN

11.6.1 Swedish University of Agricultural Sciences– Department of Aquatic Resources

Contact: Hans Nilsson (hans.nilsson@slu.se), Joakim Hjelm, Johan Lövgren, Sven-Gunnar Lunneryd and Sara Königson

A Secretariat of selective fishery was established at SLU in 2014 to help the fishery to implement the new Common Fishery Policy (CFP), with special focus on the landing obligation in 2014. This secretariat have mandated to work also between 2014 and 2017.

This secretariat main task is to collect ideas from the industry, make projects out of them and after development test them scientifically. The secretariat is founded by the Swedish Agency for Marine and Water Management and is a four-year commitment from the government. The first year main focus areas were selectivity in the Baltic cod fishery, the Western shrimp and Nephrops fishery, and the survival of salmon in the Baltic fishery on whitefish.

Development of size selectivity in the Swedish grid

This project is collaboration between gear researchers and local fishermen to include size selectivity in the Swedish grid on the target species *Nephrops norvegicus*. The size selectivity on Nephrops is obtained by a dual grid system with a lower panel with 22 mm bar distance and an upper panel with 40 mm bar distance. The later work has been focused on different codend solutions including diamond mesh to remove flatfish and

square mesh windows to reduce bycatch of smaller cod´s passing the grid system. To be continued.

Development of size selectivity in the shrimp grid

This project is very much the same as the project "Development of size selectivity in the Swedish grid" and is collaboration between gear researchers and local fishermen. In this project the focus is on size selectivity on the target shrimp species *Pandalus borealis* using a dual grid system. To be continued.

New priority areas 2015 are:

- Demersal fishery in Baltic sea - Size selectivity in gillnet and trawl fisheries
- Demersal fishery in "Kattegat/Skagerrak (North sea)", continued development of Pandalus and Nephrops fisheries
- Size and species selectivity in demersal fishery to avoid fisheries on limited and sensitive stock´s
- Pelagic fisheries - for example bycatch of saithe
- Seine fishery - evaluate/validate systems required to apply exceptions to the landing obligation in this fishery
- Survival of bycatch in the demersal fisheries with special attention on flatfish for example Sole
- The handling of catch onboard and ashore
- Development and testing of cages/traps

11.7 SCOTLAND

11.7.1 Marine Scotland – Science

Trials to investigate the physical impact of towed gear components on the seabed.

Investigation of the physical impact of towed gear components continued during 2014.The analysis of previous trials has taken place and has demonstrated that as the towing speed increases the amount of sediment mobilized also increases; that the weight of the elements does not influence the amount of sediment mobilized; and that the geotechnical drag per unit area can be expressed in terms of the towing speed and the weight per unit area acting on the seabed. Further trials are scheduled for this year and will investigate the impacts on sediment with a higher mud content and also investigate the release of nutrients behind these components.

Further details can be obtained from b.oneill@marlab.ac.uk or k.summerbell@marlab.ac.uk

A meta-analysis of haddock size-selection data

A model to predict the size selectivity of haddock (*Melanogrammus aeglefinus*) was developed through a meta-analysis of 21 trials of codend selection and 19 trials of the combined selection of the codend and a square mesh panel. Individual-haul estimates of the 50% retention length (l50) and the selection range (SR) are related to a set of explanatory variables through a structural model that describes the dual process of panel and codend selection. Codend l50 and SR are positively related to codend mesh size and negatively related to the codend twine diameter. Codend l50 is also negatively

related to the number of open meshes around the codend circumference. Panel l50 increases with panel mesh size. The panel contributes more to gear selection as it is moved closer to the codline. The panel is most effective between November and January and least between May and July, periods which broadly coincide with peak and poor haddock condition.

Further details can be obtained from b.oneill@marlab.ac.uk

IBTSWG study - Compile status quo and report on ways forward in GOV standardization

It has been acknowledged by IBTSWG that historical drift and technical creep have impacted on national GOV specifications and that deviations from the standard manual have occurred. Due to the longevity of this survey and the number of participating countries these deviations could be due in part to the complexity of the GOV (design/rigging), new survey vessels entering service, modification in deployment methods (warp to depth ratio) or discontinued materials/components. The main aims of this study were to investigate (a) the status quo of current national GOV specifications and (b) to propose a way forward in re-standardizing the materials and specifications. A detailed trawl gear specification questionnaire was drafted at IBTSWG (2013) and subsequently circulated to all GOV countries. The questionnaire covered the following aspects of the GOV specification:

- Trawl (netting) sections.
- Trawl roping and framelines.
- Groundgear construction.
- Flotation and kite.
- Wire rig and otter boards.

All gear questionnaires were finally completed by November 2014 with 9 countries providing responses. A presentation of results was given at IBTSWG 2015 in Bergen with the final results presented in the IBTS working group report due for publication summer 2015.

Further details can be obtained from r.kynoch@marlab.ac.uk

Effects of Codend Mesh Size and Twine Number on Nephrops Selectivity

A set of trials were conducted in the West Coast to examine the selectivity of Nephrops (*Nephrops norvegicus*) with regards to codends with the following mesh size and construction:

- 80 mm diamond mesh codend of 4 mm single Brezline (PE) twine
- 100 mm diamond mesh codend of 5 mm double Brezline (PE) twine
- 120 mm diamond mesh codend of 5 mm double Brezline (PE) twine

For Nephrops the catch rates of the 3 test gears differed significantly from each other. At a carapace length of 35 mm the 80 mm mesh showed 77% retention, the 100 mm codend showed 61% retention and the 120 mm codend showed 43% retention. For whiting (*Merlangius merlangus*) the catch rates of the three test gears differed significantly from each other with increasing selectivity as mesh size increased. For haddock (*Melanogrammus aeglefinus*) the selectivity increased as mesh size increased however, that of the 80 mm and 100 mm codends did not differ significantly from each other.

Further details can be obtained from j.drewery@marlab.ac.uk

Assessing the economic impact of selective gears in the Scottish North Sea Nephrops fleet

A short term economic assessment of introducing more selective gears to the Scottish North Sea Nephrops fleet is currently being carried out. Five gears are being assessed, two of which are currently available as incentivised options through the Scottish Conservation Credits Scheme (SCCS). The effect of these gears on the profitability of two fleet segments is examined and the analysis takes into account incentives that may be available and possible fuel savings that may be offered by some of the gears. The two fleet segments are categorized by vessel size and engine power, (i) North Sea Nephrops 300kW and over segment and (ii) North Sea Nephrops <300kW segment and the five gears are a large mesh top sheet panel, a low headline trawl, the Flip-flap netting grid, the Faithlie Cod Avoidance Panel (FCAP) and the 45 mm bar spaced flexible grid.

Further details can be obtained from Emma.Lines@scotland.gsi.gov.uk or b.oneill@marlab.ac.uk

Investigating the use of light to promote the selectivity of towed gears.

Initial trials to explore the possibility of using light to improve the selectivity of towed gears have taken place. These trails tested the use of an LED lit fibre optic cable, which was attached to the leading edge of a separator panel of a demersal trawl. The LED pod and the fibre optic cable proved to be very robust and no problems were encountered with either. The limited fishing trials were inconclusive. Further sea trials are planned for this year and more focused laboratory experiments are planned to help identify the cues which may elicit behavioural responses that may improve selection.

Contact b.oneill@marlab.ac.uk, k.summerbell@marlab.ac.uk or Emma.Lines@scotland.gsi.gov.uk for further details.

11.8 PORTUGAL

11.8.1 IPMA – Portuguese Institute for the Ocean and Atmosphere

Survival of Norway lobster (*Nephrops norvegicus*) escaping through diamond and square mesh codends in the Portuguese crustacean trawl fishery

Contacts: Aida Campos (acampos@ipma.pt); Paulo Fonseca (pfonseca@ipma.pt)

This study was designed to obtain comparative estimates of survival for Norway lobster escaping from the standard 70 mm mesh size vs. 55 mm square mesh codends, previously tested in this fishery with proven selective properties, providing support for an informed decision on the introduction of modifications in the gear and fishing practices. A further objective was to better understand the relationships between survival and physical damage with biological and operational factors.

Individuals escaping through codend meshes and retained in covers were assessed for survival in seabed cages which were deployed for 48 hours. Average survival rates were 17% and 30%, for individuals escaping through diamond and square meshes, respectively, and 84% for creeled individuals used as controls. The survivorship estimates obtained were quite small when compared to previous survival studies, being closer to those found for discarded Norway lobster both in the Portuguese and other EU crustacean fisheries.

The results were consistent in showing that the escape process through codend meshes was not a major factor causing mortality. Survival was found to be closely related to

the endured physical damages and vitality of escapees. The increase in survival resulting from the use of square mesh codends, although statistically significant, was moderate and the experimental results point to a great variability in the survival rate across codends of the same type. A discussion of the underlying reasons is carried out emphasizing the difficulty in disentangling the influence of the different factors contributing to condition and mortality of individual lobsters.

Cooperation with the industry and other stakeholders to reduce discards in crustacean trawl fishery

Contact: Aida Campos (acampos@ipma.pt)

A cooperative platform was established between the South Western Waters Advisory Council (SWW AC) and several research institutions at the scope of the project SIMBAD (Strategies at Sea to Reduce Discards). The objective of this platform is to propose strategies to decrease the volume of discards generated by fishing boats in the Bay of Biscay and Iberian Peninsula waters. Results from previous research in trawl fisheries, carried out in Portuguese waters, regarding fleet segmentation and landing profiles, options for improving gear selectivity and survival of Norway lobster discarded and escaping through codends have been presented to stakeholders in a number of meetings organized by SWW AC.

11.8.2 CCMAR, Centre of Marine Sciences

Comparing the selectivity and ecological impact of the Nephrops fishery with traps and trawling.

Contact: Margarida Castro (mcastro@ualg.pt)

Catch sampling was done simultaneously, in two vessels fishing in the same area, a trawler and a creeler, both targeting Nephrops. Sampling includes measuring and sexing every Nephrops and listing all the catch (total weight and subsamples to estimate numbers per species), identifying species of commercial value and discards. This procedure was repeated twice, in July and December 2015. An index to quantify ecological impacts of the two gears is being developed. Preliminary results confirm the selection of traps towards large males, and insignificant bycatch when compared with trawling.

11.9 NORWAY

11.9.1 Institute of Marine Research (IMR)

A combined grid device for size selectivity of shrimp and small fish release while shrimp trawling.

Resulting from management challenges related to highgrading in shrimp trawl fisheries conducted in the Skagerrak and in the North Sea, Norwegian authorities have initiated development work to investigate if an earlier developed sorting grid device consisting of 9–10 mm bar spacing in the lower front part, hinged to a grid with 19 mm bar spacing in the aft and upper end can be implemented in commercial trawl fisheries. The development until now has focused on an evaluation of the sorting effect of grids with 9 and 10 mm bar spacing and the effect of the slope angle of the grids. The results show that increased catches reduce the grid slope angle. Slope angles less than 25 degrees are required to avoid blocking of the grid surfaces by shrimp. The selectivity of an active sorting grid, meaning one that it is not blocked, has proven to be better than traditional diamond meshes in the codend. The combined grid system will be further

developed in consultation with the shrimp fishing industry in Norway, Denmark and Sweden, management authorities and gear researchers in the three Nordic countries.

Contact: John Willy Valdemarsen (john.willy.valdemarsen@ imr.no)

Low impact trawling.

Since the CRISP project started in Norway in 2011, a major focus has been to develop a trawl design and operation of the trawl that minimize bottom impact while maintaining the fishing efficiency for codfish comparable to traditional demersal trawling. The trawl design is basically a high-opening 4-panel bottom trawl equipped with at top wing in front of the headrope to which a netsounder cable for signal transmission and pull is attached. The trawl is rigged with sweeps attached to pelagic trawl doors that is positioned 5–15 m above bottom while towing. The trawl concept also include a groundgear with 16" roller bobbins, which reduces the bottom contact to a few contact points along its entire length.

The SeaFlex doors developed by the project can be manoeuvred vertically individually while towing. In experiments during 2014 and 2015 we have documented that only one of the doors need to be vertical adjusted by opening and closing of one hatch in the door during a tow to align both door in equal distances above the bottom. This was achieved both when towing along a slope and in a side current. The roller bobbins groundgear had high efficiency for cod as the fish lifted above the 8" rubber spacers inserted along the groundgear between the rollers. There was clearance below the spacers indicating that the bottom impact was significantly reduced.

Contact: John Willy Valdemarsen (john.willy.valdemarsen@imr.no)

Catch control in the Norwegian demersal seine fisheries.

With today's large cod stock, it has become a great challenge for the demersal seine fleet to limit their catch sizes. Incidents with hauls of tens of tons have been recorded, often too large for the boats to handle and causing safety risks for the smaller boats. This project's objective is to develop a solution that allows the vessels to control their catch sizes. In 2013, underwater observations were made during commercial fishing with dense aggregations of cod. In addition, prototypes for alternative solutions were tested in a flume tank. Experiments in 2014 resulted in a functional solution that has gained industry acceptance and the demersal seine fleet has currently a dispensation to use the system. Researchers from IMR and the Fisheries Directorate have travelled with boats from February through April 2015 and filmed the catch control device using underwater cameras. Some modifications have been done to adjust the solution to the different seines in use; but overall, the solution has proved to perform successfully to limit catch sizes without losing fish at low catch rates.

Contact: Ólafur Arnar Ingólfsson (olafuri@imr.no).

Down-scaling of square mesh codends for demersal seines.

In fishing areas east of Sørøya, N-Norway, the use of square mesh codends in the mixed cod – haddock fishery, with specified minimum length and circumference is mandatory in the demersal seine fisheries. Handling these large codends is difficult for the smaller boats. The objective of this project is to measure size selectivity of a scaled-down square mesh codend and that of the larger, legal version for management advice. Codends have been tried by commercial fishers as a pre-project and selectivity experiments were performed in 2014. Due to logistic reasons, few replicates were made with each codend, but the downscaling of the codend seems to result in sharper selection in terms of narrower selection range, for both cod and haddock. Further experiments will be conducted in 2015.

Contact: Ólafur Arnar Ingólfsson (olafuri@imr.no)

Species selectivity in the Norwegian demersal seine fisheries.

The availability of Atlantic cod and haddock on the fishing grounds and corresponding quotas has not always gone hand in hand. At IMR, Bergen, a species selection device for separating cod and haddock was tested in the late 1990s. With arising need, the dust has been wiped off that concept; it has been filmed in the commercial seine fishery and tested in a flume tank in 2013. Direct measurements of the performance of the device as well as underwater filming were performed in august 2014 onboard a commercial seiner in the Barents Sea. A horizontal square mesh panel was attached to the belly section and fish from the upper and lower sections were collected in two separate codends. The species separation is length dependent, and larger proportion of the smallest fish end up in the upper compartment. The results, however, show that separation of cod and haddock is feasible but to a certain extent; about 80% of haddock up to approximately 55 cm end up in the upper codend, while > 80% of cod above 55 cm end up in the lower codend. Further testing is planned to be conducted in May 2015.

Contact: Ólafur Arnar Ingólfsson (olafuri@imr.no)

Species selection of cod and flatfish in demersal seines.

Demersal seiners above 15 m in length are prohibited to fish for plaice and lemon sole inside the fjord areas in Norway due to bycatches of coastal cod. In 2014, a pre-study to observe fish behaviour in demersal seines was conducted. Fish behaviour was filmed using underwater cameras in at the groundgear, wings, in the opening, belly and codend. Experiments to exclude cod from a demersal seine, while maintaining viable catches of flatfish will be conducted in august and October 2015. These will include both testing of a modified flatfish seine as well as specific exclusion devices.

Contact: Ólafur Arnar Ingólfsson **(olafuri@imr.no).**

Deep Vision.

Development of the Deep Vision system for taking stereo images inside a trawl has continued as a cooperative project between Scantrol Deep Vision AS and the Institute of Marine Research. Results from using Deep Vision on a survey of young-of-the-year fish was published (Underwood *et al.*, 2014). A pilot deployment frame was successfully tested in March 2015 and resulted in much easier handling on deck than previous frames and new software development has significantly decreased processing time for length measurements and species identification.

Contact: Shale Rosen (shale.rosen@imr.no).

Ghost fishing of pots.

A new project has been initiated in 2015 to study the extent of ghost fishing by lost pots in the Norwegian fisheries for lobster and red king crab. Various technical solutions to prevent lost pots from ghost fishing will be reviewed and the more promising evaluated in field tests

Contact: Terje Jørgensen (terjej@imr.no)

Selectivity of wrasses in fykenets.

The last years 15 to 20 million wrasses have been caught live for use by the fish-farming industry in de-lousing of salmon. Fishing experiments with fykenets comparing standard nets with nets with rectangular escape vents with widths of 15, 20 and 25 mm were carried out in cooperation with commercial fishers in May 2014. The main objective was to explore the possibility of fishing selectively for ballan wrasse, the largest of the four wrasses targeted by the fishery, during the spawning season of the other wrasses. The results showed generally poor performance of the escape vents, with high retention of wrasses that based on their sizes could easily have escaped. The results support earlier findings of poor performance of escape vents during the spawning season.

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Improved catch control in purse-seine fisheries.

Earlier experiments at IMR, Bergen, have documented that crowding of pelagic fish like herring and mackerel may lead to mortality among slipped fish, but also that the mortality may be low if slipping is done in a gentle and responsible way at an early stage of hauling. Since these results were known, much effort has been put into developing tools aimed at giving fishermen better control of his fishing gear and his catch, and thereby reduce the need for slipping from seines. In addition, it has been an aim to alter the seine designs to facilitate gentle release if slipping is unavoidable.

At present IMR is working on developing a cannon kite trawl that enables the fishermen to obtain a physical sample of the fish in a purse-seine catch at an early stage of hauling while it is still acceptable to release fish. We are also developing methods that may give the skipper better control of his purse-seine during a seine set, by visualizing the 3D shape of the net on a screen in the wheelhouse using transmitter technology, and by lightening of the float line of the net during hauling at night. Another catch control tool under development is an overspill net that prevents fish from escaping above the float line.

In a project with the goal to develop and implement responsible slipping methods for the purse-seine fleet, the fishing industry, fisheries management and IMR have agreed on a first suggestion for a simple set of guidelines or "Best Practice" for slipping of fish from purse-seines. These guidelines are currently being tested and evaluated in full-scale sea trials onboard commercial purse-seine vessels.

Contact: Aud Soldal (aud.soldal@imr.no)

Pelagic sampling trawl for 0-group fish and krill.

Trials carried out in 2012 with DeepVision mounted at the end of the extension of the pelagic sampling trawl for 0-group fish, showed that fish were snagged in the meshes ahead of DeepVision during trawling and became loose when the net was hauled (Underwood *et al.*, 2014). The reason that snagged fish come loose and pass the DeepVision system, particularly near the surface, is that the net is both slackened and tightened during this phase of hauling (for instance, when the trawl-doors reach the gallows),

and this tends to release the fish. Wave motion at the surface can also affect the trawlnet in ways that cause the fish to be released.

Variations in hauling procedures and weather conditions can thus influence how many fish are released from the meshes, and thus the total catch and the index that is calculated based on the catch rate. The fact that fish become snagged in the meshes also indicate that an unknown number also pass out through the meshes of the trawl and are not retained in the catch.

In the Norwegian krill fishery in the Antarctic, the problem of krill clogging the meshes during towing was solved by the addition of fine-mesh inner nets that were mounted only at the leading edge to the outer net. Since the sections are only attached at the leading edge to the outer net, the water flow keeps them in movement, thus preventing krill clogging.

During trials in 2014 similar fine-mesh inner nets were mounted inside the extension of the Harstad trawl. Four inner nets (8 mm mesh), each 6 m long, were mounted to the outer net as described above. The inner nets overlapped by about 1.5 m, and the end of the rearmost inner net was about 1.5 m inside the codend. The underwater observations showed that the inner nets functioned as intended. The inner nets, particularly their rear parts, were in continuous motion, which meant that small organisms did not become snagged during towing. Fishing experiments showed that the fine mesh prevented small fish from escaping from the net. A new trawl design for 0-group fish and krill will be tested in 2015.

Contact: Arill Engås (arill.engaas@imr.no).

School and gear dynamics in purse seining, studied with multibeam sonar.

In this study, the dynamics of herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) schools captured by the commercial purse-seiners were studied with a Simrad MS70 multibeam sonar (75–112 kHz). The sonar was mounted on RV "G.O. Sars" and the recordings covered the whole purse-seine and the enclosed school within each single transmission. The catches were taken in the Norwegian and the North Sea in 2013 and 2014. Fish densities and school distribution in the net were estimated as the net was hauled and the available volume was gradually reduced.

Contact: Maria Tenningen (maria.tenningen@imr.no)

Reducing slipping mortality in purse-seines by understanding interactions and behaviour.

A new project funded by the Norwegian Research Council started in January 2015. The main aim of the project is to reduce slipping mortality in mackerel purse-seine fisheries by improving the monitoring and control of the fishing operation and by improving the understanding of fish behaviour in the net. The project involves small-scale net pen experiments and experiments in the commercial mackerel fisheries. The knowledge gained through these experiments will be used to provide scientifically based practical slipping guidelines to Norwegian and EU fisheries managers.

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11.9.2 SINTEF Fisheries and Aquaculture

Development of Trawl simulation software (CATS 2).

The objective of this project is to update the simulation software CATS which was made in the mid 90ties to a new version where more fishing gears can be analysed. The updated software can be used for analysis of trawls and seines with diamond, hexagonal meshes and or nets incorporating square mesh sections. The software can handle a number of different operations like trawling in either single or multi trawl configurations. The updated software will also be able to handle the seining process of a Danish Seine.

Contact: Kurt Hansen (kurt.hansen@sintef.no).

Managing trawl catches by improving the hydrodynamic performance of sorting grid sections (Catch control II).

The main objective of this project is to develop sorting grid section(s; combined with a codend) for the Barents Sea demersal trawl fishery that provides high selective performance and good control over catch sizes even when exposed to extremely high catch rates. The following topics have been identified as the main challenges: Design 4-panel grid sections (Sort-V and Flexigrid) in which the components (lifting panel(s), sorting grid(s) and guiding panel(s)) keep constant geometry. Increase the grid section's cross section area without (or minimally) increasing the size of the grids. Design a lifting panel that minimally reduces water flow and that increases grid contact probability to secure effective size selectivity. Design a guiding panel that minimally reduces water flow. Test alternatives to the lifting panel in order to improve grid contact. Experiments were carried out in March 2015.

Contact: Eduardo Grimaldo (eduardo.grimaldo@sintef.no).

Deep water tornado trolling for whitefish.

In this project a system for deep-water tornado trolling is being developed. This can be explained as a jig-/trolling line going continuously around in a closed loop from the vessel and through a stabilized, wide pulley hanging at a desired depth in a line from the vessel. The trolling line is automatically driven and shall be able to operate at depths down to 200 m and more to catch cod, haddock and saithe.

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Catch control device for seine nets.

A prototype for controlling the size of the catch in seine operations is being developed and tested. Results show that it effectively limited the catch to predefined volumes, e.g. 4, 7 or 10 tons. Most of the fish escape appears to occur during the retrieving process.

Contact: Jørgen Vollstad (Jørgen.Vollstad@sintef.no).

Danish seine: Computer based design and operation.

The main objective of this project is to develop two software tools for Danish seine fishing that ease future transition to the environmentally friendly Danish seine fishing method and that will support development of more optimized gear designs:

- A tool that enables the skipper to simulate the behaviour of the gear with different riggings and different operation procedure.

- A tool that enables the netmaker to create new net designs and evaluate their performance through simulations.

The project will run for three years (2013–2015). The research work will be divided between development of simulation models, development of software tools and verification of tools and models. The research team will be mainly SINTEF Fisheries and Aquaculture (SFH) and the University of Tromsø. However, additional international expertise will be provided through an expert workshop. Industry will be involved through workshops.

Contact: Bent Herrmann (Bent.Herrmann@sintef.no).

Performance of a new double grid design: quantification of grid contacts.

The flexigrid is a double grid design and is one of the mandatory selection devices used in the northeast Arctic cod and haddock fishery. The aim of this study was to investigate the selective performance of a new 4-panel flexigrid design for this fishery. Specifically, we wanted to evaluate if this new design increases the chances for a fish to make contact with at least one of the two grids in the design. Therefore, in addition to the selectivity parameters L50 and SR, we quantified the parameter "grid contact" for both grids independently and combined for both the mandatory 2-panel and the new 4-panel designs.

In a direct comparison carried out using a twin trawl, the 4-panel flexigrid design showed higher L50 values and lowers SR values than the 2-panel design. Underwater recordings revealed that the cause for this difference between the designs might be that the 4-panel section holds a more correct shape than the 2-panel section while fishing. The mean values estimated for the grid contact were always higher for the new design. The results also showed that undersized cod escapes mostly through the lower grid of the section whereas haddock utilizes in general the upper grid. This is in good agreement with the behavioural differences expected between these two species.

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The effect of sweep bottom contact on the catch efficiency of haddock.

The fishing efficiency of a fish trawl depends to a certain extent on the ability of the sweeps to direct the fish towards the trawl mouth. To evaluate the importance of sweep bottom contact in the catch efficiency of haddock, we compared the fishing efficiency of two different trawl setups over two cruises. In cruise 1 the difference in sweep length with actual bottom contact between the setups compared was 30 m, the average door distance measured 128.42 m and the sweep angle with respect to the towing direction 22.29°. In cruise 2, the difference in sweep length with actual bottom contact with the seabed between the setups compared was 45 m, the average door distance measured 75.94 m and the sweep angle with respect to the towing direction 12.02°. To estimate the relative change in length-dependent catch efficiency of haddock between the two setups for each of the two cruises we used catch comparison and catch ratio analyses.

The results showed that for the fishing efficiency of haddock the length of the sweeps that have actual contact with the seabed is important. Further, the results indicate that this effect of the sweeps for this species is length dependent. The differences between the two setups tested in each cruise were significant for a range of length classes in

both cruises. This demonstrates that at sweep angles of 12.02°–22.29°, the fishing efficiency of a trawl on haddock is different for at least a range of length classes when changing the swept-area.

Finally, the results of this study demonstrate that lack of control over the position of the doors in the water column when fishing with a semi-pelagic setup/rig may cause loss of contact of the sweeps with the seabed, and thus undesired effects on the fishing efficiency of haddock. Contacts: Manu Sistiaga (manu.sistiaga@sintef.no), Bent Herrmann (bent.herrmann@ sintef.no), and Eduardo Grimaldo (eduardo.grimaldo@sintef.no).

Delivery of high quality trawl caught pink shrimp (*Pandalus borealis*).

The pink shrimp (*Pandalus borealis*) is a commercially valuable species that is harvested along the whole Norwegian coast and still 100% with bottom trawls. In the coastal shrimp fisheries most shrimps are alive when they come onboard, but their survival through time varies depending on how they are treated and the conditions in they are kept on.

In some specific countries, live pink shrimps reach so high prices that fishermen in Norway could get paid double as much for their shrimps if they were delivered alive (Fiskeribladet Fiskaren, 29–08–14). Delivering live shrimps would be especially lucrative in the periods shrimp catches are low. The fact that fishermen seek for alternative fishing methods (e.g. pots) to be able to deliver live shrimp proves that shrimps captured with trawl (at least the way trawling is carried out today) do not hold the standard necessary to supply this new market.

SINTEF Fisheries and Aquaculture has developed a gentle codend for trawls and seines. The results of some preliminary tests carried out in the flume tank show that the codend maintains high volume and low intern water speed (10–20% of the incoming water speed). Such a codend would contribute to the shrimps being less exposed to mechanical forces during fishing and in the hauling process. This more gentle treatment should be reflected in a higher survival percentage and lower damage percentage of the shrimps. The aim of this pre-project is to evaluate the extent to which this gentle codend can make a difference in the survival of shrimps caught with trawls.

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Estimating the selectivity of unpaired trawl data: a case study with a pelagic gear.

Most selectivity experiments employ either the covered codend or paired gear methods. It is not always possible, however, to use these methods. Owing to operational, biological and/or environmental considerations, there may be no obvious way or it may be inappropriate to pair the test and control data. Hence, it will not be possible to estimate the selectivity of the gear and its uncertainty using standard statistical methods.

This study presents a methodology to analyse the selectivity of fishing gears from unpaired test and control data. The uncertainty in the control and test population structures is accounted for by using a double bootstrapping procedure that takes into account both between-haul and within-haul variation.

This bootstrapping approach is used to assess the selectivity of two different devices: a 139.5 mm T90 codend; and a 135.9 mm codend with 140.9 mm lateral Exit window, in the Barents Sea pelagic cod trawl fishery. The purpose of the experiment was to test

and compare the performance of the two devices in pelagic trawl fisheries, where high densities of fish can be encountered. Significant differences were detected between the T90 codend and the codend with the Exit Windows but only for sizes of cod between 55 and 76 cm.

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Estimation of the effect of gear design changes in catch efficiency: methodology and a case study for a Spanish longline fishery targeting hake (*Merluccius merluccius*).

We outline a method to estimate the relative catch efficiency of different fishing gear designs based on comparing catch data. The method described does not require equal number of deployments or alternation between the gears to be compared, and accounts for multiple competing models describing the data by using multi-model inference. Further, by applying a double bootstrapping procedure the method accounts both for the uncertainty in the estimation resulting from between deployment variation in catch efficiency and availability of fish, and the uncertainty on the size structure of the catch for the individual deployments. Finally, incorporating the multi-model inference into each conducted bootstrap the method also accounts for the uncertainty due to uncertainty in model selection.

Using the outlined method, we investigated the effect of gear design changes in catch efficiency for a Spanish longline fishery targeting hake (*Merluccius merluccius*). We tested and compared four different designs against the traditional design applied in the fishery; a new automatized design that differed in hook size, snood line length and snood line diameter, and three designs where only one of the parameters was changed at the time. The new design is favourable for the Spanish demersal hake fishery because the deploying and hauling processes are automatized, meaning that the manpower needed to conduct the fishery would be decreased. However, this study demonstrates that adopting the new automatized design results in a significant decrease in catch efficiency. The analysis conducted revealed that the reduction in catch efficiency was consequence of the thicker snood line applied in the new design. The change in hook type and snood line length used had no effect in the efficiency of the fishery.

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How many fish need to be measured in trawl selectivity studies?

The aim of this study is to provide practitioners working with trawl selectivity with general and easily understandable guidelines regarding the fish sampling effort necessary during sea trials. Particularly, we wanted to provide guidelines on the number of fish necessary to catch and length measure in a trawl haul in order to assess the selectivity parameters within an intended maximum uncertainty level. In addition, the study investigated the dependence of this uncertainty level on the experimental method applied for the data collection and on the potential effects of factors like the size structure in the catch relative to the size selection of the gear. We based the study on simulated data created from two different fisheries: the Barents Sea cod trawl fishery and the Mediterranean Sea multispecies trawl fishery represented by the red mullet. The purpose of using these two completely different fisheries was to obtain results that can be used as general guidelines also for other fisheries. The results showed that

the uncertainty in the selection parameters decreased with increasing number of fish measured and that this relationship could be described by a power model. The sampling effort needed to achieve a specific uncertainty level for the selection parameters L50 and SR was always lowest for the covered codend when compared to the paired-gear method. In many cases, we observed that to keep a specific uncertainty level the amount of fish needed to measure with the paired-gear method is around 10 times higher than with the covered codend method. The trends observed for the effect of sampling effort in the two fishery cases investigated were similar.

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11.9.3 The University of Tromsø – Norwegian College of Fishery Science

During 2014, we participated in several projects on trawls, Danish seine and trolling led by the SINTEF fisheries and aquaculture. These projects are reported by SINTEF F&A.

Trolling for Gadeoid fish species.

A trolling system for cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*). The rig is a modified version of trolling systems used for mackerels, but modified for targeting Gadoid species in deeper water. The aim of this project was to seek a cost-efficient alternative to jigging and baited longlines (and gillnets). During 2013 and 2014, various designs of the system were tested on board coastal vessels (10–15 m). Initial fishing trials showed encouraging results, but further practical experiences will be needed to draw a conclusion on designs for one-man operations. The results were presented in an MSc thesis March 2015.

Contact: Roger B. Larsen (roger.larsen@uit.no).

Studies on the escape rate of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) during bottom trawling in the Barents Sea 2014–2015.

Fish trawls used by the Norwegian trawl fleet has increased in size and weights gradually since the mid 1980ties. The industry claim that longer and heavier groundropes are necessary for the efficiency of the gear. We compared the escape below the fishing line in an Alfredo No. 3 fish trawl using the conventional 21″ rock-hopper groundrope (RHG) and a 20″ semicircle spreading groundrope (SCSG) along the 18 m fishing line.

The trials were conducted in the Barents Sea during November 2014 (mainly large cod and snow crab) and February 2015 (a mix of large cod and haddock), with rather different light and temperature conditions at fishing depth. The escapement by numbers of fish was 3 times higher for cod and 6 times higher for haddock with the RHG compared to the SCSG. The results show clearly that the lightweight SCSG is more efficient than the conventional RHG. The results will be presented in an MSc thesis in June 2015.

Contact: Roger B. Larsen (roger.larsen@uit.no).

Escape rate of snow crab (*Chionoecetes opilio*) during bottom trawling.

A new fishery for snow crab is emerging in the NE Barents Sea and it is expected to be of vital contribution for the Norwegian fisheries sector in future. The snow crab is caught by pots and each vessels may soak thousands of pots occupying a large area. The snow crab fishery will interact with existing bottom trawl fisheries for cod and

shrimps. Besides area conflicts between crab and trawl fleets, several worries are already under discussion:

a) What is the fate of snow crab if they are over-trawled?

b) Does the conventional bottom trawls catch snow crabs? (in addition, how will it for instance affect currently used sorting mechanisms in fish and shrimp trawls?)

c) Is bottom trawl a suitable catching method for snow crabs?

In an experiment in the NE Barents Sea during November 2014 we examined the catch rate of snow crabs in a trawl with conventional rock-hopper groundrope. Furthermore, we assessed the rate of injuries on snow crabs being over-trawled. We used special retainer bag attached to fishing line of the trawl to collect information. Close to 100% of snow crab encountering the central section of the groundrope escaped below the fishing line. Very few of these crabs had visual damages despite underwater videos show that many crabs were ran over by discs of the rock-hopper groundrope. Results to be presented in an MSc thesis December 2015.

Contact: Roger B. Larsen (roger.larsen@uit.no).

Initial Norwegian trials with LED lights on shrimp trawls to improve bycatch reduction.

Currently, there is a great interest in improving bycatch reduction in the Norwegian shrimp fisheries and joint efforts by the fishing fleet, the Fisheries Directorate and science started recently. The aim is to reduce bycatches well below today's strict regulations on legal numbers of fish counted as bycatch.

Despite the compulsory Nordmøre grate (since 1991/1993) removes large quantities of fish during shrimp trawling, the 19.0 mm bar distance allow small juveniles and slim fish in general to enter the codend, i.e. part of the retained catch. Typically juveniles smaller than 15–16 cm from important species like cod, haddock, redfish, etc. are likely to be retained whenever they occur along the fishing ground.

We were encouraged by the convincing results reported by Bob Hannah and Steve Jones from the Oregon shrimp fishery in August 2014. During trials in February 2015 we tried to mimic their setup with green Lindgren-Pitman Electralume LED lamps along the fishing line. We attached 16 (and 20) of these LED lamps along the fishing line. In this initial test, we managed to get only six valid hauls (30 min. tows) with small shrimp catches and rather few retained fish and the interpretation of them should therefore be done with caution. For the three comparisons, pooled numbers showed a 27% reduction by numbers of the most important and abundant bycatch species. This is a step in right direction, but a reduction close to 9% of shrimps (by weight) would not be acceptable to fishers. Results were reported to the Directorate of Fisheries in February 2015.

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11.10 NETHERLANDS

11.10.1 IMARES

Project: ICES research on pulse trawling

The new ICES WGELECTRA met in Ostend, Belgium in October 2014. This WG replaces the former SGELECTRA and will run over the years 2014–2016. Reports are on the ICES website (www.ices.dk).

A new project was started to define the research agenda in brown shrimp (*Crangon crangon* L.) pulse trawling. In close collaboration with ILVO-Fishery of Ostend, Belgium, and representatives of the Ministry of Economic Affairs, NGO's and the fishing industry.

Two new projects were started on the problem of control and enforcement in pulse trawling on flatfish and brown shrimps. The idea is to build a system monitoring the electrical performance of a pulse fishing gear and storing data over a prescribed time interval and making these data accessible to inspection services and run a pilot with inspections at sea.

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Project: Pulse trawling monitoring programme and new 'pilot project'

IMARES commenced a pulse trawling monitoring programme from December 2011 until March 2013. The objective of this programme was to get more insight in the catch composition of the pulse trawling fleet, which aims at catching flatfish. The project exists of two programmes; an independent observer programme and a self-sampling programme. In the observer programme, ten observer trips have been carried out by IMARES and ILVO in 2012. The observers followed the standard discard protocol, which is also used for trips for the EU Data Collection Framework. In the self-sampling programme, 25 vessels have collected data on their catch according to a standard protocol during the period December 2011-March 2013. Analysis of the collected data were carried out in May-September 2013. The report was published in November 2013 and came out with reference: *Rasenberg, M., Van Overzee, H., Quirijns, F., Warmerdam, M., Van Os, B., Rink, G. 2013. Monitoring catches in de pulse fishery. IJmuiden. IMARES report C122/13*. The results show that on average 30% of the catch consists of landings, mainly sole and plaice. The discard percentage varies between 17% in the self-sampling program and 29% in the observer program. The rest of the catch (more than 40%) consists of benthos and debris. The self-sampling data show that 1/3 of these catches consists of benthos. The average amounts of plaice caught in the pulse fishery (both self-sampling and observer) is lower compared with the beam trawl fishery. The average sole catches are higher in the pulse fishery; however, the discard percentage of sole is lower in the pulse fishery compared with the beam trawl fishery.

Recently, the Dutch ministry of Economic Affairs started a new pilot project 'pulse fishing and the landing obligation' to ease the implementation of the landing obligation. The pulse gear has proven to catch less discards and could help fishers with the implementation of the discard ban. Therefore, the Dutch ministry doubled the amount of pulse permits and started a pilot project to carry out more research on the pulse trawl. Part of the research is the monitoring of landings, discards and spatial distribution of the Dutch pulse fleet targeting flatfish. This will be executed through an extension of the demersal discard programme of the EU Data Collection Framework. In

addition, fundamental studies will be set up on the effects of pulse stimulation on various species, and extended catch comparisons are foreseen, as well as measurements on field strength *in situ* above and in the sediment. The Dutch Ministry will commission this research in April 2015 after which more details will become available on the extension. The exact aim and methods are still to be determined.

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Project: VIP HydroRig-II

A new model HydroRig-II was designed, built and tested in 2014. The design was based on a wider beam (15 m), for which a derogation was asked, and wheels instead of trawl shoes. In June 2014, a small UW camera was used for direct observations. The catch results were relatively good compared to other vessels in the neighbourhood with initially a rising trend over the duration of the trials, but due to the larger size of the gear, the drag reduction was lower than with the first prototype.

Video footage by Geertruida Ltd. Urk, the Netherlands

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Project: VIP VRV

This project was set up with fishing company Geertruida B.V. (also involved in the HydroRig projects). The aim is to look at potential products that can be made of fish offal from gutting on-board and use a hydrolysis process with added enzymes to create higher valued products. Samples were taken from MFV and analysed by VFC/Lipromar of Cuxhaven (linked to Saria GmbH), Germany, and FBR of Wageningen, Netherlands. The result shows products such as: fishoil and fishmeal, but potentially also bioactive peptides with medical or functional food applications. Depending on the volume that can be generated and the price that the fishermen can get there may be economic incentives to use this material. The project will be finished in 2015.

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Project: Survival of discard fish and how to improve it

Two new interlinked projects were started on the survival of discards in the demersal fishery related to the coming discard ban in Europe, first to find out what percentage

of juvenile fish actually do survive being caught, brought on-board, processed and then be discarded, and second to find out how their chances of survival can be enhanced. Considerable time was used to define the working procedures develop find the proper equipment for storing fish alive on-board and transporting fish alive from a vessel to the laboratory for further monitoring in close cooperation with ICES WKMEDS. Trips were carried out to catch fish that could be used as controls during the actual experiments. Four survival trips have been carried out so far on two pulse trawlers, showing that after a relatively long observation time (15–20 days) the survival of sole and plaice stabilizes. It was also found that the place and time fish is collected from the fish processing line as well as the damage class have an effect on survival. In addition, studies were done on reflexes that can be used in reflex impairment observations to be linked to chances of survival, but these were not very conclusive so far. A second project deals with ways of improving survival, *e.g.* by adapting the fish processing line. These adaptations typically feature better separation between fish and debris and improved water flow in the deck hopper and on the conveyor belt, keeping fish underwater as long as possible. Seven additional trips in both projects are scheduled for this year.

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Project: Avoiding bycatch of boarfish in midwater trawling

This project aims at reducing unwanted bycatches of boarfish by improved species recognition and technical adaptations to the trawls. Acoustic boarfish data recorded at multiple frequencies (38, 70, 120, and 200 kHz) were collected opportunistically by a freezer-trawler during a fishing trip targeting mackerel and horse mackerel. These acoustic boarfish data were then compared to those data of mackerel and horse mackerel in an attempt to distinguish these species based on the acoustic signatures. In an alternative attempt. In order to get more insight into the acoustic properties of boarfish in general, the reflection of sound by boarfish was also modelled based on MRI scans of fish and swimbladders. The measurements and modelling results concluded that the boarfish echo gets relatively weaker at the higher frequencies used. In terms of practical fish classification however, boarfish reflects sound at the analysed frequencies in a similar way as horse mackerel. While these two species may be distinguishable from mackerel, overall multifrequency distinction of all three species together (using frequencies of 38, 70, 120, and 200 kHz) still remains impracticable.: distinction between either 'horse mackerel and mackerel' or 'boarfish and mackerel' using the four frequencies given above has a high potential for success. However, if all three species are taken together, the identification of horse mackerel and boarfish is "blurred" due to their similarities. Bad classification results are also expected if just boarfish and horse mackerel are compared with each other, due to their acoustic similarities.

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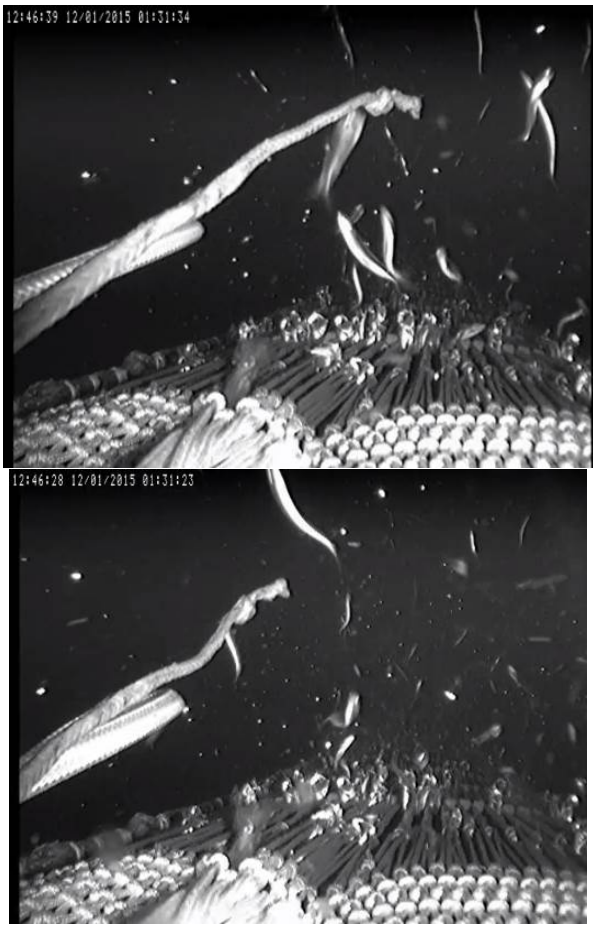
Project: Net innovation in pelagic fisheries

Following a pilot project on releasing discard fish by technical means from midwater trawls a follow-up project on this topic was started in 2014. A number of selection devices was developed, e.g. non-rigid sorting grids (length: 13.2–15 m; bar spacing 24–25 mm; three guiding panels) and different codend mesh sizes, and a few trips with these devices were made on three different freezer trawlers. The analysis of this limited number of trips did not reveal any differences and length–frequency distribution so far. In

addition, underwater TV observations were done showing some species to escape through these grids, and other not. More trips will be done this year.



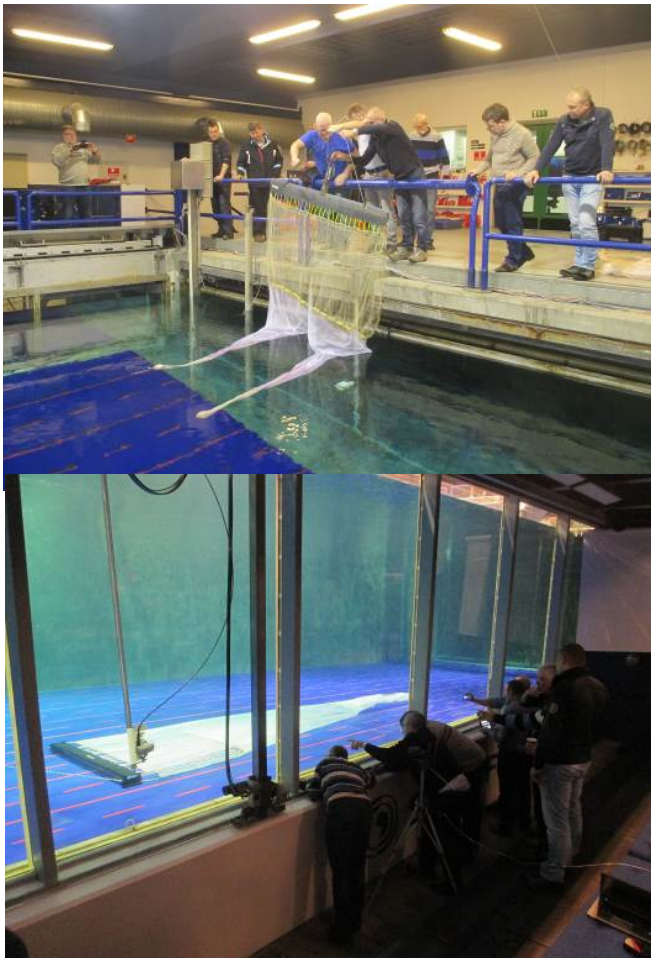
UW video footage by Maritiem Ltd. Katwijk, the Netherlands showing escapement of blue whiting

Contacts: Harriët van Overzee (harriet.vanoverzee@wur.nl); Edwin van Helmond (edwin.vanhelmond@wur.nl); Bob van Marlen (bob.vanmarlen@wur.nl)

Project: Net innovation in demersal fisheries

The project started last year. Its goal is to release discard fish at sea by innovative net designs. A first trip was carried out on a twin-rigger (OD6) with a 120 mm square mesh panel in the top sheet of the tunnel. The analysis did not statistically reveal great differences in the catch of juvenile fish between the standard and the new net. Further trips will be done this year involving more vessel and gear combinations. A second trip was recently done again on a twin-rigger (GY57), results are still to be analysed.

A group of skippers, netmakers, and (pulse) wing developers went to the Hirtshals flume tank of SINTEF in January 2015 to study a range of selective devices at model scale. At present skippers of various boats work on testing new devices. More trips will be done this year. The results will be monitored by self-sampling in the development phase and in greater detail with scientists on-board when the device is deemed to fulfil its objectives.



Pictures by Pieke Molenaar (IMARES) Model tests SINTEF flume tank Hirtshals, Denmark, 19/01/2015.

Contacts: Pieke Molenaar (pieke.molenaar@wur.nl); Bob van Marlen (bob.vanmarlen@wur.nl)

Project: Selective Twin-rig on Flatfish

This new project started also in 2014. The project has multiple objectives: developing a more selective net, adapting the fish processing line to improve survival of discards, develop an automatic sorting devices for use on-board, and monitoring survival of discard fish. A new net design was made, and a first trial was done in collecting the catch kept underwater on deck, filtering out sand and debris. The new processing line seems to work quicker enabling discarding to happen sooner.

Contact: Bob van Marlen (bob.vanmarlen@wur.nl)

Project: Selective Nephrops trawl

This project has started in 2014 and will be finished by the end of 2015. The aim of the project is to develop a highly selective Nephrops trawl for the small Dutch < 300hp vessels. Half of the landings are fish bycatch and therefore an important source of income, the Nephrops trawl should be made selective for larger fish species without loss of marketable Nephrops. The main species discarded in this fishery are undersized flatfish (dab and plaice) and small Nephrops. Trawl modifications are first monitored

by self-sampling of the catch composition. If the self-sampling results are promising a scientist will analyse the catch composition on-board.

In August 2014, one observer trip was done on the WR189 but did not result in a satisfying discard reduction. Trawls were redesigned, various ideas were exchanged and a scale model was tested in the SINTEF flume tank in Hirsthals, Denmark in January 2015. One recently developed trawl is designed to separate fish and Nephrops by a T45 separation panel. Fish and Nephrops are collected in different codends and selection is done by mesh size. The first self-sampling results indicate promising results. Several other trawl designs will be tested on-board during the Nephrops season in 2015.

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Project: Reduction of discards in shrimp trawling "the letterbox"

In this project, the "letterbox" is studied as an alternative for the sieve net or veil for the Dutch brown shrimp beam trawl fisheries. This alternative should be used during months when seaweed is abundant and clogging of the meshes in the sieve net is problematic. In addition to experiments with the letterbox trials are done with larger mesh sizes. Two vessels are involved in mesh size trials and ten vessels are involved in data collection and observer trips using the letterbox. The trials will supply paired-observations and cover the main fishing grounds of the Dutch brown shrimp fleet. Total catch and landings data are collected from April to October 2015 through self-sampling protocols. Detailed catch composition data are collected during 22 (multiple day) trips with IMARES scientists on-board.

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11.11 JAPAN

11.11.1 Faculty of Fisheries Sciences, Hokkaido University

Yasuzumi Fujimori **(fujimori@fish.hokudai.ac.jp)**

Coexistence of Fishery and Spotted Seal along the Coast of Hokkaido, Japan

This project is advanced under the policy of Ministry of the Environment, Japan, and consists of some section concerning ecological situation of spotted seal, developing a method for reducing impact of seal on fisheries. The topics that I am concerned are shown as:

(1) Gear Modification of a Salmon Set-net to Reducing Fish Damage by Spotted Seal

We tried to modify a salmon set-net in Erimo, Hokkaido to reducing fish damage by seal. The partitioning net with 30 cm mesh size was installed to one bag net of set-net to prepare a shelter of salmon from seal, then; the experiment was conducted in early fishing season. In the modified bag net, the percentage of fish damage was from 0 to 44%, while the percentage in the control bag net without the partitioning net was from 67 – 100%. Thus, fish damage was decreased obviously using partitioning net though it was not complete. Another modification has been planned; use of a rope grid that is attached with the mouse of funnel, the entrance of bag net.

(2) Observation of Salmon and Spotted Seal Behaviour in a Salmon Set-net using a Camera and Acoustic Sonar

The observation of salmon and seals in a set-net was carried out for gaining knowledge regarding their behaviour. Two types of devices, TrawlCamera (JT Electric) and dual-frequency identification sonar (DIDSON; Sound Metrics), were employed. TrawlCamera was set in the chamber end to film the entrance of the bag net at the end of the set-

net, and DIDSON was set outside the bag net to observe inside the bag net. Both devices confirmed that salmon would entered the set-net, irrespective of the time. Meanwhile, as observed using DIDSON, seals frequently appeared in the bag net from dusk to night, suggesting that seals predate salmon during this period. These results reflect that damage to catch would be decreased by changing the time of net hauling that is conducted around noon to late afternoon, approaching dusk.

Selectivity of Clamshell Dredge for Bloody Clam *Anadara broughtonii* in Sendai Bay, Japan

To investigate the optimum specification to catch 70 mm shell length or more, proper size to maintain the Bloody clam stock in this area, the fishing experiment was conducted using different specification dredges with five mesh size (51, 60, 73, 90, 100 mm) and three tooth spacing (11, 24, 34 mm). Selectivity curve was estimated with SELECT using a logistic function. For the tooth spacing, there was no difference of selectivity between 24 and 34 mm. This suggest that the large individual targeted by 34 mm (commercial use) was less in the experimental area. For the mesh size, the 50% shell length in 100 mm mesh size was about 70 mm, while the 50% shell length in 51 mm mesh size (commercial use) was about 42 mm. From these results, it was concluded that the combination of 34 tooth spacing and 100 mm mesh size was better to conservation of Bloody clam.

11.11.2 Graduate School of Fisheries and Environmental Science, Nagasaki University

Yoshiki Matsushita (yoshiki@nagasaki-u.ac.jp)

Development of a low-drag gear for fuel saving in offshore pair trawl fishery

A low-drag trawlnet partially using Ultra-high-molecular-weight polyethylene (Dyneema) has been tested in the pair trawl fishery in the East China Sea. We achieved 4.5% reduction in fuel consumption last year. We modified hanging ratio of the net this year and tested. The new net reduced fuel consumption to 90% of the conventional net (10% saving) without any catch loss.

Evaluation of the hypotheses on squid attraction to the light for feeding

We have conducted sampling of small organisms and squid attracted to the light of squid jig fishery. Small organisms were sampled by vertical tows of a plankton-net while swordtip squid *Photololigo edulis* were captured by jigging. We also sampled stomach contents of captured squid. Stomach of squid became empty as time elapsed. We found squids frequently showed cannibalism as well as predation of juveniles of commercial fish such as *Etrumeus teres* and *Auxis rochei*. Squid had fed those species attracted to light opportunistically.

Investigation of fishing technology and its spatial/temporal effort distributions in Lake Victoria, Kenya

We conducted fishing gear design survey at several communities at Lake Victoria region, Kenya. Gear designs of seine net, gillnet, longline, and pole and line fisheries were identified with some variations. We also conducted survey on the spatial and temporal distributions of those fishing activities of sample boats by using data loggers.

11.12 IRELAND

11.12.1 Bord Iascaigh Mhara

Contact: Daragh Browne Browne@bim.ie, Daniel McDonald mcdonald@bim.ie

Nephrops Catch Comparison Trials

In 2014 BIM carried out catch comparison trials in the Celtic Sea onboard the 24m quad rigger the MFV Celtic Warrior II. The objective of the trials was to establish the difference in Nephrops catches between a 70 mm, 80 mm, 90 mm and 100 mm codend. The results of the trials found that there were no significant differences between the 70 mm, 80 mm, 90 mm codends. The 100mm indicated that there were slight reductions in undersize Nephrops and no significant difference in Nephrops above MLS. Further work is to be carried out in 2015 to compare the 70 mm codend and the 100 mm codend in the Nephrops fishery.

Square Mesh Codend Trials

Preliminary Trials were carried out onboard the MFV Stella Nova using Square Mesh Codends. During the trials two sizes of square mesh codends were tested which were 74.5 mm and 50.2 mm (Omega Measurements). These were tested against the 70 mm standard codend. Results showed that there was no significant reduction in Nephrops catches between the 70 mm diamond and the square mesh codends. In 2015 BIM intend to carry out further square mesh codend trials in the Nephrops fishery possibly looking at different twine and means of constructing codends.

300 m Square Mesh Panel Trials

Trials were carried out onboard the 23m MFV Stella Nova in 2014 using the 300 mm SMP. The 300m SMP had been previously tested by Northern Ireland and reviewed by STECF and is used as a cod friendly gear in the Irish Sea. The results of the trials were comparable with the Northern Ireland study which had no significant losses of Nephrops and showed significant reductions in haddock and whiting.

Quad Rig vs. Twin Rig

From October 2012, many Irish Nephrops vessels changed their operation from twin-rigging to quad-rigging. Because quad-rigged nets are much smaller than twin-rig nets and have a reduced headline height it's possible that they could reduce discards. Many of the fishermen using the gear had reported that the catches of Nephrops had increased and fish discards had significantly reduced. BIM carried out trials on board the 23 metre trawler MFV Celtic Chieftain towing a twin-rig on one side and two quad-rig nets on the other side. Comparisons were carried out between the two gears to test if there were any reductions in discards as a result of changing their operations. The results of the trials showed that there were significant reductions in Haddock and Whiting. The trials also indicated that a larger number of small Nephrops are caught in the quad rig gear compared to the twin rig gear.

Selectivity Trials

In recent years BIM have undertaken a number of selectivity trials using a range of codends and square mesh panels mainly using 80 mm, 100 mm and 110 mm. There has been few data collected using a 120 mm codend combined with a 120 mm smp. In order to gather additional data on the 120 mm mesh size BIM chartered the 25m trawler MFV Northern Celt. The SMP was positioned 9–12 m from the codend and the method used was the covered codend.

At Sea Simulation of the Landing Obligation on Irish Vessels

The objective of the study was to assess the impacts of the landings obligation on the Irish fleet with particular focus on the impacts that choke species are going to have at an operation level. The study was carried out on board two different types of vessels, a 24m quad-rig Nephrops trawler and a 24m single rig whitefish trawler. The trial was carried out over a two month period and highlighted a number of issues that face the industry with the introduction of the discard ban.

11.13 SPAIN

11.13.1 AZTI–Tecnalia, Basque Country, SPAIN

Luis Arregi larregi@azti.es), Iñigo Onandia and Esteban Puente

The projects described below have been developed during last years but also some ongoing projects to. The projects have been developed in the new scenario of the European Fisheries Policy especially in the areas that affect the landing obligation

Fish survival from slipping in purse-seine fisheries: the case study of European southern waters

Slipping (releasing fish before the net is fully hauled onboard if the catch is unwanted by the skipper) has been prohibited by the European fisheries regulation (Regulation EU No 227/2013) for herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and horse mackerel (*Trachurus trachurus*). In the new regulatory framework (Regulation EU No 1380/2013; Article 15), an exemption to the landing obligation can be provided for species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem. This study presents the results of experimental tests on survivability of several species subject to slipping in southern European purse-seine fisheries, i.e. mackerel, horse mackerel, anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*), and chub mackerel (*Scomber japonicus*). Tests were carried out on board a commercial fishing vessel, which is representative of the purse-seine fleet of European southern waters; and they were conducted during real commercial fishing activity. High survival rates were found in the tests, particularly for crowding times of less than 10 minutes. This also suggests that the approach followed to simulate slipping, i.e. using fish tanks filled up with seawater on board to keep the catch in captivity, is suitable for discard survival studies as an alternative to other methods.

DESMAN (Discards Handling)

The new European regulations related to the landing obligation for all species with TAC have been applied in certain fisheries in 2015. The new scenario may involve a radical change in the fishing operational processes and handling onboard the fishing vessels.

Focusing on the handling of unwanted catch, it will mean a substantial increase in fish to be separate, classify, conserve, store, transport onboard and land, especially in some fishing methods such as trawling, where the discard levels still quite high.

This is an ongoing project that aims to: i) Quantify the volume of the different unwanted species that could be associated to the fishing operations in the Basque fishing fleet, taking into account different fishing methods (inshore, offshore and artisanal fishing fleets). ii) Assess the added effort and operational possibilities for different fishing boats to address the increased workload by handling due to the landing obligation.

iii) Study the existing technical possibilities and new work processes to solve the problem of extra fish to be handled. iv) Evaluate the potential increase in risks and their implications on the job security of the crews that will manipulate extra fish linked to compliance with the landing obligation.

BIZIRIK (alive)

The overall aim of this study is to analyse the survival of discarded species in the purse-seine fleet of the Basque Country in order to provide arguments to discuss technically and scientifically exemption of the landing obligation. This is an ongoing project where we are trying to: i) Get discard survival rates according to the operational fleet. ii) Study the performance of the machinery or equipment on board that affect survival. iii) Identify and analyse the factors that determine the survival of discards. iv) Development of a good practices manual on catch handling to optimize the survival of discards. Even still much work to do but the first results are very promising.

Energy performance of fishing vessels and potential savings

Commercial fishing is heavily fuel dependant. The increase in the fuel price, together with the stock decline, occupational risks of fishing, the possibilities of finding a different future for new generations, are some of the reasons that have made fishing arrive at its 'survival limits', in many parts of Europe. This contribution aims at providing ship-owners and researcher with the experience of undertaking energy audits, to reduce the fuel bill of fishing vessels. In order to do so, three fishing vessels were assessed comprehensively, for 2010–2012, to determine their energy consumption flow. The results indicate that energy consumption depends upon: (a) the structure and size of the vessel; (b) the engine conditions and use patterns; (c) the fishing gears used; (d) the fishing and trip patterns; (e) the distance to the fishing ground; (f) target species and their migration routes; and (g) the traditions onboard. Likewise, no generalization can be made regarding the way energy is consumed by onboard equipment/machinery when different fishing gears are compared. Energy audits will need to be site-specific and to include sufficient data to obtain representative results; these are likely to be more than in land-based industries, due to the peculiarities of this sector.

On the other hand, this field has a huge potential to improve and still some ongoing projects at AZTI's energy efficiency pilot plant, related to: i) Development of a test bench for the recovery of residual heat from marine diesel engines for energy generation. ii) Tests, under controlled conditions, with fuel consumption and exhaust gases emissions reduction systems on specific test benches.

11.14 FRANCE

"REDRESSE" project: selectivity in the Bay of Biscay

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The objectives of this project are to test strategies and devices allowing to reduce discards of the fishing fleets in the Bay of Biscay. This project concerns the following "*métiers*":

- Bottom trawlers: Nephrops and fish ;
- Netters: gillnet and trammelnet;
- Pelagic trawlers: small pelagic fish and tuna ;

- Danish seine: whiting and red mullet.

The project holder is the AGLIA (Association du Grand Littoral Atlantique). Other partners are Ifremer, CNPMEM (French National Fishermen Committee) and the South Western Waters RAC (Regional Advisory Council). The financial partners are « France Filière Pêche » association and the four Regions Councils of the Atlantic façade, Brittany, Pays de la Loire, Poitou-Charentes and Aquitaine.

First results 2014:

Among devices tested on bottom trawlnets, the panel separator, aiming to separate most fish (in the top part) from Nephrops (in the bottom part), to apply them adequate and different selective systems, gives promising results which will be deepened in 2015. T90 (diamond meshes turned at 90°), which do not close under the traction of the trawl, also give very encouraging results for the "fish métier".

For the problem of separation of Albacore tuna / Atlantic Bluefin tuna in the pelagic trawlnets, net barriers of large dimensions (40cm and 80 cm mesh side) showed difficulties of implementation at sea. At the same time, trials are in progress with a Simrad echosounder to consider if such a tool, associated with the expertise of the captains, can allow to better recognizing the species, even the sizes, making up the pelagic shoals of fish, before to catch them.

As regards to netters, the proposed improvements concern changes of fishing strategy (spatio-temporal management, modifications of practices, duration of immersion). A specific work will be also led on the selectivity of the Danish seine in 2015.

Improvement of selectivity in the Celtic Sea

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The objectives are identical with those of the REDRESSE project but are limited to the trawling fishery and target more particularly the following species: whiting, haddock, boarfish, gurnards, skates, monkfish…

The holder of the project is fishermen's organization "Les Pêcheurs de Bretagne". Other partners of the project are Ifremer and the equipment manufacturer LE DREZEN. The financial partners are the association « France Filière Pêche » and the Brittany Region Council.

First results 2014: until now, the T90 (100 mm mesh size) extension and codend gave the best results to reduce very significantly the discards with very few short-term commercial losses. Encouraging trials are also going on with semi-rigid monkfish grid.

"LANGVIVANTE" project: Better selectivity and quality for Nephrops

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The work package 'selectivity' of the *LangVivante* project aimed at studying the effect of using selective devices on *Nephrops* quality in the twin trawl fishery of the Celtic sea. This project is carried out by the French company "La Houle", financed by "France Filière Pêche"; Ifremer and IDMer are partners of the project. It has begun on March 2013 and has ended recently. The hypothesis tested stated that a reduction of the catch volume in the codend obtained from the diminution of the bycatch quantity, combined to shorter tow duration would preserve the vitality of commercialized *Nephrops*. Four

experimental devices were tested along two trials at sea on board of a French commercial trawler : [1] a square mesh cylinder combined to a 18 mm space grid and a ventral square mesh panel, [2] a square mesh cylinder combined to a 20 mm space grid and a ventral square mesh panel, [3] a square mesh cylinder combined to a 18 mm space grid and [4] a square mesh cylinder combined to a 18 mm space grid and a 'swimming-pool' codend designed to preserve the catch quality. The results obtained show that:

1) The devices tested show a significant escapement of the *Nephrops* but not of fish species. The *Nephrops* discards are reduced, but commercial losses are also observed.

2) The catches per hour of commercial *Nephrops* are generally higher with short hauls (< 2 hours) than for long hauls (> 2 hours). This trend was not observed for fish species.

3) The vitality of commercial *Nephrops* can be significantly preserved using a selective device combined to short tow (< 2 hours).

4) At this stage of conception, the "swimming pool" codend is not a viable option on board of a commercial trawler. However, improvements are possible to make it more ergonomic and more efficient on *Nephrops* quality, especially by avoiding mud in the codend.

"ENSURE" project: Evaluation of discards survival

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This project was launched in June 2014 and will run until the end of 2016. It is carried out by Ifremer. The other partners are the "Haute Normandie" Fishermen Committee, "Nord Pas de Calais" Fishermen Committee and "Pays de la Loire" Fishermen Committee. The project is financed by the association France Filière Pêche and by the Fisheries and Aquaculture French Authority.

The landing obligation is one of the main issues dealt by the new Common Fisheries Policy. Article 15 indicates that all species under TAC have to be landed; however the species for which high survival rate can be demonstrated scientifically may be exempted. In such context, the ENSURE project aims at 1) identifying the species that present a potential of survival after discard, 2) determining the optimal condition of survival and 3) describing the state of discarded individuals. These objectives will be reached from observations on board of commercial vessels: the vitality of discarded individuals will be assessed as well as their reflex impairments. The experimentations carried out will enable to determine the maximum duration of emersion that can be obtained without compromising the survival. Once the lethal levels will be defined, the proportion of individuals discarded according to their vitality and reflex status will be estimated. In the meantime, individuals discarded alive will be tagged. Based on the significant explanatory variables and observations made on-board, technical and operational improvements will be proposed to ensure the best survival rates. The expected results should feed the discard plans relative to the three métiers addressed by the ENSURE project : bottom trawl targeting mixed fish species in the bay of Biscay and English Chanel, twin trawl targeting *Nephrops* in the bay of Biscay and trammelnets targeting sole in the English Channel.

"PREDADOR" project: Limiting predation of shells by gilthead sea breams

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This project, carried out by the Shellfish Farming Regional Committee of the south Brittany (CRC Bretagne Sud), concerns the implementation of physical and acoustic barriers to rule out the predators (in particular the gilthead sea bream) of zones of shellfish farming (mainly mussels and oysters). It is financed by the Regional council of Brittany, the Department of Morbihan, and by the contribution of the industrial and scientific partners.

After collecting field data, Ifremer has designed physical barriers which are going to be tested at sea in 2015. These devices are square mesh nets (200 mm mesh side), lines and floats with frightening twines.

Ifremer's fishing gear laboratory designed a simple system of observation with Gopro cameras, 60m depth waterproof, and offering especially a 3 days autonomy taking a photo every 10 seconds. Such an order of magnitude of autonomy was necessary to observe the predation. At the same time, the Department of engineering and Marine Instrumentation in Brest developed on the same basis a complementary video system with 24 hours of autonomy. These simple developments based on "off-the-shelf" equipment, can have numerous applications except the PREDADOR project.

Besides the observation of nets barriers, these cameras enable to observe the effects of the acoustic deterrent developed in the same time by the Acoustics Department.

First results: at the end of October 2014, some predation was observed on a reference zone without acoustic deterrent in the Bay of Quiberon (oysters site) while the test zone with acoustic deterrent was not attacked. In Brest harbour (mussel site), the deterrent seems also very effective but the experiments must go on in 2015. The physical barriers will be tested and observed from May to November 2015 in the Bay of Quiberon.

"Jumper": optimization of low seabed impact trawl doors

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"Jumper" was a 24 months national project with private funds (FFP France Filière Pêche). It was a continuation of previously developed low impact trawl doors (part of DEGREE EU project and OPTIPECHE national project). The objective was to improve these doors in order to make them applicable to most fisheries where herding effect of doors is not concerned. Numerical simulation of the door behaviour, tank trials and field trials aboard 16m and 25m trawlers were undertaken along the project. Initial objectives have been reached: improved Jumper doors provide good trawl spreading and have very low impact. The shape of the lower part of the door produces a small hydrodynamic wake, as well as small impacted surface and forces applied on the seabed. Consequently, suspension is very low (an order of magnitude lower than standard doors). The design of these doors (high vertical extension, high GC position) make them sensitive to backstrops and bracket adjustments. However, this is probably a common observation when coming to "high tech" doors.

Simulation of fishing gears

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DynamiT software has not been developed during 2014. It will progressively be replaced by its successor which will make it possible to simulate other fishing gears than trawls. This new software package will include a simplified interface to input fishing gear parameters which will possibly be more detailed than in DynamiT software, a 3D simulation results viewer and simulation modules. First demo versions will be available by the end of 2015.

"SOIP" (French acronym for Service for Optimization and Innovation for Fisheries)

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This project aimed at establishing a state-of-the-art regarding the trawl gears used by fishermen along the French coasts and how they could be adjusted to their nominal operating point in order to minimize energy consumption and maximize fishing efficiency. About 30 trawlers were addressed by SOIP. Cable tension and geometry were measured on the fishing gear and simulations were undertaken by 6 fishing gear technicians.

The holder of the project was F2DP (Sustainable Fisheries Development Fund). Other partners were Ifremer and the equipment manufacturer 'Les Docks de Kéroman". The project was funded by the association "France Filière Pêche" and Ifremer.

"ENERSENNE" Project:

Contact: Daniel PRIOUR (daniel.priour@ifremer.fr) Laboratory behaviour of the structures at sea

The objective of this project is first, to assess the fuel consumption for the Danish seine fishing technique, including assessing its distribution in each phase of its implementation and second, investigate potential improvements in energy consumption.

Sensors have been installed on the boat and on the gear. Measurements were carried out during sea trials. The boat and gear were simulated. From these measurements and simulations, we observe that the route and fishing phase have more or less the same consumption (58% and 42%). During fishing phase, the gear focuses the main share of consumption (60%). This energy is transmitted to 2/3 by winches and 1/3 by the propulsion. Areas for improvement were evaluated: changing the type of winch (electric vs. hydraulic), speed adaptation drive at the optimum speed, zero speed consumption, cables modification, stopping the boat when cables are contiguous and therefore assumed ineffective on fishing.

This project is funded by the association France Filière Pêche and is funded by Ifremer. Other partners are the company Marinelec (electronic at sea), the fishing company Richard in Les Sables d'Olonne, and the Naval School in Brest.

"FREGATE" project: Experimentation of fish pots in the North Sea and Channel

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In parallel with its work on "engine technology", this project launched the development of alternative or complementary fishing techniques to trawling, in particular the study

concerning pots fishing in the North Sea and Channel. The Ifremer Fishing gear technology and biology laboratory in Lorient, which has already introduced several works on this emergent technique in France, works with the association "France Pêche Durable et Responsable" to test and implement fish pots onboard the private trawler "Frégate". The trials are still going on.

"HYDROTAMIS" project: a new sieve to improve elver quality

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Benoît VINCENT (benoit.vincent@ifremer.fr) Ifremer Fishing gear technology and biology laboratory – Lorient

To continue the efforts for the reconstruction of the eel stock, the "Pays de la Loire" Fishermen Committee launched a study, which aims first to state the knowledge of the quality of the catch of glass eels, and to test a set of changes in fishing gear to reduce the mortality of eels due to injury during the capture. The proposal of Ifremer therefore focuses on improving the quality of the catch by reducing fishing mortality due to gear, to preserve elver and optimize restocking actions.

From December 2013 to April 2014, six shipments were carried out on all fishing areas concerned. The glass eels sampled were immersed in a solution of indigo carmine, a dye that binds to tissue and can reveal lesions. Each elver was then observed to count and characterize the lesions. This resulted in a quality percentage linked to a given type of device, considering that a good quality glass eel is free of any lesion. Although the protocol has been developed with the aim to remove all possible biases, some still need to be mentioned as the weather, the location of eels caught, handling by the fisherman, and the weight of elver present in the sieve. In parallel, the debris from the sieve and bycatch species were also collected and analysed.

Depending on the type of sieve (linked to the fishing estuaries) the results gave a 73% to 93.3% percentage of high quality glass eels. Recognizing this potential for improvement, the fishermen with lower results actively involved in the program to improve their screens. New prototypes, based on the best results have been built and the trials are in progress.

11.15 DENMARK

11.15.1 Danish Technical University (DTU AQUA)

Sustainable development of the Nephrops fisheries in Kattegat and Skagerrak

An EU-INTERREG project with partners from IMR (Norway), SLU (Sweden), AAU (Denmark), Danish Fishermen's Association, and DTU Aqua (Denmark, lead) has been running from 2012–2014.

The project has focused on optimizing the exploitation of the Nephrops resources of Skagerrak and Kattegat in an economically and biologically sustainable way. Work has included development of length based assessment model, establishing knowledge of the genetic structure of the stock, describing the regulation of the fishery as well as the spatial and temporal distribution of the fishery. Different types of creels have been tested as an alternative to trawl and their economic viability has been analysed. Results are summed up in a synthesis which can be found on the project home page: http://www.imr.no/sjokrepsfiske/nb-no

Contact: Rikke P. Frandsen (rif@aqua.dtu.dk)

Using grids to reduce round fish bycatch in the Nephrops trawl-fisheries in Kattegat

Based on a request from the Danish government, DTU Aqua plans two sea trials in the 4th quarter of 2015. Aim of the trials is to: 1) Test handling and possible loss of legal sized Nephrops when using the Swedish steel grid. The grid will be fished parallel with a SELTRA codend and catches from the two gears will be landed separately. Furthermore, Nephrops will be measured and analysed in a catch comparison setup; and 2) Test if a Scottish netting grid is functional in Kattegat trawls and document its potential in releasing round fish. The trial is a catch comparison setup and grid is tested against a standard codend.

Contact: Rikke P. Frandsen (rif@aqua.dtu.dk)

Collecting bags used to quantify trawl disturbance of aquatic organisms

DTU Aqua has developed and tested the use of small-meshed collecting bags mounted on the wings and on the belly section of the trawls in order to document the escape of target and non-target species. Catches in the collecting bags provide information of the organisms that encounter the trawl, but are not retained by it. Combined with knowledge of behaviour and habitat utilization of these organisms, their presence can be used to indicate differences in the mechanical effect, such as penetration depth of the groundgear of different trawl designs. We expect to publish the first results from the trials over summer.

Contact: Ludvig A. Krag (lak@aqua.dtu.dk) and Rikke P. Frandsen (rif@aqua.dtu.dk)

Review on programs established to encourage industry-led approaches to selective gear development

DTU Aqua is putting together a review on programs established to encourage industry-led approaches to selective gear development (e.g. Cefas – The 'Clean Fishing' competition, DTU Aqua's MINIDISC project providing fishermen with free gear choice, WWF smart gear competition). The idea is that such collaborative projects (a bottom up approach) have a better success rate of implementing selective gears as opposed to a top down approach where selective gears are enforced into legislation and the selective performance of these gears negated. We also intend on looking into where the legislative structures in certain countries inhibit such types of programs from being undertaken.

Contact: Jordan Feekings (jpfe@aqua.dtu.dk)

The use of Hagfish traps to increase catch rates of Norway Lobster/ Exploratory survey on Hagfish biomass

DTU Aqua has planned a trial (May 2015) to determine whether the use of eel trap in combination with Nephrops creel can increase the catch rates of the target species. This is based on video observations from a previous trail, which showed that there were large numbers of Hagfish on the grounds and that when Hagfish were inside the creels Nephrops tended to refrain from entering. Furthermore, the trail aims to establish densities of hagfish and whether there is a potential for a trail fishery for Hagfish.

Contact: Jordan Feekings (jpfe@aqua.dtu.dk)

The fate of discards in the benthic environment

DTU Aqua has planned a trial (May 2015) to determine what key species are scavenging on discards. Under the new EU common fisheries policy there is a ban on discards of commercial species. This will reduce the biomass of discarded material which reaches the seabed. This trial aims to understand what species may potentially see a shortfall in their food due to the new CFP.

Contact: Jordan Feekings (jpfe@aqua.dtu.dk)

Danish seine – Ecosystem effects of fishing

Since the amount of scientific studies on Danish seining is rather low, the current study "Danish seine – Ecosystem effects of fishing" tries to cover various topics to increase the knowledge of impacts, Danish seines have on the environment and to give advices to potentially improve selectivity characteristics and efficiency of the gear. So far, a comparison to bottom trawls, based on a perennial discard dataset (1997 – 2012) started and selectivity experiments were carried out in summer 2014. Thereby, escapements of fish and invertebrates from the codend as well as from different other parts of the gear has been examined. Future trials are planned to aim at a detailed description of the whole capture process in terms of geometry and acting forces and at estimating direct impacts of the fishing gear on the seabed.

Contact: Thomas Noack (thno@aqua.dtu.dk)

Gear technical contributions to an Ecosystem Approach in the Danish set-nets fisheries

Although the fleet has reduced since the mid-1990s, Danish gill- and trammelnets are still of importance and are likely to gain increasing interest as environmentally friendly practices. However, such a development may only happen if the ecosystem approach is guaranteed. There is limited knowledge of ecosystem impacts, such as for example physical damage to habitats or discards, and their minimization may require development of alternative practices. With regard to the upcoming challenges of an Ecosystem Approach to Fisheries, the project aims at (1) studying the sweeping behaviour of nets and their effect on the seabed; (2) quantifying invertebrates and fish discards and understanding how the capture process can influence discard behaviour; (3) developing technical innovation that could improve catch quality and therefore maximize the production. Trials are conducted on gill- and trammelnets within the Danish coastal waters. This is a PhD run as part of the Skånfisk project financed by the Ministry of Food, Agriculture and Fisheries of Denmark.

Contact: Esther Savina, PhD student, esav@aqua.dtu.dk

Understanding and predicting size selectivity and escape mortality in commercial zooplankton fisheries: case study on Antarctic krill. SILF

The volume of the present fisheries on Antarctic krill is modest and considered to have a significant potential to increase. This resource is considered to be one of the least exploited fisheries worldwide. There are, however, expressed concern regarding future sustainable harvesting and what affect the fishery can inflict other animals that depend on krill. These are typically set in the context of ongoing changes in the environment, affecting production, distribution and life cycle of krill. Today many different types of fishing gear to catch krill are utilized. A pilot study (NEAT) used both mathematical modelling techniques and practical experiments on larger selection of krill in trawl, demonstrates that krill can escape even from some of the smallest commercial

meshes used in the fishery. Because of major gaps in knowledge of this marine ecosystem and potential adverse effects that may be caused by an increased fishery, both the Commission and the scientific committee of the CCAMLR (Convention on the Conservation of Antarctic Marine Living Resources) strongly requested the need for more knowledge of indirect effects of various fishing gear on krill mortality. Indirect mortality in this context includes krill that die after being in contact with the fishing gear due to injuries. In this study, we assess mortality as a result of that they've escaped trawl masks, establish selectivity properties of krill with different sizes for all types of trawl design being used in today's fishing, including trawl panels and the codend. We will produce a set of design guides that allow the evaluation and optimization of trawl design being used in the commercial krill fishery to reduce possible negative effects on the ecosystem and to streamline fishing effort. There is an urgent need to address these issues, also in consideration of the development of other new and exploratory fisheries.

The project is made in collaboration with IMR, Bergen and SINTEF, Hirtshals and is financed by the Norwegian Research Council. Contact: Ludvig A. Krag (lak@aqua.dtu.dk)

Test and development of an Excluder system in the Danish industrial fishery for Norway pout.

The project aims at testing and further developing the Excluder system for Danish trawl fisheries. The Excluder system is used on a voluntary basis in Alaska today in the flatfish fisheries and the systems design principals have a potential to improve both the sizes and species selectivity in several fisheries in EU waters. The Excluder system however needs to be modified and tailored for these fisheries. The system will initially be tested in the industrial fishery for Norway pout where there is bycatch of gadoid species and herring. With the landing obligation system, which is introduced into the EU waters by the new Common Fisheries Policy there is a great need for selective systems that can improve the fishers ability to improve both species and sizes selectivity.

The project is made in collaboration with the Pelagic Fishermen's Association, TORMO trawl and SINTEF Hirtshals. Contact: Ludvig A. Krag (lak@aqua.dtu.dk)

Optimizing the economic value of the fish catch in the Danish mixed fisheries (VærdiFisk)

This project was conducted in close collaboration with netmakers, fishers, exporters, fishermen's collecting central, the fish auction and the Danish Fishermen's association. A vertically divided codend showed prospects of increasing the income in the Danish mixed fishery by improving the quality of fish as well as increasing the size selection while retaining valuable catch compared to a standard codend. Successful separation of fish and organisms with hard and spiny outer surfaces led to significant improvements of several quality parameters of whole fish, fillets and Nephrops in several steps of the value chain. Quality improvements were observed by exporters, who affect the fish prices, and scientists. There was an indication of reduced stress in fish caught in the vertically divided codend and so there may be a potential of prolonging the shelf life of fish caught in trawls as well as improving animal welfare. The different netting in the upper and lower parts of the vertically divided codend was customized to increase the selection of small fish and Nephrops, respectively, while retaining the most valuable catch. The experimental codend had 10% higher catch rate of Nephrops compared to the standard codend. Increasing the efficiency of the fishery gives less fuel consumption per kilogram Nephrops caught, and may, if evaluated over longer periods, imply less impact on the seabed.

Contact: Junita D. Karlsen (jka@aqua.dtu.dk)

Selective and low impact gear for fishing live Nephrops

This project was conducted in collaboration with netmakers, fishers, the Danish Fishermen's association and packaging development company. The main aim was twofold; to reduce the amount of unwanted catch of roundfish, especially cod in the mixed fisheries for Nephrops, and to optimize the conditions throughout the value chain for exporting live Nephrops. Two alternate haul experiments with different sweep lengths and towing speed, respectively, did not give conclusive results due to technical challenges. Handling routines onboard a commercial trawler to ensure high survival rates and allow fast recover of Nephrops stressed during towing was investigated. A survival study showed high survival rates of Nephrops collected for the live market, but no effect of supplying seawater before and directly after sorting was observed. Body damages for dead and live individuals were mapped to see if the degree and type of damages could be related to survival.

Contact: Junita D. Karlsen (jka@aqua.dtu.dk)

11.16 ITALY

11.17 National Research Council (CNR), Institute of Marine Sciences (ISMAR) Fishing Technology Unit, Ancona

Antonello Sala, Alessandro Lucchetti, Emilio Notti, Massimo Virgili, Jacopo Pulcinella, Sara Bonanomi, Fabrizio Moro

Discatch

The aim of the project is to support the identification of viable solutions to address factors determining the catches of unwanted species and specimens in trawl fisheries with a view to reducing unwanted catches and eliminating discards. The main objectives of the present project are: 1) to provide an overall assessment of the fishing fleet discarding behaviour and to identify the main reasons for discarding in Mediterranean continental shelf demersal and small pelagic trawl fisheries; and 2) to identify measures, including technical ones related to fishing gear characteristics, to mitigate or eliminate bycatches of unwanted species and measures to eliminate discarding based on existing or new measures.

The project covers the following three non-adjacent Mediterranean subregions, as identified by the FAO Statistical Divisions, within the Western, Central and Eastern Mediterranean Basin where relevant demersal and small pelagic trawl fisheries occur.

To reach its objectives the project will include:

1) A comprehensive review and analysis of the existing information on fishery discards produced by demersal and pelagic trawl in order to identify factors determining the catches of unwanted species, to report the reasons for discarding and to present mitigation measures associated with discarding, with special focus on gear selectivity, and analyse their effectiveness.

2) A comprehensive analysis of the relevant data collected through the Commission Decision No 2010/93/EU adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector. Identification of gaps and weakness in monitoring programmes recording catches, landings and discards, focusing particularly on those implemented through the DCF. Prediction of the effects of factors related to

changes in selectivity/fishing pattern and the factors driven discards in a spatial scale.

3) Provide a prediction about expected size selectivity of a range of species for many different codend constructions (e.g. mesh size, mesh type). The method includes collecting morphometric measurements of the species, simulating selection process and estimating selectivity parameters. FISHSELECT methodology is used in this purpose.

4) Provide forecasts about the evolution of fishing mortality and related output in terms of total production, production by fleet segment or métier (landings and discards) and related fishing pattern. Provide estimation of direct and indirect impacts of the fishery to the ecosystem, for demersal and benthic species, as well as for pelagic compartment.

5) Establishment of a stakeholders' platform in order to disseminate the results obtained.

eApulie

The aim of this project is the introduction of innovations in the design of a traditional bottom trawl gear in the South Adriatic. New pelagic otter boards and modifications on the trawlnet design have been implemented and the through a vessel monitoring system (VMS) conceived at CNR the comparison of the traditional and modified fishing gears has been evaluated, both in terms of gear parameters and in terms of catches. The VMS consisted of two mass flow sensors, one multichannel recorder and one GPS data logger, trawl monitoring sensors. Three vessels have been involved The VMS system and the modifications have be applied on three bottom trawlers with different length and power, working in the Puglie Region, in Monopoli, Brindisi and Molfetta harbours. A preliminary series of sea trials has been carried out for the setup of the new otter boards. Then fishermen have been requested to use the monitoring system to further optimize their fishing technique. Results obtained showed a decreased overall gear drag with new otter boards and an increased horizontal net opening, while no sensible variations in the catch composition and quantity has been noticed. Thus the implementation should be considered as an overall improvement as the ratio between catch and fuel consumption increased.

Nevertheless, overall fisheremen remained sceptical and not enough collaborative due to a general suspicious and a poor interest to innovation, especially with respect to the monitoring system. Despite the opportunity for fishermen to learn how to use monitoring systems and to use system and that, the overall cost for the monitoring system, the fishing gear modifications and for the otter boards were totally covered by the project, fishermen decided to not use the new otter boards and the monitoring system after the project. The lesson learned through this project is the need to include in the project tasks a particular attention to the involvement of fishermen, in order to support them in the technology transfer and to compensate their leakage in methodical approach.

Benthis

BENTHIS (Benthic ecosystem fisheries Impact Study) is a five years project, aiming at integrating the role of marine benthic ecosystems in fisheries management. The European Union has funded the Benthis project to provide the urgently needed knowledge to support an integrated approach to the management of human activities in the marine environment, in particular fishing. Main objectives of the project are:

1) the assessment of different marine benthic ecosystems status;

2) the development of tools to assess effects of bottom trawling on the structure and functioning of EU benthic ecosystems;

3) development and testing, in close collaboration with fishing industries, of innovative technologies that reduce the impact of trawl fisheries on the benthic ecosystem;

4) development of sustainable management plan in order to reduce the impact of fishing and quantify its ecological and socio-economic consequences, together with the fishing industry and other stakeholders on a regional scale.

Project activities are organized in many case studies (Baltic sea, North sea, Western waters, Mediterranean sea, Black sea), in close collaboration with industry and stakeholders through regional meetings and other events.

The activities carried out for the Mediterranean case study focused on the evaluation of the performances of experimental otter boards and on the design and test of some innovative modification of the bottom trawl.

Two Italian door manufacturers, involved in the project as SMEs, developed two innovative otter boards aiming at reducing the physical seabed impact, using as a reference the Thyborøn VF15 pelagic otter board. A complete cycle of tests has been deployed; including facilities tests in wind tunnel and flume tank and sea trial onboard the RV and a commercial bottom trawler.

Some relevant modifications on the design of a typical bottom trawlnet will be carried out on June 2015. One of the nets of a twin trawl fishing gear will be modified in the upper part, in order to compare net openings and catch for each haul carried out. Catch comparison and selectivity analysis will allow for a complete evaluation of the efficiency of such modifications. Furthermore, the implementation will be evaluated from the energy efficiency perspective.

More info at: www.benthis.eu

BYCATCH VI

The project is an extension of previous monitoring programmes (BYCATCH I, II, III, IV and V) of accidental catches of cetaceans by Italian pelagic pair trawling. The programme was funded by the Italian Ministry of Agriculture, Food and Forestry, in compliance with Regulation (EC) No. 812/2004. Under this regulation, 'Member states shall design and implement monitoring schemes for accidental catches of cetaceans […]'. The programme also include monitoring of other species of conservation concern such as sea turtles and elasmobranchs which are considered relatively vulnerable species to commercial fishing. Several observations on board pelagic pairtrawlers have been carried out to record cetacean's interactions with trawling, bycatch events and all fishing operations including towing, hauling and discard. In order to reduce bycatch events, CNR-ISMAR of Ancona led sea trials to test mitigation measures such as TED (Turtle Excluder Device) and acoustic pingers. From preliminary analysis, grids exhibited a good escape cover performance while acoustic deterrents showed a poor efficiency in chasing away dolphins during fishing operations. Further investigations are required in order to optimize TED performance and to understand cetacean behaviour against pinger.

The project aims at evaluating the bycatch of protected species in pelagic trawl. The second goal of the project was to find solutions to avoid the bycatch of protected species. Pelagic trawlers in the Adriatic Sea only target small pelagic species (Anchovy

and Sardine). CNR-ISMAR carried out several observation onboard finalized at monitoring the catch and the eventual bycatch. In order to reduce the bycatch in pelagic trawl a modified TED (Turtle Excluder Device) was developed and adapted to a single boat pelagic trawl. The preliminary results are encouraging. Next step will be to test the TED in a pair trawl, which is the main activity in the Adriatic Sea.

Tartalife+

TartaLife project aims at reducing sea turtle mortality by reducing bycatch caused by pelagic longline, bottom trawl and fixed nets, disseminating circle hooks and TEDs (Turtle Excluder Devices) and testing STARs (Sea Turtle Acoustic Deterrent) and a new type of pot. The second goal is to reduce post-capture mortality, by training fishermen and strengthening the Marine turtles First Aid/Rescue Centres. The project is financed with the contribution of the LIFE+ 2012 financial instrument of the European Community and co-financed by the Italian Ministry of agricultural, food and forestry policies and Marche Region. In line with the UNEP RAC/SPA's MAP (2001) and the National Action Plan on Marine Turtles which the Italian Ministry of Environment is currently drafting, the project TARTALIFE+, involving all 15 Italian regions overlooking the Mediterranean Sea, aims at reducing the mortality of *Caretta caretta* and thus contributing to the conservation of the species in the Mediterranean, via 2 specific objectives:

- reducing bycatches caused by pelagic longline, bottom trawl and fixed nets disseminating circle hooks and TEDs and testing STARs and a new type of pot
- reducing post-capture mortality, training fishermen and strengthening the Marine turtles First Aid/Rescue Centres

The project is organized in different actions:

1) dissemination of circular hooks in pelagic longline fishing;

2) update and dissemination of TEDs Turtles Excluder Devices in bottom trawl fishing;

3) testing of new acoustic deterrent for marine turtles STAR Sea Turtles Acoustic Repellent and of a new type of pot;

4) training of fishermen on how to rescue and deliver first aid to accidentally caught turtles;

5) strengthening Marine Turtles Rescue Centres (equipment and re-training of staff), setting up a Centre in Lampedusa and first aid points on Emilia Romagna and Marche coasts;

6) setting up information desk and technical assistance contact point to support fishermen in requesting funds for the replacement of traditional fishing gears with low-impact ones;

7) monitoring of conservation actions, including socio-economic impact of the project;

8) Communication and dissemination actions, such as: info days for fishermen, website, raising awareness campaign for tourists, local populations and schools, information material, layman's report, etc.;

9) project management and monitoring and networking activities.

More info at www.tartalife.eu

EfficientShip

The EfficientShip project will demonstrate the efficiency of an innovative ORC technology for reducing the GHG emissions of thermal engines.

The project challenges are:

1) To adapt an innovative heat recovery technology (ORC) to mobile thermal engines, allowing the reduction of between 5 to 10% of the GHG emissions.

2) To raise awareness of the European fishing sector on the importance of the reduction of the vessels GHG emissions in a context of global warming and to offer them some simulation on the adaptation of the EfficientShip innovation on their vessels.

An Irish vivier crabber has been selected for the implementation of the ORC system. The electrical energy produced for water pumps will be supplied by the ORC system in order to reduce the load of auxiliary engines. The reduction on engine load will determine a reduction in fuel consumption and in GHG emissions. The ORC system will recover the heat by the exhaust gas pipe of the main engine and the remaining heat will be discharged by the heat exchangers of the vessel.

The sea trials have been scheduled for the period January-March2016. The evaluation of the effects of the implementation will be assessed through a fuel consumption monitoring system which will be independent by operators and data collected will be forwarded to an ftp server.

More info at: www.efficientship.eu

Demersal fisheries discard in Italian waters: preliminary assessments for the implementation of Community provisions concerning the landing obligation (EU Regulation 1380/2013, Art. 15

In the light of the future entry into force of the provisions on the landing obligation for demersal species, it is necessary to develop a concise and comprehensive characterization on the problem of discards, in order to have relevant information useful for the implementation of the provisions of the new regulation. This project shows a number of innovative features, which are not limited to simple critical review of existing data. In particular, we will be evaluating:

1) the estimated discard rate due to specimens below the minimum landing size;

2) the selectivity of fishing gear for the capture of demersal species and simulations of possible scenarios induced by the increase of the mesh size of bottom trawls

3) logistical issues related to the management of discard on board and at landing sites

4) the identification of potential new lines of market for the commercialization of species obliged to land.

5) the potential impact, in terms of bioeconomic development, of the application of EU Reg. 1380/2013, art. 14/15, through simulation of specific scenarios.

12 Other Business

12.1 Date and Venue for 2016 WGFTFB Meeting

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour will meet in Merida, Mexico during the 25–29 April 2016. The meeting will be lead and sponsored by FAO. It is proposed that the meeting will include a three-day symposium-style presentation and two days for Topic Groups' work dealing with existing Terms of References (below) and regular FTFB business. The three-day symposium will cover topics of interest to the group and the region (South and Latin America), including stationary gears and alternative capture technologies, facilitating technological change in capture fisheries, energy and greenhouse gas (GHG) reduction, bycatch and reducing discards (incl. protecting sensitive species, sustaining ecosystem, reducing food loss, and assessing discard survival), and new and novel developments in fishing and monitoring equipment.

12.2 Topic Groups for 2016 WGFTFB Meeting

The topic groups on 'Technological Innovation in Spreading Trawls'; 'non-extractive fisheries sampling'; 'change management in fisheries'; and 'contact probability of selective devices' will meet at the WGFTFB in 2016.

12.2.1 Ongoing Topic Group: Technological Innovation in Spreading Trawls

A WGFTFB topic group of experts, convened by Paul Winger (Canada), Bob van Marlen (Netherlands), Antonello Sala (Italy), will be formed in 2014 to document and evaluate recent technological advancements in spreading technology for mobile trawls. The terms of reference will include:

1) Describe and summarize new and innovative technological advancements under development (or recently developed) for spreading mobile trawls.

2) Review technical challenges and obstacles for uptake by industry.

3) Identify new applications for these technologies and opportunities for technology transfer.

Justification:

Mobile bottom trawls are known to produce ecological impacts in many fisheries (He and Winger, 2010; Lucchetti and Sala, 2012). The devices used to spread these trawls (typically doors) contribute heavily to fuel consumption and seabed impacts. In response to these concerns, several countries have initiated research projects in recent years toward the development of creative and innovative approaches to spreading mobile trawls. Moving beyond basic doors and beams, new research efforts are now breaking ground toward off-bottom doors, manoeuvrable or steerable doors, kites, and hydrodynamic beam concepts. A synthesis of these technological advancements will provide up-to-date information, stimulating innovation and opportunities for technology transfer.

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12.2.2 Ongoing Topic Group: Non-extractive fisheries sampling

A WGFTFB topic group of experts, convened by Shale Rosen, Institute of Marine Research, Norway (shale.rosen@imr.no) and Haraldur Einarsson, Marine Research Institute, Iceland (haraldur@hafro.is) will be formed in 2015 to evaluate current methods and recent technological advances applicable to sampling without physically removing organisms from the sea. The topic group will have the following terms of reference

1) Summarize current needs for non-extractive sampling (e.g.. regulatory restrictions, sampling threatened or endangered species, sampling in sensitive or protected habitats)

2) Inventory currently available equipment and techniques

3) Identify current gaps between available technology and sampling needs

Justification:

Fisheries are one of the few disciplines in biology where data collection continues to rely on the removal and destruction of the organisms being studied. This practice has come under increasing scrutiny in recent years. Research projects have been terminated due to denied permits; researchers have had difficulty publishing results due to animal welfare concerns and in some instances, research budgets have had to absorb the cost of purchasing quota for the fish captured. Research focused on fishing gear design and selectivity, a major focus of the members of the Working Group on Fishing Technology and Fish Behaviour, is particularly vulnerable to such restrictions due to the need to conduct tests with commercial-scale catches.

Fisheries Acoustics is a mature solution, but is addressed by the Working Group on Fisheries Acoustics Science and Technology and will therefore not be taken up by this topic group. Techniques for collecting and analysing underwater images have advanced significantly in recent years, and may fill many sampling needs. In habitats that are difficult to sample or for fragile species, no-catch techniques may also provide better information than traditional methods that rely on catching the organisms of interest and bringing them to the surface. New observation techniques to quantify all fish entering a fishing gear could revolutionize selectivity studies by eliminating the need for control sampling gear, codend covers, or trouser trawl configurations (released fish could be calculated as the difference between the number of individuals entering the gear and the number retained after the selectivity device).

A thorough review of the problems, existing solutions, and technological gaps will assist FTFB members in both their own research and in the role, they often play advising other fishery biologists in designing and carrying out surveys.

It is proposed that the topic group runs for two years. Year 1 will focus on a review of both peer-reviewed and grey literature on current needs for non-extractive sampling and techniques/systems that are currently available or under development. Year 2 will focus on synthesizing the results into a review paper with recommendations for how to implement non-extractive sampling techniques as a part of standard fisheries research.

12.2.3 Ongoing Topic Group: Change Management in Fisheries

A WGFTFB topic group convened by Steve Eayrs and Michael Pol aims to evaluate the application of change management concepts and models in a fisheries context and recommend new approaches to facilitate change in the fishing industry. The terms of reference will include:

1) Evaluate the applicability of change management concepts and models in a fisheries context

2) Review and evaluate fisheries case studies and initiatives to bring about change, including Knowledge networks, Environmental Management Systems, Fisheries Improvement Projects, and others

3) Explore models of human behaviour that may contribute to resistance to change

4) Identify and categorize circumstances and approaches that led to both the successful and unsuccessful introduction of change initiatives in fisheries.

Justification:

Despite a plethora of efforts by fishing technologist, conservation engineers, and others to reduce the environmental impacts of fishing and increase fishing efficiency and profitability, commercial fishers are generally highly resistant to changing their fishing gear and practice. In the business world, responses to change are increasingly being guided by change management concepts and models; however, their application to the fishing industry has been scant, piecemeal, and incomplete. These concepts and models provide greater understanding of resistance to change and could potentially provide an insight into new approaches to facilitate change in the fishing industry. By reviewing knowledge of these concepts and models, and past efforts to facilitate change in fisheries including holistic approaches such as Knowledge Networks, Environmental Management Systems, and Fishery Improvement Projects, we hope to identify circumstances, models, techniques, and approaches that will result in smoother, more cost-effective change initiatives in the fishing industry in future.

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12.2.4 Ongoing Topic Group: Contact Probability of Selective Devices

A WGFTFB topic group of experts convened by Daniel Stepputtis and Bent Herrmann will be formed in 2015 to investigate, understand and improve the contact probability of specific selective devices (e.g. grids, netting). It will **document and evaluate** current and past work regarding the influence and improvement of contact probability. This will include studies from a wide range of scientific fields, such as selectivity, behaviour, hydrodynamics and gear design. Special attention will be given to investigating how to improve the performance of gears and selective devices with suboptimal selective properties.

The terms of reference will include:

1) Summarize current and past work in relation to contact probability

2) Discuss and describe methods (experimental and statistical) to investigate and quantify contact probability

3) Investigate and make recommendations on how to improve contact probability in selective devices, including:
   a) Identification of gears and selective devices with suboptimal contact probability (preferably based on current gear trials from group members)
   b) Discussion on potential causes and solutions
   c) Recommendations on experimental/theoretical work to understand and improve the contact probability

Justification:

Over the past decades, numerous selective devices have been developed and tested. Many of them did not fulfil expectations and even those that are now being used can probably be improved.

A key factor influencing the effectiveness of selectivity devices is the probability of a given specimen to contact the specific selection device. Nevertheless, this factor is often not sufficiently considered when developing selective devices. Additionally, few selectivity studies have quantified the contact probability of these devices although it underpins how they perform and how they can be improved.

This Topic Group will be highly relevant to the further development of sustainable fisheries, especially in the light of discard ban, single and multispecies selectivity and potentially also for balanced harvesting - in a wider sense.

Annex 1: List of participants

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Annex 2: Agenda

Monday 4 May 2015		
Main Auditorium		
8:00		Registration
9:00	Chair	Opening/Welcome
	Aida Campos	Introduction/Welcome
		Welcome remark by Dr Antonina dos Santos, Director, Department of Sea and Marine Resources, IPMA Algés
9:20	Petri Suuronen	Recent FAO activities related to the work of FTFB (P. Suuronen)
9:50	Shale Rosen	Introduction to Topic Group Non-extractive fisheries sampling (S. Rosen, H. Einarsson)
10:10	Steve Eayrs	Attitudes and approaches of FTFB Working Group members to change in the fishing industry (S. Eayrs, M. Pol)
10:30	Coffee break	
11:00	Bent Herrmann	How many fish need to be measured in trawl selectivity studies? (B. Herrmann, M. Sistiaga, J. Santos, A. Sala)
11:20	Daniel Stepputtis	The myth of improved selectivity (D. Stepputtis, U. Krumme)
11:40	Tadashi Tokai	Size selectivity of selective devices unveiled by contact probability: separator panels (grid and window) of trawl and tooth space of dredge (T. Tokai)
12:00	Ludvig Krag	Escape panels in trawls – a consistent management tool? (L. A. Krag, B. Herrmann, J. Feekings, J. D. Karlsen)
12:20		Discussion
12:30	Lunch break	

13:30	John Wily Valdemarsen	Manoeuvrable pelagic trawl doors (J.W. Valdemarsen, T. Nedrebø, A. Sæstad, J. T. Øvredal, T. Bærhaugen)
13:50	Roger Larsen	New approaches to bycatch reduction in bottom trawling for shrimps *Pandalus borealis* (R. B. Larsen, I. Tatone)
14:10	Gokhan Gokce	Can the rectangular mesh codends solve multi-species fishery selectivity problems? (G. Gokce, B. Herrmann, H. Ozbilgin, I. Saygu, E. Kalecik, O. Demir, A. Tokaç, L. Krag)
14:30	Adnan Tokac	Understanding and predicting size selection of European hake (*Merluccius merluccius*) for bottom trawl codends: a simulation-based approach (A. Tokaç, B. Herrmann, A. Ünlüler, D. S. Nezhad)
14:50		Discussion
15:00	Coffee break	
15:30	Bernd Mieske	Development of concepts for reduction of flatfish catches in roundfish fisheries (B. Mieske, J. Santos, D. Stepputtis, B. Herrmann)
15:50	Heui-Chun An	Environmentally friendly fishing gear with bio resin to reduce ghost fishing and bycatch of non target species (S. Kim, H-C. An, S-W. Park, K. Lee)
16:10	Agustín Fernández	Fishing effort control for Mediterranean trawlers based on quotas of area and volume of filtered water (A.M. Fernández, I.J.M. Soler, A.V.M. Sanz, V.C. Romero)
16:30	Thomas Noack	Danish seine – Ecosystem effects of fishing (T. Noack, R. Frandsen, L. Krag, N. Madsen)
16:50	Rikke Frandsen	Catchability of *Nephrops* (*Nephrops norvegicus*) in creels. A study on the effect of orientation of the creel. R. P. Frandsen, J. P. Feekings, C. M. Albertsen)
17:10		Discussion
17:20		END

Tuesday 5 May 2015		
Main Auditorium		
8:30	Chair/organizer	Introduction, logistics, announcement
8:40	Luis Arregi	Questioning the effectiveness of implemented technical measures under the EU landings obligation: the Basque Otter Bottom Trawl fishery case study (N. Alzorriz, L. Arregi, B. Herrmann, M. Sistiaga, J. Poos)
9:00	B. Van Marlen	Recent discard survival experiments related to the EU discard ban - Technology and first findings (P. Molenaar, B. van Marlen)
9:20	Daragh Browne	Discard reduction in the Irish quad-rig *Nephrops* trawl fishery (D. Browne, R. Cosgrove, D. McDonald, P. Tyndall)
9:40	Yoshiki Matsushita	Change in the catch composition in a fishing community of northern Japan over last two decades – capture fishery needs to be adaptive to change in local ecosystem? (Y. Matsushita, N. Sakaki, K. Suga, T. Higashide, S. Taniyama, K. Shimizu, K. Kameda, K. Tachibana)
10:00	Roger Larsen	Improving the catch efficiency for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) during bottom trawling in the Barents Sea (R. B. Larsen, J. M. Brinkhof, B. Herrmann)
10:20		Discussion
10:30	Coffee break	
11:00	Soetaert Maarten	Possible applications of electrical pulses for a more selective fishery (S. Maarten, B. Verschueren)
11:20	Song Liming	The Dynamic Simulation of the Pelagic Longline Retrieving (L. Song, Z. Shen, J. Li, X. Zhang)
11:40	Steve Eayrs	A pilot project to audit commercial shrimp trawlers in Thailand (S. Eayrs, W. Wanchana, P. Suuronen)
12:00	Agustín Fernández	Improving energy efficiency in new trawlers fishing gear in Mediterranean sea (A. M. Fernández, I. J. M. Soler, A. V. M. Sanz, V. C. Romero)

12:20	Junita Karlsen	Fishing for food: simple changes in codend design improves the quality of fish products (J. D. Karlsen, L. A. Krag, C. M. Albertsen, R. P. Frandsen)
12:40	Shale Rosen	Trials of ruffled small-meshed inner nets to reduce loss and clogging of small organisms in a pelagic survey trawl (S. Rosen, A. Engås, E. Eriksen, A. Pavlenkov, T. Prokhorova, J. T. Øvredal, A. Aasen)
13:00	Lunch break	
14:00		Field trip to Peniche – Auction House

Wednesday 6 May 2015		
Room (to be determined)		
8:30	Chair/organizer	Announcement/Logistics
8:40	TG chairs	Topic Group meeting
10:30		Coffee break
10:50	TG chairs	Topic Group meeting
12:30		Lunch break
13:30	TG chairs	Topic Group meeting
15:00		Coffee break
15:20	TG chairs	Topic Group meeting
17:00		END
Evening		Working group meeting dinner

Thursday 7 May 2015		
Main Auditorium		
9:00	Chair/organizer	Announcement/Logistics
9:10	Barry O'Neill	Country report summary
9:30	Eduardo Grimaldo	Summary of completed ToR on Catch control

9:50	TG chairs	Topic group summary (about 20 min each TG)
10:30		Coffee break
10:50	TG chairs	Topic group summary (continued)
11:30	Mike Pol	The fate of SELDAT database
11:40	Chair	Other related reports
12:30		Lunch
13:30	Chair	FTFB findings and recommendations
	Chair	Meeting place and time for 2016
	Daniel Aguilar-Ramirez	Fisheries of Mexico: Status, perspectives and challenges (D. Aguilar-Ramirez, S. Lizarraga-Saucedo, J. De La Cruz-Gonzalez)
	Chair	New topic groups for 2016
	Chair	ICES symposium and conference theme session proposals
	Heui-Chun An	Announcement and invitation for the 7th World Fisheries Congress, 2016, Pusan
	Chair	Other relevant discussions and information
16:00		END

Ongoing Topic Group:

- Technological Innovation in Spreading Trawls (**SpreadTrawl**). **Conveners:** Paul Winger (Canada), Bob van Marlen (Netherlands) and Antonello Sala (Italy)

New Topic Groups:

- Non-extractive fisheries sampling **(Non-Extractive Sampling).** **Conveners:** Shale Rosen (Norway) and Haraldur Einarsson (Iceland).
- Change Management in Fisheries (**Change Mangement**). **Convener:** Steve Eayrs (USA) and Michael Pol (USA).
- Contact Probability of Selective Devices **(Contact Probaility).** **Conveners**: Daniel Stepputtis (Germany) and Bent Herrmann (Denmark).

Annex 3: WGFTFB multi-annual terms of reference

The **ICES-FAO Working Group on Fishing Technology and Fish Behaviour** (WGFTFB), chaired by Pingguo He, USA, and Petri Suuronen, FAO, will meet to work on ToRs and generate deliverables as listed in the table below between 2015 and 2017. WGFTFB will report on the activities by 25 June each year to SSGESST.

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Present recent investigations into and synthesize current knowledge of topics related to: "Design, planning, and testing of fishing gears used in abundance estimation"; "Selective fishing gears for bycatch and discard reductions"; "Environmentally benign fishing gears and methods" and summary of research activities by nation	Through open sessions and focused, multiyear topic groups, the Working Group provides opportunities for collaboratively developing research proposals, producing reports and manuscripts, and creating techncial manuals on current developments and innovations.	21, 34, primarily; others are possible (e.g. 11,133, 223, 33, *et al.*)	3 Years	ICES report;
b	Organize an FAO hosted FAO-ICES mini-symposium with thematic issues as described in the Barange-Matthiesen exchange of letters	Under mutual agreement between ICES and FAO, FAO develops and leads a mini-symposium of relevant topics, while also continuing ICES commitments	21, 34	Year 3	FAO report, ICES report
c	Present recent investigations into topics of mutual interest between WGFTFB and WGFAST	Every third year, WGFAST and WGFTFB meet for one day to share information on topics of mutual interest (JFATB)	16, 21	Year 1	JFATB report
d	Every second year, describe changes in EU fishing fleets and effort relevant to assessment working groups	WGFTFB has produced this advice for several years and been encouraged to continue by Assessment WGs		Years 1, 3	Reports to individual EGs
e.	Organize an ICES-sponsored international fishing technology Symposium	Organize the Third ICES Symposium of Fish Behaviour		Fall 2017 (outside scope of this Multiannual ToR)	Symposium and special issue in ICES Journal of Marine Science

e	Develop survey and gear expertise support for survey working groups via ASC and survey group meetings	SSGESST has identified gear expertise gaps in survey working groups.	Year 1,2	Identify WGFTFB members who can fulfill advisory roles ; Review survey protocols.

Summary of the Work Plan

Year 1	Produce the annual report; hold joint session with WGFAST; inform assessment EGs on fleet effort changes; connect to survey WGs
Year 2	Produce annual report; Continue development of relationships with survey EGs
Year 3	Produce the annual report; inform assessment EGs on fleet effort changes; organize FAO mini-symposium

Supporting information

Priority	The activities of WGFTFB will provide ICES with knowledge and expertise on issues related to the ecosystem effects of fisheries, especially the evaluation and reduction of the impact of fishing on marine resources and ecosystems and the sustainable use of ecosystems and other topics related to the performance of fishing gears and survey gears.
Resource requirements	The research programmes, which provide the main input to this group, are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 40–45 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Linkages to advisory groups via reports on changes to fleets and fleet effort
Linkages to other committees or groups	There is a very close working relationship with all the groups of SSGIEOM, WGFAST, and the survey groups.
Linkages to other organizations	The WG is jointly sponsored with the FAO.

Annexe 4 to the WGFTFB report is available for download as separate document