# ICES-FAO WGFTFB 2024

## Book of Abstracts

In this section, the abstracts are listed in the order presented during the meeting (plenary presentations), followed by those included in the Focus Session, and those presented as posters. The abstracts of presentations given during the Topic Groups will be provided in the annual report. The presenting author is indicated with an asterisk (*).

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# 1. Presentations in Plenum (1-50)

## 1.1. Benthic Interactions

### (1) Enhancing our understanding of global variability in industrial fisheries footprints; a synthesis of mobile, bottom-contacting fishing gears

Mollie Rickwood[1], Christopher Kerry[1], Ole Eigaard[2], Ciaran McLaverty[1,2], Antonello Sala[3], Ruth Thurstan[1] & Kristian Metcalfe[1]

*[1] Centre for Ecology & Conservation, Faculty of Environment, Science and Economy, University of Exeter, Penryn, Cornwall, UK*

*[2] DTU Aqua, National Institute of Aquatic Resources, Technical University of Denmark, Kemitorvet, 2800, Kgs. Lyngby, Denmark*

*[3] Consiglio Nazionale delle Ricerche (CNR), Istituto di Scienze Marine (ISMAR), Sede di Ancona, (National Research Council (CNR), Institute of Marine Sciences (ISMAR), Section of Ancona), Largo Fiera della Pesca, 60125 Ancona, Italy*

The Convex Seascape Survey is a five year project which aims to better understand interactions between carbon and the seascape. To achieve this, a greater understanding of the influence of human activities on redistributing oceanic carbon is required. One of the greatest sources of carbon release within marine environments is thought to come from sediment disturbance as a result of bottom contacting fishing gears. However, currently global assessments rely on the extrapolation of vessel size â€“ gear relationships from the European fleet. In this talk, we will present findings from an extensive literature review that demonstrates how bottom-contacting gear sizes in the European fleet differ from other regions which may be leading to an overestimation of carbon release. We will call on the working group to help populate a survey that aims to collect more regionally representative gear size information in order to improve the accuracy of estimates.

### (2) Sediment penetration by bottom contacting fishing gear components

Finbarr G. O'Neill[1], Morteza Eighani[1] & Esther Savina[1]

*[1] DTU Aqua, Hirtshals, Denmark*

The penetration of towed fishing gears into the seabed is directly related to their contact drag and fuel consumption, habitat alteration and to the depletion of benthic fauna. Here, we investigate the penetration of bottom contact gear components into soft sediment substrates by using a benthic sledge to tow cylindrical components over the seabed. We take high resolution measurements of the penetration depth of the

components while the impact is taking place, with a stereo camera system that has sub-millimeter accuracy. We develop an empirical model which relates the penetration of these components to their weight, towing speed and to the type of sediment on which they are towed, and demonstrate that penetration is greater both on softer sediments and with increased weight, and decreases with faster towing speeds. We emphasize the need to extend these studies to all bottom contact components. The resulting models would lead to better assessments of the impact of towed demersal fishing gears. Specifically, they would provide more accurate estimates of the Relative Benthic State of a fishery, which is an indicator that is central to the fisheries impact assessment methodology being developed by ICES WGFBIT. They would also help identify mitigation measures and contribute to the design of low impacting, fuel efficient gears of reduced drag.

### (3) The snagging of towed demersal fishing gears on boulders

Nurul Huda[1], Ole Eigaard[1] & Barry O'Neill[1]

[1] *National Institute of Aquatic Resources (DTU AQUA), Technical University of Denmark, North Sea Science Park, 9850, Hirtshals, Denmark*

The interaction of towed demersal fishing gears and seabed features and obstructions can have economic, safety, ecological and environmental consequences. The loss or damage of a snagged gear can result in missed fishing opportunities, and the financial cost of having to replace or repair the gear. Snagging gears on seabed obstructions can also have serious safety implications, and there have been incidences where vessels have sunk, and lives lost following a snagging event. Further, there are ecological and environmental concerns, and Abandoned, Lost or Discarded Fishing Gear (ALDFG) can continue to fish, and will degrade with time to produce microplastics. The physical interaction between fishing gears and seabed structures may damage, displace or remove underwater features which can lead to habitat destruction, benthic mortality and the degradation of seabed integrity.

In this study we investigate the interaction of towed fishing gears and seabed features. We carry out a flume tank study, using small scale models of an otter trawl, seine net ropes, and tickler chain and chain mat beam trawls and idealized boulders of different size and shape. Our aim is to (i) identify which gears are more likely to snag on boulders, (ii) evaluate at which part of a given gear snagging is more likely to occur, and (iii) determine if there are any characteristic features of a boulder that increases the likelihood of snagging. Our results indicate that it is the tickler chain beam trawl that is the most likely to snag or come fast and suggest that it is gear strength and vessel power that are the determining factors informing decisions on where fishing takes place rather than the likelihood of snagging.

## (4) Impact of the mooring systems on seabed

Chiyo Takahashi[1], Saranya Raju[1], Yutaka Maruyama[1], Satoshi Masumi[1], Jun Uchida[1], Makoto Kabeyama[1], Alifro Maldini[1], Gregory N. Nishihara[1], Miyuki Hirose[1] & Yoshiki Matsushita[1]

[1] *Nagasaki University*

The objective of this study is to investigate the impact of mooring systems on the seabed. Two studies were conducted in waters in Nagasaki, western Japan. The first was to estimate the scoured area near the anchor rope of a fisheries training vessel (gross tonnage: 155 tons, total length: 42.79 m). The depths at seven points on the anchor rope were recorded by depths gauges during mooring at the recordings were conducted at seven locations from July to November 2021. The position of the vessel, current speed, current direction, wind speed and wind direction during mooring were recorded with instruments onboard the vessel. The position at which the anchor rope touched bottom was estimated from depth gauge data and was used to estimate the scoured area (i.e., the area of seafloor swept by the anchor rope). The scoured area had a maximum value of 11,031.9 mÂ$^2$ and a minimum of 0 m2. A GLM was used to analyze the data and we inferred that scoured area was related to wind speed.

The second study was done in an eelgrass (*Zostera marina*) beds from July to November 2023. We deployed a mooring system consisting of an anchor, chain, rope, and buoy in an eelgrass bed (study area) and compared changes to eelgrass coverage and surrounding biota among the deployment area an area where no mooring equipment were placed (control area). Coverage of eelgrass decreased from the margins of the eelgrass beds in both areas. In addition, eelgrass coverage declined in the interior of the eelgrass bed of the study area, suggesting that the mooring system causes a negative impact. No clear relationship was found between the decrease in eelgrass coverage and changes in the surrounding biota for this short-term observation (less than a year) and longer observations are necessary in any future study.

## 1.2. Energy Use

### (5) Assessment of artificial light on the headline towards improving energy efficiency in the Celtic Sea trawl fishery for demersal fish species

Martin Oliver[1], Matthew McHugh[1], Daragh Browne[1], Shane Murphy[2], Cóilín Minto[2] & Ronán Cosgrove[1]

[1] *Bord Iascaigh Mhara, New Docks, Galway, Ireland*

[2] *Atlantic Technological University, Dublin Road, Galway, Ireland*

We assessed the use of artificial lights on the headline of a mixed demersal trawl targeting haddock and hake in the Celtic Sea. BIM previously assessed lights on raised-fishing line (RFL) trawl gear. Results showed a significant reduction in low-quota cod but also some reductions in targeted haddock, hake and whiting with fish likely moving away and dipping under lights mounted on the fishing line to escape. Potential negative effects on commercial viability made it difficult to recommend use of lights on the RFL at that time but the study did raise some interesting questions around potential energy efficiency applications. This trial aimed to take advantage of this negative phototaxis to try and improve catch rates of target species and operational efficiency.

The trial was conducted on board a 23.4 m trawler targeting mixed demersal fish species in the Irish sector of ICES Division 7j in the Celtic Sea in March 2023. The vessel fished a single rig otter trawl with 18 mm leaded footrope attached to the fishing line. The vessel deployed a 100 mm diamond (T0) mesh codend and 160 mm square mesh panel. Alternate hauls were conducted with lights on and lights off. 14 Lindgren-Pitman® green (LPG) light emitting diodes were attached to the headline of the trawl with ~ 150 cm spacing between each light.

Trial results were positive. Haddock was the dominant species corresponding to 90% by weight of all commercial species landed with 60% of haddock catches occurring at night-time. Observed haddock catches were 51% greater with lights on the headline during night and 9% lower with lights on the headline during daytime. Size dependency, variable diurnal effects and economics of the effects of lights on haddock are discussed.

### (6) Development of an innovative and light-weight chain mat for the Belgian beam trawl fishing fleet

Van Opstal Mattias[1] & Van Vlasselaer Jasper [1]

[1] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences - Fisheries, Ankerstraat 1, 8400 Oostende, Belgium*

Impacts of chain mats on the marine environment form a major challenge in Belgian beam trawl fisheries. In this project, a new chain mat design was developed that aimed to reduce the ecological impact of the fishing gear by reducing fuel consumption, limiting bottom impact, improving catch composition and improving survival. We developed a low tech and low cost design to guarantee maximum accessibility for the sector.

Traditional chain mats in beam trawl fisheries serve a dual purpose of preventing debris from entering the codend and startle flatfish from the seabed. We replaced the conventional chain mat with a lighter variant solely dedicated to the prevention of debris entering the net, while introducing "tickers" ahead of the bobbin rope to startle flatfish from the seabed. Through fishing trials conducted on board of RV Belgica, we evaluated the performance of the innovative gear compared to traditional chain mat gear. Results indicated similar catch rates between the two gear types, but significant reductions in the catch of small sole (<26 cm) and small dogfish (<45 cm) were observed when using the innovative gear. Short-term (72 h) survival assessment of plaice showed no difference between the two gear types. Despite the current design leaving room for improvement, it already proves an accessible innovation for fishers operating in areas with limited sole quota. This study underlines the potential of low-tech innovations in mitigating the ecological footprint of beam trawl fisheries.

### (7) Using pair seining to reduce fuel in a demersal fishery

Matthew McHugh[1]*, Martin Oliver[1], Daragh Browne[1], Rory Campbell[1], Ronan Cooney[2] & Ronan Cosgrove[1]

[1] *BIM, New Docks Galway, Ireland.*

[2] *BIM, Limerick, Ireland*

Irish fly shooters (seiners) typically operate individually with one net. Following on from a recent pair bottom trawling trial, BIM completed a trial on pair seining with the primary aim of assessing catches and energy efficiency. Two similar vessels were chartered to tow a single seine net using 660 m (60 mm Ø) combination wire rope near the net and 259 m (32 mm Ø) wire before a (1,000kg) clump weight and Dyneema warp. For a solo vessel comparison, the vessels involved supplied data on catches and operational information from subsequent trips. Operationally there was a greater (68%) swept area—7.6 versus 4.5 km2. While catches were similar between solo and pair operations, it was possible to fish effectively at night for the pair operation, whereas nighttime fishing is not commercially viable for solo operations. Fuel consumption and carbon emissions (kg CO2 eq/hr) were estimated to be 25% lower for each of the pair seiners compared to solo operation. Additionally, engine load was lower by up to 33% while pair seining. The results suggest that pair seining is a viable option for Irish seine-net fleet and with potential for improved profitability and energy efficiency once nighttime fishing is fully evaluated.

## (8) Two birds with one stone: simultaneous improvements of fuel efficiency and catch performance in demersal trawling

Ludvig A. Krag[1], Valentina Melli[1], Finnbar G. O'Neill[1]& Junita D. Karlsen[1]

[1] *Technical University of Denmark, DTU Aqua*

In demersal trawl fisheries, advancements in gear technology have enhanced size or species selectivity. The integration of these developments into the technical legislation remains limited, with minimal uptake within the industry. Moreover, demersal fisheries are challenged by simultaneously evolving challenges, needing not only to reduce unintended bycatch but also preserve habitat and improve fuel efficiency. Consequently, there is a pressing need for fishing gear innovations that offer more comprehensive solutions.

This study addresses a suite of these challenges by aiming to i) minimize catches of unwanted bycatch and ii) simultaneously reduce drag during gear towing, thereby decreasing fuel consumption and associated $CO_2$ emissions, while iii) avoiding conflicts with existing technical regulations. Moreover, the study endeavors to iv) devise a straightforward design alteration that allows for easy conversion and reversion of existing demersal *Nephrops (Nephrops norvegicus)*-directed trawls.

Our findings demonstrate, in a catch comparison set-up, that constructing the top panel of a *Nephrops*-directed trawl with very large mesh significantly reduces the bycatch of roundfish without compromising the yield of *Nephrops*. Concurrently, the drag was diminished by 10% during gear towing. This research underscores the potential for simple, yet effective, gear modifications to mitigate environmental impacts and enhance sustainability in fisheries operations. The developed gear design does not conflict with the technical legislation and the first fishing vessels have on a voluntary basis been using the design in seasons and areas with high catches of unwanted roundfish.

## 1.3. Selectivity

### (9) INSER R Package: INdicators of SElectivity in Routine

Marie Morfin[1] & Sonia Méhault[1]

[1] *IFREMER, Fishing Gear Technology and Biology, 8 rue François Toullec, 56100 Lorient, France*

Reducing fishing discards is a major concern for fisheries resource managers. Modifying gear by increasing mesh sizes or inserting selective devices is one of the means used by fishermen to reduce catches of undersized individuals or unwanted species. Experiments are regularly carried out on board commercial vessels to quantify the effectiveness of the devices tested. This involves observing catches by collecting a series of indicators such as the size, number and weight of individuals and species caught. The R package developed as part of the INSER project is designed to apply several treatments and statistical tests to these indicators in order to produce a summary report of the performance of the devices tested onboard of trawlers. This work, still under progress, presents the approach and functions of the 'inser' tool, which is intended for the entire community of fisheries scientists who want a rapid and systematic analysis of selectivity data. The final output will allow to assess the effectiveness fishing gear modification which can be rapidly reported to managers and professional fishermen.

### (10) Are we wasting tax-payers money? Questioning the use of sea trials to test simple codend modifications

Tiago Veiga-Malta[1], Ludvig Ahm Krag[1] & Jordan P. Feekings[1]

[1] *DTU Aqua*

A T90 120 mm codend, i.e. standard diamond mesh (T0) rotated by 90°, was proposed for the Danish demersal trawl fishery in the North Sea to address high catches of undersized roundfish, including haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). This proposal was based on the legality of a similar codend in the Baltic Sea, suggesting its applicability to the North Sea. However, the Danish fisheries authorities recommended an experimental sea trial to specifically assess the T90's effectiveness in the North Sea compared to the legal codends in the area (e.g., 120 mm diamond mesh codend). A sea trial was then set to compared T90 and T0 codends using a twin-rig trawl setting, sampling four commercial species: cod, haddock, plaice (*Pleuronectes platessa*), and lemon sole (*Microstomus kitt*). Results indicated an overall reduced catch efficiency with T90 meshes for fish below minimum landing size. For cod and haddock, a loss of catch efficiency was found for individuals below 43 and 40 cm, respectively, resulting in loss of some commercially sized individuals. For both flatfish, a moderate increase of catch efficiency for some length classes of the smaller commercial sizes was

also found. These findings closely matched predictions based on Baltic Sea data, prompting reconsideration of the need for costly sea trials given the accuracy of predictive modeling in evaluating gear efficacy. Our findings advocate for reallocating resources towards refining predictive models for gear selectivity, while reserving sea trials for testing more intricate or untested gear modifications. In conclusion, while sea trials can validate theoretical models, our study suggests that in certain cases, such as assessing a simple gear modification like T90 codends in North Sea fisheries, modelling exercises may adequately replace extensive field testing, highlighting the importance of efficient resource allocation in fisheries research and management.

**(11) Improving the size selectivity and exploitation pattern of cocktail shrimp (*Trachypenaeus curvirostris*) in shrimp trawl fishery of the South China Sea**

Bingzhong Yang[1,2*], Bent Herrmann[3,4,5]& Rong Wan[2]

[1] *Key Laboratory of Open-Sea Fishery Development, Ministry of Agriculture and Rural Affairs, South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, 510300, China*

[2] *College of Marine Science, Shanghai Ocean University, Shanghai, 201306, China*

[3] *SINTEF Ocean, Fishing Gear Technology, Hirtshals, Denmark*

[4] *University of Tromsø, Breivika, Tromsø, Norway*

[5] *DTU Aqua, Technical University of Denmark, Hirtshals, Denmark*

In order to improve the size selectivity and exploitation pattern for cocktail shrimp (*Trachypenaeus curvirostris*) in shrimp trawl fishery of the South China Sea (SCS), selective properties of four codends were tested and compared. These experimental codends involved two mesh sizes, 30 and 35 mm, and two mesh shapes, diamond-mesh (T0) and diamond-mesh turned by 90 degree (T90), respectively. Our results demonstrated that increasing the mesh sizes in T0 codends or/and applying T90 codends would improve the selective properties for

cocktail shrimp in the SCS. By comparing selectivity parameters, delta selectivity and exploitation pattern indicators, the T90 codend with 35-mm mesh size (T90_35) presented the best selective properties for cocktail shrimp in the studied areas. It will be a potential choice to substitute the currently legal codend in fisheries management to mitigate the bycatch of undersized cocktail shrimp in shrimp trawl fisheries of the SCS.

## (12) Novel escape window reduces redfish bycatch in Northern shrimp trawls

Tomas Araya-Schmidt[1], Shannon M. Bayse[1], Paul D. Winger[1] & Sidney Andrade[1]

*[1] Centre for Sustainable Aquatic Resources, Fisheries and Marine Institute, Memorial University of Newfoundland, St. John's, NL, A1C 5R3, Canada*

The offshore Northern shrimp bottom trawl fishery in eastern Canada faces challenges associated with significant bycatch of juvenile redfish (*Sebastes* spp.) prompting the exploration of novel behavioural bycatch reduction devices (BRDs). This study assesses the effectiveness of an experimental escape window integrated into a traditional shrimp trawl with 22 mm bar spacing Nordmøre grids to reduce redfish bycatch while maintaining targeted Northern shrimp catches. Video recordings and catch comparison methods were employed during at-sea trials off the coast of Labrador in Eastern Canada. The experimental trawl caught significantly fewer redfish for all size classes and was more efficient at reducing smaller individuals as showed by the increasing slope of the modelled proportion retained and catch ratio. The catch ratio suggested that on average the escape window trawl caught 57.09% fewer redfish (CI: 47.72% - 64.39%). Qualitative video observations provided evidence of the active swimming behaviour of redfish through the escape window. While the escape window demonstrated promise, challenges remain as ~43% of redfish could not escape, suggesting the need for further modifications and testing. The research also highlighted the importance of considering additional modifications to the escape window to improve its efficiency as well as testing the escape window in combination with smaller bar spacing Nordmøre grids. Further studies could explore the combined benefits of these BRDs and assess their impact on overall bycatch reduction.

## (13) Make fisheries better by reducing size selectivity

Ilmar Brinkhof[1], Manu Sistiaga[1,2], Bent Herrmann[1,3,4], Jesse Brinkhof[1, 2]

*[1] The Arctic University of Norway, UiT, Breivika, N-9037 Tromsø, Norway*

*[2] Institute of Marine Research, Postbox 1870 Nordnes, N-5817 Bergen, Norway*

*[3] SINTEF Fisheries and Aquaculture, Brattørkaia 17C, N-7010 Trondheim, Norway*

*[4] DTU Aqua, Technical University of Denmark, 9850 Hirtshals, Denmark*

In the Barents Sea demersal trawl fishery targeting cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*), it is mandatory to use a fish sorting grid with minimum bar spacings of 55 mm. However, earlier studies have reported low catch efficiency for this gear, resulting in increased fishing effort to catch available quotas, higher fuel use and greenhouse gas emissions, and seabed disturbance as

consequences. Further, it reduces the profitability of the fishery. Therefore, the effect on capture patterns and efficiency of lowering the grid bar spacings was investigated in a specific case study. Our results demonstrated that lowering the grid bar spacing by 10 mm improved the catch efficiency for cod, haddock and saithe by 51%, >100%, and >300%, respectively, when measured in number of fish. The fraction of undersized fish was low for all cases and did not exceed 2% for any species. When quantified by weight, a 10 mm reduction in grid bar spacing resulted in a 26%, 84%, and >200% improvement in catch for cod, haddock and saithe, respectively. The fraction of undersized fish did not exceed 1%. Furthermore, the results showed that the grid selection alone enables the use of a gentle, but potentially non-selective codend, because the fraction of undersized fish, when measured in number of fish, was less than 3% for cod and saithe and about 10% for haddock. Thus, our results indicate that environmental impacts, and the profitability of the fishery could be improved by allowing fishers to use sorting grids with smaller bar spacings. However, additional studies are needed to confirm that our results can be extrapolated to fisheries beyond our case study.

**(14) Uppers and downers: picking a sustainable gear for a new redfish fishery**

Shannon Bayse[1], Paul Winger[1], Zhaohai Cheng[1], Vang Nguyen[1], Gebremeskel Kebede[1], Harold DeLouche[1], David Kelly[2], Haraldur Einarsson[3], Michael Pol[4] & Stephen Walsh[5]

*1 Fisheries and Marine Institute, Memorial University of Newfoundland, P.O. Box 4920, St. John's, NL, A1C 5R3, Canada*

*2 Hampidjan Canada Ltd., 527 Conception Bay Hwy, Spaniard's Bay, NL, A0A 3X0, Canada*

*3 Marine and Freshwater Research Institute, Skúlagata 4, 101 Reykjavík, Iceland*

*4 Responsible Offshore Science Alliance, 1050 Connecticut Ave., NW, #65036, Washington DC 20036, USA*

*5 Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, 80 East White Hills, St. John's, NL, A1C 5X1, Canada*

The redfish (*Sebastes mentella* and *S. fasciatus*) trawl fishery in the Gulf of St. Lawrence, Canada has been in moratorium for the last 25 years. Massive recruitment events from 2011, 2012, and 2013 have led to a large biomass of slow-growing redfish soon to be targeted again by commercial fishing. Over the last five years, much research interest has been invested in developing a sustainable redfish trawl. Of many gears tested, a T90 mesh codend showed promise to reduce small-sized redfish. However, industry and management had concerns that reductions in the catch of small redfish were only realized at the surface, i.e. the majority of escapes happened when the trawl was at the surface, which would have led to mortality given redfish's biology. Thus, a second study investigated the timing of when redfish escaped from a T90 mesh codend to determine if

it happened at fishing depth, haul back, or at the surface. Results showed that redfish have escape events periodically during trawling at fishing depth with a T90 mesh codend and relatively few fish were observed to escape during haul back or at the surface. Overall, results from two studies show promise for using a T90 mesh codend in the incipient Canadian redfish fishery.

### (15) Understanding and predicting codend size selection for flatfish species

Zita Bak-Jensen[1], Bent Herrmann[1,2,3], Juan Santos[4], Daniel Stepputtis[4], Valentina Melli[1] & Jordan P. Feekings[1]

*[1] DTU Aqua, Technical University of Denmark, Hirtshals, Denmark*

*[2] SINTEF Ocean, Brattørkaia 17C, N-7010 Trondheim, Norway*

*[3] The Arctic University of Norway, UiT, Breivika, N-9037 Tromsø, Norway*

*[4] Thünen Institute for Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany*

In several demersal trawl fisheries flatfish constitute a large part of the catch, but often a significant fraction of these flatfish are unwanted species or sizes. A key knowledge when designing trawls to address this problem is to understand and quantify size selection of flatfish species by meshes in the codend. In the laboratory we tested the ability of different sizes of three flatfish species, plaice (*Pleuronectes platessa*), flounder (*Platichthys flesus*) and dab (*Limanda limanda*) to physically pass through different diamond meshes. By combining these results with results from fishing trials we were able to obtain a deeper understanding of how flatfish species are selected by size in trawl codends. Specifically, our results suggest that variation in the angle of the fish approach to the meshes when attempting to escape appears to play a major role in the size selection of flatfish species. Opposed to swimming power during mesh penetration that appears to have very limited effect. The results raise questions about if it is relevant to include more factors and which in the future selectivity and FISHSELECT studies.

**(16) Evaluating bottom trawl fishery in the Bay of Biscay from the fish community perspective**

Elsa Cuende[1], Mikel Basterretxea & Bent Herrmann

*1 AZTI*

Typically, the capture performance in trawl fisheries is evaluated based on only considering a few target species or a few species of special concern. However, in mixed species fisheries this can lead to ignoring a major fraction of the catch when evaluating the impact of the fishing activity and/or the use of a specific gear design in the fishery. One such example is found in the demersal trawl fishery in the Bay of Biscay. Therefore, for the first time we adapted and used a newly developed method to evaluated the fishery from a species community perspective by considering all fish species captured. Further, we discriminated between landed and discarded fractions of the catch and made the evaluation based on both number of individual fish captured and on biomass in terms of catch weights. Results showed that, compared to a none-selective codend, the used of the mandory codend increased the dominance of the main targeted species in the catch from 1.8% to 27% when measured in number of fish and from 16% to 44% when measured in biomass demonstrating the benefit of the selective gear. However, even with the use of selective gear, only 64% of the total number of fish captured is landed, demonstrating an unintended impact on the ecosystem.

**(17) Selectivity in snow crab (*Chionoecetes opilio*) pot fishery: effect of escape gap shape and size for conservation of fishery resources**

Kristine Cerbule[1,2*], Bent Herrmann[1,2,3], Jure Brčić[4], Eduardo Grimaldo[1] & Zita Bak-Jensen[3]

*[1] UiT The Arctic University of Norway, Tromsø, Norway*

*[2] Department of Fisheries Technology, SINTEF Ocean, Trondheim Norway*

*[3] DTU Aqua, Technical University of Denmark, Hirtshals, Denmark*

*[4] University of Split, Department of Marine Studies, 21000 Split, Croatia*

Conical pots are commonly used fishing gear for capturing snow crab (*Chionoecetes opilio*). In these fisheries, optimal snow crab size selection is important for reducing unintended mortality of undersized individuals aiming at conserving fisheries resources and reducing sorting time onboard fishing vessels. Size selection in snow crab pot fisheries is commonly taking place through pot netting meshes during deployment. The diamond mesh netting has varying opening angles affecting retention of snow crab of different sizes, and often large proportions of catches consist of undersized crab challenging natural resource conservation. Therefore, in some snow crab fisheries

escape gaps are considered to supplement mesh selection. We predicted the size selection potential of escape gaps with different shape and size and investigated whether such additional size selection mechanism can have a potential to improve selectivity compared to mesh selection. Results showed that circular escape gaps have potential to provide sharper size selection compared to netting meshes and thus could be used to limit the capture of undersized snow crab which is relevant for management and conservation of snow crab resources. However, a similar positive effect cannot be obtained to the same extent with elliptical and rectangular escape gaps.

### (18) King scallop selectivity in the English Channel dredge fishery

Daragh Browne[1], Shane Murphy[2], Matthew McHugh[1], Cóilín Minto[2], Martin Oliver[1] & Ronán Cosgrove[1]

[1] *Bord Iascaigh Mhara (BIM), New Docks, Galway, Ireland*

[2] *Atlantic Technical University, Dublin Road, Galway, Ireland*

The western and eastern English Channel/ la Manche (ICES Divisions 7.e and 7.d) are important fishing areas for Irish dredge fishing vessels targeting king scallop (Pecten maximus). A number of EU technical measures are in place to protect scallop stocks in these areas such as: closed areas and minimum conservation reference sizes (MCRS). Newhaven-style dredges predominate in the fishery, with dredge backs comprising steel rings and washers. Irish scallop dredge fishers typically use a ring size diameter of 85 mm, whereas French fishers use 92 mm and 97 mm diameter rings. Irish scallop fishing representatives requested BIM carry out a trial to assess the effect of increased ring size on scallop catches using fishing gear and practices representative of the Irish fleet. A catch comparison trial was conducted in the western Channel (ICES Division 7.e) during November 2023 to assess the effect of increasing ring size on scallop catches. Dredges were fitted with 85, 92 and 97 mm ring sizes and deployed simultaneously. Scallop catches were weighed and measured. Proportional differences in catch at width were modelled using a generalised additive model (GAM). Compared with the 85 mm ring size: the 92 mm ring size significantly reduced scallop catches less than the MCRS (≥ 100 mm) and did not reduce scallop catches greater than the MCRS (100 mm); and the 97 mm ring size significantly reduced scallop catches less than and greater than the MCRS. Our experimental design attempted to account for differences in dredge fishing power related to position along a beam. It was not possible to change ring backs from one beam to another to assess differences in beam fishing power due to poor weather. The trial Skipper kept the 92 mm gear on board his vessel after the trial and reported some loss of greater than MCRS scallops as the rings were subject to wear. These caveats aside the findings of this trial are similar to those of a 2020 French study (SELEDRAG) conducted in the eastern Channel (ICES 7.d).

## 1.4. Discard Survival

### (19) Discard survival and fish quality improvements by using a Modular Harvest System (MHS) in demersal beam trawl fisheries

Pieke Molenaar[1], Alessa Mattens, Lennert van de Pol & Edward Schram

[1] *Wageningen Marine Research*

Demersal tickler chain beam trawl fishery targeting sole (*Solea Solea*) in the North Sea catches substantial amounts of undersized plaice (*Pleuronectus platessa*). Our captive observation studies show that only 8% of these plaice survive being caught and discarded. To increase discard survival probability and improve fish quality and catch welfare a Modular Harvest System (MHS) was customized for the Dutch beam trawl fishery. The Modular Harvesting System (MHS) is a novel cod-end originally developed in New Zealand by Precision Seafood Harvesting Limited, Timaru, New Zealand to reduce fish damage during trawling, haul back and unloading. The MHS is a membrane-like fabric tube with escapement holes that replaces the mesh lengthener and cod-end of a trawl. The terminal section of the MHS is non-porous, which allows fish to be lifted aboard in a fluid environment. This and the graded flow reduction and open geometry of the MHS reduces fish damage during trawling, haul back and unloading. The openings in the escape module are tailored to retain sole above its MCRS size (24 cm). This study investigated whether the MHS improves capture conditions with as a result better marketable fish quality and significantly higher discards survival.

During six 4-day trials the performance of the MHS was compared to regular 80mm mesh trawls on a small and large commercial vessel by replacing one of the two cod-ends of the double rigged beam trawlers by a MHS. In these trials fish condition was assessed using the Reflex Action Mortality Predictor (RAMP) combined with scoring external damage. Those two methods provided insights in the differences in damage and exhaustion between MHS and mesh caught fish. During two trials survival of undersized sole, plaice and turbot was measured by captive observations. For all tows marketable catch weights were compared.

Underwater camera footage collected during trawling clearly shows turbulent conditions in the traditional mesh trawls and much calmer conditions inside the MHS. This difference results in significantly less damaged fish in the catches, where the RAMP scores show significantly less impaired reflexes for MHS fish. Discards survival measurements show a significantly higher survival probability for turbot and plaice, but not for sole. Quality of the marketable fish caught by the MHS was better. Marketable catches by the MHS were lower in the first trials, but trawl optimalization resulted in higher marketable sole catches in the last experimental week and equal catches for all

other species. Overall discard quantities were reduced by 15% compared to conventional 80mm mesh cod-ends. The MHS has shown to be suitable to improve fish quality and discards survival without compromising landings of marketable fish. Future work will focus on legalization, endurance experiments and application in other European fisheries.

## (20) Survivability of spurdog (Squalus acanthias) caught in the Irish demersal trawl fishery

Martin Oliver[1]*, Ross O'Neill[2], Matthew McHugh[1], Daragh Browne[1], Shane Murphy[3], Cóilín Minto[3] & Ronán Cosgrove[1]

[1] *Bord Iascaigh Mhara, New Docks, Galway, Ireland*

[2] *Marine Institute, Renville, Oranmore, Galway, Ireland*

[3] *Atlantic Technological University, Dublin Road, Galway, Ireland*

We assessed spurdog (*Squalus acanthias*) condition and post release survival in an Irish bottom trawl fishery towards an application for a survival exemption under the EU landing obligation. Fish condition was assessed using a modified five-point scale; excellent, good, poor, moribund and dead based on fish movement and injuries. Survivability was assessed using pop-up satellite archival tags (PSATs). Ten spurdog in excellent and good vitality were tagged and released. Tagged spurdog ranged in size from 80 to 100 cm, this size range was chosen based on the tag requirements and maximum commercial landing size (MXCRS) for spurdog in Ireland. The tags were set to release after 30 days at which point fish were assumed to have survived.

Of 469 spurdog caught during seven trips, 56 (12 %) were between 80 – 100 cm with 77 % of these found to be in excellent or good vitality. 95 % of spurdog > than the 100 cm MXCRS were in excellent or good condition while fish < 80 cm were generally in poorer condition. Nine out of the ten tags popped off after 30 days providing a 90 % survival estimate. Study results suggest relatively high survival of spurdog between 80 – 100 cm and provide supporting information in relation to the current MXCRS. Further condition assessment work and pop-up tagging of spurdog in poor or moribund condition is planned.

## 1.5. Topic Group Introductions (ALDFG, Multi-Use, Indicators)

### (21) ALDFG: Effects of ALDFG on sessile organisms and eelgrass bed

Yoshiki Matsushita[1], Gregory N. Nishihara, Makoto Kabeyama, Alifro Maldini, Chiyo Takahashi & Saranya Raju

[1] Nagasaki University

Effects of ALDFG (Abandoned, Lost or Otherwise Discarded Fishing Gear), which constitutes a large portion of benthic macroplastic debris in our study sites, on habitat forming eelgrass and other biological organisms were investigated in Nagasaki, western Japan. A search and recovery study of ALDFGs on the seafloor in an active lobster gillnet fishing area was carried out in 2023. The survey was done by skin diving (June and Oct), deploying an underwater drone (July), and scuba diving (Aug). Divers towed a buoy equipped with a GPS logger to record the approximate location of ALDFGs, which were photographed and recovered. Forty-one ALDFGs were recovered during three diving surveys. Three were gillnets and remainder were netting and ropes. All gillnets were found to be entangled with sea-fans Acanthogorgiidae weighing approximately 1 kg and one small spiny lobster Panulirus japonicus. Of the 38 other ALDFGs, 14 were entangled in algae, oyster beds, and hard corals. Although several reports indicate that the ghost-fishing ability of abandoned gillnet decreases rapidly over time, the entanglement of ALDFGs on sessile organisms may continue for longer periods. The second study was done in eelgrass (*Zostera marina*) beds, where benthic litter on the seafloor was removed and collected once a month from 2021 to 2023. At the same time, the cover rate of eelgrass was recorded at 310 points using a line-transect. Most of the benthic litter collected was netting and ropes of fishery origin. The monthly amount of litter collected tended to decrease as removal progressed, and at the same time, the coverage of the eelgrass beds increased. The ALDFG deposited on the seafloor may cover the eelgrass and inhibit photosynthesis or may be buried in the seafloor and interfere with the growth of the rhizomes.

### (22) ALDFG: Global inland fisheries: plastic pollution and other conservation challenges

Drake Ssempijja[1,2*], Haraldur Arnar Einarsson[3,4] & Pingguo He[1]

*[1] Department of Fisheries Oceanography, School for Marine Science and Technology, University of Massachusetts Dartmouth, 836 South Rodney French Blvd, New Bedford, MA 02744, USA.*

*[2] Department of Zoology, Entomology and Fisheries Sciences, Makerere University College of Natural Sciences, Makerere University, Kampala, Uganda.*

[3] *Fishing Technology and Operations Team (NFIFO), Fisheries Division (NFI), Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla Rome 00153, Italy.*

[4] *Marine and Freshwater Research Institute, Fornubúðir 5, 220 Hafnarfjörður, Iceland*

This presentation reviews and analyzes current fishing gear types used in global inland fisheries, with emphasis on their conservation challenges, regulatory mechanisms, and the potential to cause plastic pollution. Forty-nine studies published between 2003 and 2023 are included in this review. There are thirty-six gear types in use in world's inland fisheries according to the Revised International Standard Statistical Classification of Fishing Gears (ISSCFG). It was observed that inland fisheries are multi-gear and multi-target fisheries during different fishing seasons, with set gillnets being the most common fishing gear type. On conservation challenges, the review showed evidence that links inland fishing gear to environmental destruction and degradation that lead to biodiversity loss, overexploitation, ghost fishing, bottom impact, bycatch, and habitat destruction. Factors that may contribute to plastic pollution from ALDFG in inland fishing gear include mode of operation, open access nature, level of enforcement, and material used for fishing gear. The main regulations for inland fishing gear are mesh size limitations, banning of specific gears, and closed seasons. The future of inland fisheries depends on using sustainable fishing gear types and practices, enhanced fisheries resource monitoring and assessment, and creating a conducive policy and regulatory environment that reduces plastic pollution and other environmental impacts.

**(23) Multi-Use: Staying in your lane: scaled images of mobile fishing gears in U.S. offshore wind arrays**

Mike Pol[1]

[1] *Responsible Offshore Science Alliance*

Development of offshore wind may result in voluntary exclusion of fishing effort from within turbine arrays, particularly mobile gears. Offshore wind developers in the U.S. have attempted to provide adequate spacing for fishing to continue, but fishers for the most part say that safe operation of their gears requires greater distances than those provided. The size and scale of these inter-turbine distances as well as of the individual turbines is quite large: turbine heights can be 850 m from the surface of the water and inter-turbine distances can be 1.3-1.8 km. To aid discussion of gear-related issues related to access, scaled 2-dimensional drawings were made of three different gear types: demersal otter trawls, scallop dredges, and hydraulic clam dredges. Sizes of gear and rigging were vetted with multiple fishing industry representatives. Drawings appear to show sufficient space for fishing, although fishing practitioners still indicate they will choose not to fish in these areas. This response suggests gear technologists should investigate and develop a better understanding of spatial use by mobile fishing gears and

vessels both at the surface or at the bottom to attempt to provide deeper insight of their spatial needs.

**(24) Multi-Use: A global assessment of fishing within offshore windfarms to inform recommendations for Ireland marine spatial planning process**

Elizabeth Tray[1], Shane Murphy[2], Cóilín Minto[2] & Ronan Cosgrove[1]

[1] *An Bord Iascaigh Mhara, New Docks, Galway H91 HD92 Ireland*

[2] *Atlantic Technical University, Old Dublin Rd, Galway H91 T8NW*

Globally, governments have committed to decrease reliance on fossil fuels and increase renewable energy generation. To date, Ireland has 59 offshore wind farm (OWF) applications in pre-planning stages, with a further 6 projects recently expedited by government to reach full commissioning by 2030. These developments will occupy marine space which is currently the source of Ireland's 1.26 billion euro seafood sector. Research has broadly examined OWF impacts on ecology, socioeconomics, fisheries, etc., although no global analysis of fishing activity occurring directly within operational OWF's exists. To date, there are approximately 300 OWF's reported as fully operational in the marine environment. This study aims to investigate these OWF site footprints and frequency of fishing within their spatial extents to reveal infrastructure design, legal, and operational factors which may be conducive to coexistence. The methodology utilizes both open source and proprietary datasets and includes a statistical spatial overlap assessment. The results will identify key barriers or enablers which facilitate coexistence and ascertain real life factors which compound spatial squeeze in the marine environment. Implications and recommendations for Ireland's developing OWF industry & marine spatial planning process will be discussed.

**(25) Indicators: Fisheries ecolabels and FIshing Gears Indicators (FIGI): overlap, synergies and future directions**

Valentina Melli[1]

[1] *Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua), DK-9850 Hirtshals, Denmark*

Fisheries ecolabels, such as the Marine Stewardship Council (MSC), utilize comprehensive indicators-based systems to assess the sustainability of fisheries prior to and during their certification. These indicators-based systems typically encompass a range of ecological, social, and governance criteria to evaluate the environmental

impact, management practices, and community involvement of fisheries operations. In particular, the MSC fisheries standard is based on three overarching principles:

Principle 1: Sustainable fish stocks.

The fishing activity must be at a level which is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not overexploiting the resources.

Principle 2: Minimising environmental impact.

Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends.

Principle 3: Effective management.

The fishery must meet all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.

As fishing gears technologists, Principle 2 is particularly relevant to us as it includes indicators to assess the impact of the fishery on a range of ecosystem components, including non-target species, endangered, threatened and protected (ETP) species, and habitats. Therefore, this talk will focus on identifying the overlap and potential synergies between the indicators used to certify a fishery and the FIshing Gears Indicators (FIGI) that we use to quantify the performance and impact of a given fishing gear. Moreover, we will discuss the role that recent technological developments (e.g. electronic monitoring, underwater sensors and cameras) could play in the future of fisheries ecolabels, as they allow to assess the performance and impact of a fishing gear at the vessel, single fishing trip, or even single deployment level.

## (26) Indicators: An indicator based, voluntary assessment scheme enabling transition towards a more sustainable fishery

Lancelot Blondeel[1], Ellen Pecceu[1], Katrien Verlé[1], Els Vanderperren[1] & Hans Polet[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO)*

The Belgian fishing fleet, mainly composed of beam trawlers, has faced numerous challenges in the past decade. High fuel prices led to economic hardship, competition for space at sea encroach on the known fishing grounds (windfarms, MPA's, Brexit), and the use of beam trawls is criticized for its lack of selectivity and the large impact on the marine environment. The beam trawl also limited the possibility of obtaining certification through initiatives like MSC which puts fishers at risk of losing market access.

Additionally, fishers were wary of interference from fisheries management and scientific institutions, limiting constructive exchanges between stakeholders.

To meet these challenges, Belgian stakeholders decided to develop a sustainability assessment tool called VALDUVIS which utilises 10 indicators to monitor the social, economic and ecologic progress of the Belgian fleet. This system is currently used to guide the Belgian fishers to further improve their scores through a voluntary fishery improvement program. The aim has been to apply a step-by-step approach with progressively increasing thresholds for participation and to gradually convince and prepare fishers to change their current practices. This would enable the entire fleet to evolve into a more sustainable direction that would benefit everyone in the long term.

Early on, motivating vessel owners to participate proved to be difficult, with only 3 of the 65 vessel owners showing interest in the initiative. A change of heart came with the introduction of a market recognition, which was awarded to those who achieved a set minimum score and declared to participate in the improvement program. Consequently, participation increased to 51 vessel owners in one year.

We explore how the indicators of the fishery improvement program (Visserij Verduurzaamt) translate to a market recognition that motivates vessel owners to participate in the FIP. Additionally, attention will be given to the two ecological indicators that try to estimate the impact of the fishing gear on the benthic environment and selectivity.

## 1.6. Human Behaviour

### (27) Advancing the uptake of proven fishing gear: an update

Mike Pol[1]

[1] *Responsible Offshore Science Alliance*

A 2016 WGFTFB Topic Group on Application of Change Management in the Fishing Industry began exploring the process of uptake of proven fishing gears. A successful publication based on that exploration documented how much remains to be learned or understood regarding facilitating or improving uptake. Since that time, progress has been made on incorporation of the skills and tools of social scientists, in addition to the continuing development of models of human behaviour, including the production of a Themed Set for the ICES Journal of Marine Science partly dedicated to this specific topic. Of the eighteen articles in the set, seven investigated the behaviour of fishers and applied existing or novel models to deepen understanding of motivations and incentives to change; little overlap among theories was found, and more and deeper consideration of this topic is needed. This presentation will highlight the lessons learned from the Themed Set on uptake of proven fishing gears.

### (28) Investigating the barriers and challenges for UK fishers in taking up more selective fishing gears to avoid unwanted catches

Thomas Catchpole[1], Marieke Desender[1], Stuart McLanaghan[2] & David Warwick[2]

[1] *Centre for Environment Fisheries and Aquaculture Science (www.cefas.co.uk)*

[2] *Seafish (www.seafish.org)*

PART I - The sustainability of many fisheries could be improved by reducing the catches of marine animals other than those targeted by fishers. However, effective tools, techniques and strategies to improve the selection of commercial catches frequently seem to be overlooked or unused (Pol and Maravelias, 2023). Voluntary as well as mandatory approaches, including bottom-up or fishers' led initiatives, have had mixed success in the implementation of more selective gear to avoid unwanted catches. This study investigates what possible barriers might need to be overcome to encourage the uptake and implementation of more selective fishing gears for the UK fishing industry. This was done in two stages: firstly, a targeted review of literature was conducted, focusing on the recent publication "Challenges to incentivizing avoidance of unwanted catch" (Pol and Maravelias, 2023); and secondly, an online questionnaire survey, utilising the findings from the review, was jointly designed by Cefas and Seafish and delivered to

UK fishers, through their regional / national bodies. The findings from the literature review and the survey of fishers were combined to make some overarching conclusions and recommendations presented here. These also informed the design of a project to encourage uptake of more selective trawl designs in the English northeast Nephrops (N. norvegicus) fishery. An abstract has been submitted to present this project - PART II.

**(29) Road test selected trawl designs in the English northeast Nephrops (N. norvegicus) fishery**

Samantha Stott[1], Thomas Catchpole[1]

[1] *Centre for Environment, Fisheries and Aquaculture Science*

PART II- Improving selectivity is the most effective way of reducing catches of marine animals other than those targeted by fishers and will contribute to reducing handling costs for unwanted catches. However, uptake of more selective fishing gear is often associated with a risk of investing in unsuitable trawl designs and of losing marketable catches. This study provided an opportunity for a group of skippers working in the English northeast *Nephrops* (*N. norvegicus*) trawl fishery to 'road test' preferred trawl options, selected from a 'show room' of designs that have demonstrated potential to reduce unwanted catches in limited scientific trials. In this study, eight skippers led in selecting and testing the trawl designs under commercial conditions for a sufficient time to gain experience and confidence in the designs. The tested designs included coverless trawls, separator trawls and large escape panels in the trawl. Furthermore, skippers were given the opportunity to record information on the performance of the trawls which was then analysed to evaluate whether the trawls had demonstrated a reduction in unwanted catches. The findings of this study are presented here. This study built on the recommendations from the study investigating the possible barriers on the uptake of more selective fishing gears for the UK fishing industry (PART I). An abstract has been submitted to present this project - PART I.

**(30) Moving forward: Australia national extension officer network facilitating change in the fishing and aquaculture industry**

Steve Eayrs[1], Jamie Allnut, Nathan Bicknell, Kris Cooling, Felicity Horn, Matt Jones, David Maynard & Lauren Thornton.

[1] *Fisheries Research and Development Corporation, Canberra, Australia*

In 2022, Australia's Fisheries Research and Development Corporation (FRDC) established a national extension officer network (EON) for the purpose of extending research and development outcomes to stakeholders, bringing stakeholders together to

tackle issues, and to identify research needs suitable for FRDC funding. Fundamentally, the Extension Officers (EO) have agency to facilitate change in the fishing and aquaculture industry, with one appointed in each Australian state and territory.

With a focus on recent revolutionary changes to the Queensland East Coast Otter Trawl Fishery and East Coast Inshore (net) Fishery, this presentation will describe the EON and provide examples of their impact to date, guided by a fundamental theory of change. It will also highlight how such a network can help overcome extension and outreach challenges to facilitate change, including those identified in the WGFTFB Change Management in Fisheries Topic Group (2015-17) such as reliance on researchers to achieve this outcome, inadequate communication, and poor voluntary adoption of proven R&D outcomes. The challenges measuring the performance and impact of the EON's extension efforts will also be discussed.

## (31) Increasing uptake of the Ultra Low Opening Trawl (ULOT) in the New England Groundfish Fishery

Aaron Whitman[1] & Stephen Eayrs[2]

[1] *Gulf of Maine Research Institute*

[2] *Smart Fishing Consulting/Fisheries Research and Development Corporation*

Despite having successfully demonstrated the Ultra-Low Opening Trawl (ULOT) in research trials, reducing Atlantic cod (*Gadus morhua*) by 46.8%, there has been little uptake in the New England groundfish fishery for the ULOT. To increase the uptake of the ULOT we received funding to have nets custom built for five fishers along will be compensated for using the net and providing feedback for outreach materials. We utilized a scientific communication specialist from the Gulf of Maine Research Institute (GMRI) to create a targeted ad on Facebook for our program. Through this method, we received more applications and interest in a cooperative research project in two weeks than we have ever had before. In total we received 29 applications to the project with over 1,000 clicks onto our link, reaching over 13,000 individuals, all for the low cost of $0.12 per click. We believe that this method is an effective way to reach your intended audience and increase fisher participation in projects as well as spread information about your results.

## (32) Economic viability of new passive fishing methods for brown shrimp (Crangon crangon) in the Dutch Wadden Sea: a business-economic approach

Edward Schram[1], Pieke Molenaar[1], Marc Robert[2] & Kees Taal[2]

[1] *Wageningen Marine Research, IJmuiden, The Netherlands*

[2] *Wageningen Economic Research, The Hague, The Netherlands*

New fishing methods not only need to be technically feasible, they should also provide viable business cases. Technical performance of new fishing methods thus needs to be placed in a business-economic perspective. For this purpose we develop a generic bio-economic model. We will use this model to evaluate two alternative passive brown shrimp fishing methods in the Dutch Wadden Sea: stow nets and pots. Passive shrimp fishing methods for the Wadden sea become of increasing interest because the traditional beam trawl fisheries for shrimp are under debate for their fuel consumption, emissions, seafloor disturbance and bycatch of juvenile fish inside a UNESCO World Heritage site. Shrimp fisheries with stow nets and pots will be tested and optimized by fishermen supervised by scientists over a period of 12 months to account for seasonal variation in catches. Data collection will include catches (landings & discards), catch compositions and operational aspects and costs.

Both passive methods are likely to catch fewer shrimp than active methods like beam trawls but may still provide viable business cases for fishermen provided costs are also substantially lower. The bio-economic model will place the realised catches and associated fishing efforts in a business-economic perspective. Model input will include operational expenses, capital expenditures and gross income generated by the fisheries. Model output will include total investments, break-even, internal rate of return and cost price.

Different scenarios will be evaluated, such as the comparison between newly commissioned electric vessels and adapted existing vessels, seasonal fisheries combined with other activities compared to full-time fisheries, or the impact of various effort levels (e.g. the number of pots used and days at sea). Sensitivity analyses will be conducted to reveal which variables predominantly determine economic viability. Economic performance and realized catches will be compared to traditional shrimp beam trawling. All this will allow us to evaluate under what conditions either passive fishing method provides a viable business case for shrimp fishermen.

## 1.7. Fish Behaviour

### (33) Time for action: a plea for establishing quo vadimus on the future relevance of animal behavior in the development of sustainable fisheries

Junita D. Karlsen[1]

[1] *DTU Aqua*

It is widely recognized that fishing gears are designed to influence animal behavior to maximize capture. The first descriptions of species-specific differences in responses to trawl inspired a large range of gear modifications to avoid retention of unintended catch. During the last couple of decades, sophistication of our understanding of animal responses in fishing contexts has been called upon to accelerate the development of efficient gear modifications. Recent expansion in the range of gear modifications required to develop sustainable fisheries and increased focus on animal welfare in conjunction available technologies to digitize the catch process, makes understanding animal behavior during the capture processes more relevant than ever before.

Through a range of examples from a literature case study, the aim is to critically review how animal behavior has been studied, reported, and referenced. Emphasize will be on the collected data supporting the interpretation, understanding, and use of different observed behaviors. The results will be used to highlight potential barriers to future improvements in understanding behavior. Recommendations to limit these barriers are given, but it is prudent to identify the future framework of animal behavior in the development of sustainable fisheries.

### (34) Optimizing fish pot design for targeting flatfish: a two-phase approach to enhance efficiency

Sara Berzosa[1], Thomas Noack[1], Andreas Hermann[1], Andrea Milanelli[1], Uwe Lichtenstein[1] & Daniel Stepputtis[1]

[1] Thünen Institute for Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany

Gillnets are a popular fishing gear worldwide due to their effectiveness, ease of handling, and affordability. They are also considered sustainable, characterized by low carbon emissions, selective targeting of specific species, and low impact on seabed habitats. Nevertheless, their contribution to marine mammal and seabird bycatch presents significant conservation challenges. To mitigate bycatch, transitioning to alternative fishing gear, such as fish pots and traps, offers a potential solution. However, further research is needed to improve the catchability of fish pots. To improve the catch

efficiency of fish pots by opening the fishery up to new target species, this study investigates different entrance designs for flatfish using a two-step approach. In the first phase, understanding flatfish behaviour and interaction with the gear is essential. In semi-controlled conditions of a net pen, we tested different entrances and recorded the behaviour of the fish using infrared cameras and light to understand how the fish enter and exit. In the second phase, we validated the efficacy of the identified optimal entrances under commercial conditions. Collaboration with experienced fishers can facilitate field testing and provide valuable insights into the practical applicability of the modified fish pots. The initial results from this study, which will be presented, provide valuable insights for improving the design and development of fish pots, contributing to their effectiveness in capturing a diverse range of species while minimizing environmental impact.

## (35) Bridging missing links in fish attraction to lights through field and laboratory studies

David Gauld[1], Chris Rillahan[1], Pingguo He[1]

*[1] School for Marine Science and Technology, University of Massachusetts Dartmouth; 836 South Rodney French Boulevard New Bedford MA 02744 USA*

It is well known that many species of fish are attracted to light under various conditions. There are several hypotheses on why fish are attracted to light, but the behavioral mechanisms which drive fish attraction to light are not well understood. Previous research on the application of light attraction in fish capture has focused on whether a fish or crustacean is attracted to a certain color of light but not on why and how fish are attracted to light. We conducted both field and laboratory studies to understand why fish are attracted to light. The field work recorded and compared fish attraction to different colors of light using a camera and a high-resolution imaging sonar at night. The laboratory component compared fish attraction when in filtered water and when zooplankton were added to the filtered water in a large tank. Field results showed that Scup (*Stenotomous chrysops*) were attracted to green light. In the laboratory, scup showed little attraction to lights of any color in a filtered seawater environment but when small invertebrate prey was added into the tank an attractive effect was induced. These findings suggest that for scup light attraction may not be based on the light itself, but instead may be due to attraction of small aquatic invertebrates that scup might be feeding on. There may be more than one species or species group along the food chain that are attracted to the light, inducing an attractive effect on their predators. Research on the missing link will help our understanding of the mechanisms of light attraction, and seasonal and spatial variations in light attraction.

## (36) Snow Crab Vision Fishing Gear, Phosphorescence, and the Environment

Colin Frank[1], Shannon Bayse[1,2], Rioghnach Steiner[1] & Pierre-Paul Bitton[2]

[1] *Centre for Sustainable Aquatic Resources (CSAR), Marine Institute at Memorial University of Newfoundland*

[2] *Cognitive and Behavioural Ecology (CABE), Memorial University of Newfoundland*

This study explores the visual abilities of snow crab (*Chionoecetes opilio*) concerning their interaction with phosphorescent-netting pots used in commercial snow crab fisheries. Light emitted from such pots increases catch per unit effort, yet little is understood about the factors driving these higher catch rates. In this study, we measure pot light emission and snow crab acuity. Combining these data with estimates obtained in the literature for other biotic and abiotic factors, we model snow crab vision in relation to the pots. Utilizing these factors and environmental conditions, we find the photon flux of the pots and derive a contrast ratio between the pot light and the ambient light. Findings reveal that the visibility of pot lights at a 200-meter depth depends primarily on solar angle (time of day) and time elapsed post-deployment. Additional factors influencing the vision of the pots include water column quality and benthic boundary layer turbidity. This study is the first to model the visual ecology of snow crab and the first study to estimate snow crab acuity. These insights into snow crab visual ecology can enhance fishing techniques, promote catch efficiency and sustainability, and help provide a path forward for visual ecology research in the fisheries science field.

## 1.8. Innovative Gear

### (37) Innovative fishing gears

Antonello Sala[1]

[1] *CNR*

In the ICES Workshop on Innovative Fishing Gear (WKING2) in August 2023, fishing technologists and other individuals involved in the development of the innovative fishing gear were requested to complete a new factsheet for any newly developed innovative fishing gear. The purpose of WKING2 was to:

a) Evaluate/endorse the catalogue of gears considered 'innovative';

b) Assess the level of uptake of innovative gears by the EU industry (per sea basin and fishery) that are ready for deployment, investigate aspects that impact the uptake of innovative gears including finance, user-friendliness, health, and safety;

c) Discuss the main drivers that prevent their use if known, and where possible, include analysis of the socio-economic trade-offs and propose ways to facilitate their implementation;

d) Produce a report detailing the process taken and presenting the results;

e) Draft summary advice based on the report produced.

The performance criteria used in the WKING2 report, their definition, and their underlying assumptions must be considered more deeply from a wider audience before any future steps are taken to replicate the report. We made several assumptions based on our knowledge and long history of experience with the commercial fishing sector. While we are comfortable with the assumptions, and have justified them, they are subject to our personal bias. A dedicated effort such as an ICES WGFTFB Topic group would be a useful next step. Such an effort could also be responsible for deliberating on appropriateness or otherwise of the array of criteria used in this report, their definition, and the coarse and limited ranking of each performance criteria. It is requested to present the insights from the WKING2 as well as propose a new Topic Group for the next three years.

## (38) A: Selectivity design for the Modular Harvesting System, a non-mesh codend

Damian Moran [1], Si Thu Paing [1] & Martin de Beer [2]

[1] *New Zealand Institute for Plant and Food Research Limited*

[2] *Precision Seafood Harvesting (New Zealand) Limited*

The Modular Harvesting System (MHS) is a membrane-like fabric tube with escapement holes that replaces the mesh codend of a trawl, and is designed to reduce damage to catch by providing fish a low-flow, low-turbulence environment that allows them to maintain swimming control and avoid compaction during trawling and haulback. Despite the MHS material having a low porosity compared to mesh, the MHS can achieve comparable size selectivity characteristics to mesh codends due to the way it hydrodynamically inflates and the stable geometry of the escapement holes. In this presentation we discuss the design of escapement holes of MHS units that have been used to target fish with different morphologies, together with studies on the size and species selectivity of various MHS designs versus mesh codends. Size selectivity for the MHS is generally more knife-edge than for mesh codends, with flow-on effects to factors such as fishing efficiency and fisheries population management. The mechanisms of fish escapement from the gear are broadly understood, though the relative importance of active versus passive selection are still being determined.

## B: The behaviour of fish in the Modular Harvesting System, a non-mesh codend

Damian Moran[1], Glen Aspin[1], Si Thu Paing[1] & Martin de Beer[2]

[1] *New Zealand Institute for Plant and Food Research Limited*

[2] *Precision Seafood Harvesting (New Zealand) Limited*

When fish herded by trawl nets enter the Modular Harvesting System (MHS) they encounter a low-turbulence environment with graded water velocities and space to allow them to maintain swimming control and avoid compaction during trawling and haulback. In this presentation we discuss the velocity and turbulence profiles within different MHS codends using computer modelling and in-trawl measurements, together with a review of how fish with different swimming styles and morphologies behave in this environment. Allowing fish to maintain swimming control is critical to enabling both active and passive selection through the escapement holes, and examples will be shared where understanding fish behaviour has been used to improve the selectivity of the MHS, as well as understanding causes of damage and product down-grading. Allowing fish to maintain swimming control has enabled skippers to adopt new fishing strategies with the MHS, such as long duration trawls and capture plus storage-at-depth while waiting for processing lines to clear aboard factory vessels. Examples of these skipper-driven fishing strategies will be discussed along with images of fish quality from 5â€“13 hour trawl durations.

## (39) Ibero-American Network for the Study of Bycatch and Discards

S. Dans*, M.E. Gongora, M. SanMartin, L. Clavijo, V. Iriarte, P. Rosero, E. Secchi, D. Monteiro, L. Coccus, J.C. Baez & M.A. Hall

*Red para el estudio de Capturas Incidentales y Descartes - redCID (Network for the Study of Bycatch and Discards)*

The study of fisheries bycatch and discards is critical in achieving the goals of sustainable fisheries and ecosystem conservation. Those interested in these subjects in Ibero-America have experienced limitations when it comes to regional communication and attending international conferences. This was due to language barriers, economic limitations and, more recently, COVID-19. In order to facilitate the regional interaction and integration, a network to study fisheries bycatch and discards was initiated in 2021. The name of the network is redCID (Red para el Estudio de Capturas Incidentales y Descartes) and includes researchers, technologists, fishers, and others. The network is a virtual space for open and creative discussions and is based on individual participation–expressing ideas on a personal basis rather than an institutional one.

These meetings focus on collaborative solutions and embrace local experiences and practical knowledge. RedCID makes a special effort to involve the artisanal fisheries that are so significant in this region. Because of the economic conditions, there are excellent opportunities for experimental research on gear and devices. The network neither positions itself nor assumes the representation of its members, which encompass a range of stakeholders, including fishers, managers and researchers.

RedCid's has 252 members (116 women, 136 men) from 19 nationalities. The majority of members are biologists/ecologists (77%), followed by fisheries engineers (13%). Others includefisheries managers and veterinarians. Average attendance over three years has been 38 attendees with an average of 91 subsequent views. The network meets once per month online, operating in Spanish or Portuguese. Since its launch, the network has organized 38 webinars,virtual workshops and conferences which are then published in RedCid's YouTube channel (https://www.youtube.com/@redcapturasincidentalesyde5275). Topics discussed have included community-based strategies, discard management, spatial approaches, habitat models, fishing gear mitigation technology and workshops for fishers on handling and release techniques.

## (40) Fisheries in transition: researching innovative bait and novel potfishing opportunities

Van Vlasselaer Jasper[1] & Van Opstal Mattias[1]

*1 Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences - Fisheries, Ankerstraat 1, 8400 Oostende, Belgium*

Beam trawling in the North Sea is encountering significant pressures from political, socio-economic, and environmental dimensions. Declining revenues resulting from diminished catches, quota constraints, and spatial limitations compel fishers to either adapt or face economic demise. A potential avenue for adaptation lies in transitioning towards alternative fishing methodologies such as pot fisheries. In support of this transition, our research explores possibilities of pot fishing for economically significant species, with a particular emphasis on employing innovative baiting strategies, such as light and odors to attract target species.

Our current investigation focuses on four commercially important species: the brown crab (*Cancer pagurus*), the brown shrimp (*Crangon crangon*), and two species of flatfish, sole (*Solea solea*) and plaice (Pleuronectes platessa). The brown crab is traditionally captured through trawling and pot fishing methods, with pot-caught specimens having a better quality. For this species, we are evaluating the efficacy of light stimulation as a means of augmenting crab catch rates, while also investigating whether crabs are drawn to pots primarily for feeding or sheltering. For brown shrimp (*Crangon crangon*), little knowledge exists regarding effective attractants or pot-fishing methodologies targeting this species. Within our laboratory, diverse baiting strategies and pot designs are under evaluation, contributing to the development of a novel and sustainable fishery. We are also investigating whether we can attract flatfish into pots, as sole and plaice represent the primary targets for beam trawling activities. While light stimuli demonstrate limited efficacy, olfactory cues emerge as promising avenues for pursuit.

In summary, our investigations into novel baiting approaches, encompassing both light and odors, seek to facilitate a transition from beam trawling to pot fisheries for diverse commercially valuable species. By elucidating the dynamics of attraction and behaviour, our efforts contribute to the development of a resilient and forward-looking fishing industry.

## (41) Survey dredges do not sample well in high-density scallop grounds: New evidence from high-definition cameras

Christopher Rillahan[1], Sally Roman[2], David Rudders[2] & Pingguo He[1]

[1] *University of Massachusetts Dartmouth*

[2] *Virginia Institute of Marine Science*

The Atlantic sea scallop, *Placopecten magellanicus*, fishery is one of the most valuable fisheries along the US East Coast with an ex-vessel value in excess of $670 million USD from a landing of 19,631 mt of scallop meat in 2021. The fishery is typically supported by several surveys (i.e., dredge and optical surveys) which provide multiple, spatially explicit annual biomass estimates. From 2015 to 2022, significant divergence in area specific biomass estimates were noted between the different survey methods, where optical survey estimates were greater than dredge estimates in areas of high scallop density. The main theory for these differences is that the dredge may have saturated during the standard 15-minute tow in high-density areas. The objective of this study was to assess the influence of scallop density on dredge efficiency (q). High-definition cameras were placed on the dredge to enumerate the number of scallops in the dredge path. Estimates of efficiency were derived by comparing the number of scallops in the dredge path to the number collected in the dredge bag. Additionally, the behavior and capture of bycatch species were examined. The estimated dredge efficiency for sea scallops was observed to decline with increased scallop density. At low densities, q estimates were similar to those reported in the 2018 stock assessment (0.4). As densities increased q declined to 0.09, indicating gear saturation. This finding suggests that the assumption of static catchability is invalid and needs to be adjusted to account for high density scallop aggregations.

## (42) KingGrid: An innovative design paradigm for rethinking sorting grids

Juan Santos[1], Frederik Furkert[1], Daniel Stepputtis[1] & Annika Brüger[1]

[1] *Thünen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069, Germany*

Sorting grids are commonly used in crustacean trawl fisheries to reduce by-catch by preventing unwanted species from entering the codend. While sorting grids can provide well-defined and efficient catch separation, their implementation in commercial fisheries can be difficult, particularly if the design of the grid is not optimised to address practical implementation challenges. This was the case in the North Sea beam trawl fishery targeting brown shrimp (*Crangon crangon*). In this fishery, sorting grids and sieve-nets are the two alternative technologies available and mandatory to the fishermen. However, steel grid designs originally proposed didn't meet the needs of the fishermen,

and were never commercially adopted, while sieve-nets became the prevalent technology. However, in recent years and specially during summer season, the use of sieve-nets has become unpractical due clogging issues linked to increased occurrence of algae and/or benthos invertebrates. Recognising the current need for efficient alternatives to sieve-nets, we have rethought the potential of sorting grids I the fishery through an innovative design paradigm that aims to deliver efficient, problem-focused solutions while addressing the practical challenges that can hinder the commercial adoption. Based on such design paradigm, herein we introduce the so-called KingGrid. The KingGrid is a 80x60 cm rectangular grid concept made from polycarbonate material which, combined with its functional design, results in a lightweight, mechanically flexible and robust device. It is designed to facilitate the transport of algae, benthos organisms and debris out of the net and is easy to access and clean, especially when compared to sieve-nets. The KinGrid is built using a simple modular assembly process, making it easy for fishermen to repair and to adjust the bar spacing to suit their preferences and changing regulations. Based on a paired-gear experiment, we investigated the sorting efficiency of the KingGrid with different bar-spacings, and compared it with the sorting efficiencies of traditional grids and a standard sieve-net with a nominal mesh opening of 60 mm. Using the KingGrid with a bar-spacing of 12 mm (8 mm below the maximum allowed bar-spacing in the fishery) led to an average catch efficiency of the targeted shrimp above 90%, a value comparable to the catch efficiency obtained with the standard sieve-net. On the other hand, using the 12 mm bar-spacing resulted in cleaner catches compared to catches obtained with the sieve-net, suggesting improved bycatch-reduction capabilities. Moreover, the KingGrid outperformed traditional sorting grids in terms of sorting efficiency, ease of handling, stability and robustness. Several KingGrid units have been already transferred to the fishery and intensive commercial trials are expected during summer under challenging fishing conditions. We believe that by adopting the KingGrid design paradigm, sorting grids can become a viable solution in any trawl fishery with similar bycatch problems.

## (43) Developing techniques to reduce Greenland shark bycatch in Northern shrimp trawls

Sidney Andrade[1], Shannon M. Bayse[1], Morgan Snook[2], David Kelly[3], Paul. D. Winger[1], Harold DeLouche[1] & Tomas Araya-Schmidt[1]

*[1]Fisheries and Marine Institute, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador, Canada*

*[2]Hampidjan Canada Ltd., Halifax, Nova Scotia, Canada*

*[3]Hampidjan Canada Ltd., Paradise, Newfoundland and Labrador, Canada*

Greenland sharks (Somniosus microcephalus) are captured as bycatch in Northern shrimp (*Pandalus borealis*) bottom trawls by becoming stuck in the Nordmøre grid system in certain instances. Thus, an additional bycatch reduction device (BRD) should be considered to ease Greenland shark's escape from the trawl. This study used underwater videos to understand the interactions of Greenland sharks with the grid system and evaluated the information to develop alternative trawl designs. Video analysis showed that the grid system opening was too small and disturbed Greenland sharks' escape. Thus, two experimental trawls were designed with: 1 – a sieve panel with a large exit opening attached before the grid system; and 2 – an increased exit opening (2.5 m) at the grid. Catch comparison methods were employed to test the treatment's effectiveness. Northern shrimp carapace length (CL) ranged between 12 and 27 mm, with 15, 20, and 24 mm modes. In the sieve panel treatment, the control caught significantly more shrimp between 19 and 24 mm CL, however, catch proportion differences were <3.5%. In the large opening treatment, the control caught significantly more shrimp for 25 and 26 mm CL but catch proportion differences were <1.0%. Overall, experimental treatments had a small Northern shrimp loss, hypothetically promoting an easier escape for Greenland sharks. However, further studies are needed to evaluate how the experimental designs affect the escape of Greenland sharks.

## (44) Effective techniques to develop a sustainable redfish fishery in Canada

V.Y. Nguyen[1], S.M. Bayse[1], P.D. Winger[1], H. DeLouche[1], G. Legge[1], Z. Cheng[1] & G.E. Kebede[1]

*[1] Fisheries and Marine Institute, Memorial University of Newfoundland, P.O. Box 4920, St. John's, NL, A1C 5R3, Canada*

Two effective techniques have been developed for an emerging redfish (Sebastes spp.) trawl fishery in the Gulf of St. Lawrence, Canada. Firstly, a shaking codend was developed to reduce the bycatch of small redfish in the catch. We attached an elliptical-shaped piece of canvas to the back of a T90 codend, and its movement and fishing

characteristics were tested in a flume tank and field experiment compared to the T90 codend without canvas. The results from the flume tank test showed that the shaking codend had a higher amplitude ratio, period (1 revolution), and total acceleration than the T90 across all flow velocities. Further, a small comparative fishing experiment showed that the shaking codend significantly reduced the capture of small redfish (< 22 cm) and had a better contact probability than the non-shaking T90 codend without canvas. Secondly, a semi-pelagic trawl was developed to capture redfish off the seabed. We applied the French rigging technique to connect the upper bridles of the trawl to the warps, anterior of the trawl doors, leading to the trawl system being fished off the seabed. The results from the first experiment indicated no problems in handing the semi-pelagic trawl and the hauling back process was similar to typical operations. Additionally, the trawl was able to perform effectively on or off-seabed as desired. The capture results, though preliminary during the second experiment indicated that redfish can be targeted commercially with a semi-pelagic trawl and that the catches of bycatch species may be reduced. Overall, these effective techniques developed in current studies can have potential implications for the development of the emerging redfish fishery in Canada and other trawl fisheries.

**(45) Test fishing meeting mechanistically understanding- a case study of gear development targeting the invasive round goby (Neogobius melanostomus)**

Peter Ljungberg[1], Stefan Eiler[1], Manuel Blanco[2], Anders Persson[2] & Ann-Britt Florin[1]

[1] *Swedish University of Agricultural Sciences*

[2] *Lund University*

The round goby (*Neogobius melanostomus*) is invasive to the Baltic Sea. In a three year project we have investigated the impact of round goby in Swedish waters along with developing and tested new methods for decreasing the negative effect by reducing dispersal and reduce the population along with the potential to capitalize the species. This is of high relevance for management of sea and water since round goby are known to cause negative effects both on aquatic biodiversity and on ecosystem services such as fishery and reduction of nutrients. In order to reduce the round goby we have developed and tested now passive gear types. Our aim has been on targeting both round goby but also other common species in the Swedish coastal fishery, as amongst others perch (*Percha fluventalis*). Exept for catch efficiency, research have focused on how the fishery could be conducted in a way that the European eel (*Anguilla anguilla*) may be selected from the gear. Moreover, to make our results more viable we conducted lab based selection and predator-prey interaction trials between perch and round goby to validate our fisheries results. We found the combination of field studies and lab experiments to give a synergistic effect on gear development.

## (46) Screw, Snap, Fish: First experiences with a modular and more resilient Pontoon Trap design

Thomas Noack[1], Sara Berzosa[1], Andrea Milanelli[1], Uwe Lichtenstein[1] & Daniel Stepputtis[1]

[1] *Thünen Institute for Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany*

Traditional trap nets have long been and continue to be effective and sustainable tools for shallow-water fishing, offering advantages such as live catch retrieval, adjustable selectivity, and minimal seabed impact. The evolution of this method led to the development of pontoon traps, introducing benefits like surface-level catch handling and increased fishing depth flexibility. However, their susceptibility to strong currents and storm events sparked our idea of redesigning them to enhance resilience. Our approach focuses on optimizing the pontoon trap design for robustness against external forces while transitioning from large, rigid components to a modular system. This shift offers several advantages, including easier repairs through the replacement of damaged modular units and efficient storage when not in use. In this presentation, we unveil our novel trap design and share initial insights and experiences gathered from a pilot trial initiated in March 2024 in the southern Baltic Sea. Collaborating with a traditional coastal trap fisher, we aim to demonstrate the practicality and efficacy of our redesigned pontoon trap in real-world fishing scenarios, thereby contributing to the advancement of sustainable and resilient coastal fishing practices.

## (47) Embracing new and more efficient fishing gears with focus on their impact on the catch composition

Rikke Petri Frandsen[1], Jordan P. Feekings[1] & Bent Herrmann[1]

[1] *DTU Aqua*

A targeted fishery for lobster (*Homarus gammarus*) is relatively new in Denmark and gears used in the fishery reflects what was already used by the coastal fleet i.e. gillnets, trammel nets, pots and fyke nets. Each gear type has its own set of regulations and preference of gear is area- and season specific, and there is no regulation aiming at restricting catches of juvenile lobsters or bycatches of other species. In 2018 a new trap design was introduced in the Danish lobster fishery. It was imported from China and was given the name “China trap”. It can be folded as a fyke net and when unfolded, it consists of a series of chambers, each resembling a creel. Catch rates were good and the gear was easy to store and handle from small vessels. The new gear was therefore readily adopted by the fishery, leaving behind a regulative system that needed an update. A comparative study was conducted to investigate catch rates of the different gears. Furthermore, escape gaps was investigated with regards to their optimal size and shape to match the minimum landing size and the minimum amount needed to allow for an efficient release of juvenile lobsters.

## 1.9. Innovative Gear - Whales

### (48) Protecting fish captured on longline gear from removal by whale depredation

Claude L. Dykstra[1] & Ian J. Stewart [1]

[1] *International Pacific Halibut Commission*

Whale depredation of captured fish is a growing challenge among many hook and line fisheries worldwide. In Alaska, both Killer (Orcinus orca) and Sperm (*Physeter macrocephalus*) whales are involved in depredation behavior in the Pacific halibut (*Hippoglossus stenolepis*), sablefish (*Anoplopoma fimbria*), and Greenland turbot (*Reinhardtius hippoglossoides*) longline fisheries. Depredation leads to increased costs to fishers, presents challenges to estimating removals for fisheries managers, and can lead to potential risks to whales including physical injury due to being near vessels and gear, disruption of social structure, and developing artificial reliance on non-primary food items. Following a workshop to identify effective methods for protecting hook captured fish from depredation, the International Pacific Halibut Commission recently pilot tested the two most promising designs: (1) an underwater shuttle which removed catch near the ocean floor and securely transported the catch to the surface, and (2) an underwater shroud which slid over a cluster of captured fish to cover them as they are brought to the surface. Key findings and outcomes from the pilot testing will be presented.

### (49) Co-existence of species at risk and fisheries through the trial and adoption of on-demand gear

E. Vézina[1] & S. Brillant[1,2]

[1] *Canadian Wildlife Federation, Halifax, NS, Canada*

[2] *Dalhousie University, Halifax, NS, Canada*

In Canada and the US, fishing grounds are being closed to protect critically endangered North Atlantic right whales from the threat of entanglement. Due to the economic and social impacts this management measure has on the fishing industry, a solution must be found that would allow whales and fisheries to co-exist safely. On-demand or 'ropeless' gear has been used effectively for military and scientific applications for decades, but until recently it's application in fisheries has been minimal. Over the past six years, significant efforts have been made to evaluate the suitability of this technology for fixed-gear fisheries. In 2019, the Canadian Wildlife Federation co-developed an innovative fishing gear trial program with fishing industry partners to evaluate the technology for Atlantic Canadian fisheries (see abstract by Skripsky et. al.). Using the knowledge gained through these trials, we established the CanFISH Gear Lending Program in 2022 to

provide access, training, and support to any fish harvesters in Atlantic Canada interested in using on-demand gear in areas closed to traditional fishing to protect right whales. To date, the program has successfully removed more than 500 buoylines from right whale habitat and has helped catch nearly 400,000lbs of marketable snow crab. Additionally, the L'Association des crabiers acadiens has been fishing with on-demand gear for the past three years in Canadian waters. Other organizations in both the US and Canada have been or are becoming involved in the trialing of on-demand gear in fixed-gear fisheries due to increased interest from industry. A regulatory framework is not yet in place to permit on-demand fishing on a broad scale, but recent steps including modifying the Fisheries General Regulations to allow fishing without a surface marker demonstrate a step in the right direction. Continued regulatory development and demonstration of the success of on-demand fishing will be essential to its continued adoption throughout Canada and abroad.

## (50) A framework for evaluating on-demand fishing gear suitability for Atlantic Canadian commercial fixed-gear fisheries

S. Skripsky[1], E. Vézina[1], R. Frith[2], K. Urbancic[1], K. Johnson[1], H. Vatcher[1], H. Drake[1] & S. Brillant[1,2]

[1] *Canadian Wildlife Federation, Halifax, NS, Canada*

[2] *Dalhousie University, Halifax, NS, Canada*

To determine its suitability for commercial fisheries, on-demand gear must be trialed under fisheries conditions. In 2019, the Canadian Wildlife Federation co-developed an innovative fishing gear trial program with fish harvesters to establish a method to evaluate this suitability across different on-demand systems and fisheries. Through regional discussions with harvesters, we built a framework that considered operational conditions, expectations of how the gear will function, and a way to measure factors that affect these functions. We implemented this framework in at-sea trials, completing more than 1000 deployments of nine different on-demand systems in snow crab and lobster fisheries from 2019 through 2023. A method of categorizing successful and failed deployments was developed that allowed individual components of each system to be evaluated, improving our ability to identify specific problems. In the interest of improving the suitability of on-demand systems for fishing, we provided this detailed feedback to gear developers on an annual basis. The data collected during these trials allows us to understand how the systems perform in varying environmental conditions and fisheries. Since the beginning of the program, more than 14 commercial harvesters have been engaged in trials throughout the Maritime provinces. These collaborations have been essential for identifying suitable on-demand systems for use in commercial fisheries in Atlantic Canada.

# 2. Presentations Included in the Focus Session (51-65)

## (51) Improving discard quantification on commercial fishing vessels. Discard valves, load cells and catch estimations

Allard van Mens[1]

[1] *Wageningen Marine Research*

We want measurements, not estimates!

The aim of this project was to test multiple technical solutions for accurate measurements of total catch and discard quantities onboard commercial beam trawl vessels, that are participating in gear technology trials and discards monitoring programs in the Dutch North Sea. For these programs, amounts of discards are usually calculated by subtracting landings (i.e. marketable fish) from the total catch (i.e. all fish caught in the net). The total catch is usually inferred through an estimation of the haul weight by the skipper and/or researchers (i.e. optical estimations). The composition of discards is rendered by taking a discard subsample, weighing it and sorting it to species level. These species are then individually measured for length and weighed collectively. This way, with a ratio of estimated discards weight to the discard subsample weight, the composition of all discards is estimated. This method has been criticized by stakeholders in the Dutch fishing industry and scientists alike for being imprecise due to the visual estimation of the total catch.

To investigate other, potentially more precise, catch and/or discard measurement methods a trial aboard a commercial fishing vessel was undertaken. During this trial the following measuring methods were considered: sea state compensated measurements of the total catch in a cod-end, 'traditional' visual catch estimations by fishermen and scientific observer, hopper fill combined with volume to weight conversions, conveyor belt rotations (in sorting area), collecting all discards (which was used as a reference) and a discard valve with integrated sea state compensated scale. Also, a discards subsample basket was taken from every sampled haul. From the subsample a common and less frequent discard species (plaice and sole respectively) were selected and measured. The sample was raised to the total catch or total discards for every method. The results for both species for every method were then compared to the exact amount in the collected discards. From every sample taken the length of 50 plaice and sole was measured. These length frequencies were then raised by the subfactors resulting from every method and compared to 150 measured individuals in a completely sorted haul. The differences in length frequencies differed (in some cases by more than 150% for an individual length).

The discard valve appeared to be the most precise method, although the total amounts of discarded sole and plaice were consistently underestimated. The valve is still a prototype and will have to be improved to be able to process larger amounts and occasional large objects (larger fish, wood, stones, debris). This method was also relatively workable on board the vessel. The other methods had large uncertainties and performed worse than the discard valve. The further development of a functional tool for accurately measuring catch and discards on commercial vessels will be at the heart of future developments in monitoring and fishing techniques (e.g., Electronic monitoring).

## (52) Reducing fishing impacts in marine ecosystems: modifications to set nets

Monika J. Szynaka[1], Pedro Rocha[1], Pedro Monteiro[1], Karim Erzini[1,2], Jorge M.S. Gonçalves[1,2], Aida Campos[1,3]

*[1] CCMAR - Center of Marine Sciences Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal*

*[2] FCT, Faculdade de Ciências e Tecnologia, Universidade do Algarve, 8005-139 Faro, Portugal*

*[3] Instituto Português do Mar e da Atmosfera - Av. Alfredo Magalhães Ramalho, 6*

*1495-165 Algés, Portugal*.

Trammel nets and gillnets are used by many vessels of the Portuguese coastal multi-gear fleet, comprising around 500 vessels with LoA above 9 m. This type of gear is used to catch a variety of species, with impacts both on benthic populations and their habitats. Modifications to trammel nets (e.g. the “greca”) were tested in many fisheries to reduce by-catch, but not commercially adopted given the observed reduction in commercial catches along with reductions in unwanted by-catch. In this study, modified trammel nets and gillnets, raised off the bottom through a system of ropes (‘aranha’, according to the local fishers) were tested in the cuttlefish (Sepia officinalis) and the hake (Merluccius merluccius) fisheries in a rocky bottom area, where by-catch of invertebrates, including sensitive habitat-forming species is high. A reduction in the capture of corals and sponges was attained when the modified nets were used, with non-significant changes in the capture of the target species. During the experiments, a video analysis assisted in accounting for all individuals of the habitat-forming species caught in high volumes that were overlooked in real time data collection onboard due to regular hauling procedures by commercial fishers. A net damage assessment was carried out, showing that the damaged area in standard nets triples that observed in modified nets. The financial impact of the use of the modified nets is discussed, along with the possibility of automating the video analysis, with a focus on quantifying the number of habitat-forming species as the individuals of various species are difficult to assess. Finally, the upcoming work within the framework of TramSel will be addressed. Opinions from fishers on the

usefulness of a future implementation of the proposed changes were collected, offering a solution to be disseminated to the sector in the near future, within the scope of the TramSel project.

**(53) Developing an intelligent discard chute with optical imaging and machine learning to revolutionize the electronic monitoring program for New England groundfish fishery**

Pingguo He[1], Christopher Rillahan[1], Ming Shao[1], Rick Usher[2], Josh Wiersma[3] & Jeff Douglas[3]

[1] *University of Massachusetts Dartmouth, New Bedford, MA, USA*

[2] *Issac Davison and Peter Melanson, A.I.S. Inc.*

[3] *Integrated Monitoring Inc.*

This presentation reports the design and construction of an intelligent discard chute that incorporates optical imaging and machine learning to automatically detect species and measure sizes of fish that are being discarded through the chute. Images from the camera inside the chute are integrated to other video images from other deck cameras, and are streamed via satellite or cellular network, more recently via more affordable Star Link service, to the office for processing and auditing. Algorithms for video image analysis using artificial intelligence and machine learning are being developed to document species and measure size (length) of fish being discarded. This project is a collaborative effort among an electronic monitoring enterprise, an at-sea observer company, and fisheries researchers and an AI/ML expert, with an aim to incorporate new technologies in the field of fisheries monitoring to meet the increased fisheries monitoring requirement in New England and elsewhere in the world.

**(54) Panoramic Perspectives and Extended Battery life: Advancing Underwater Observation in Fisheries technology**

Peter Ljungberg[1], Andreas Sundelöf[1], Sara Berzosa[2], Andreas Hermann[2], Andrea Milanelli[2], Daniel Stepputtis[2], Hampus Södergren[3] & Thomas Noack[2]

[1] *Department of Aquatic Resources, Swedish University of Agricultural Sciences, Almas Allé 5, 756 51 Uppsala, Sweden*

[2] *Thünen Institute for Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany*

[3] *Hanö Torskrev, Bivägen 2, 294 36 Sölvesborg, Sweden*

Action cameras have found diverse applications in fisheries science, from recording animal behavior in and around fishing gear to evaluating gear performance and modifications. However, two primary challenges have traditionally been faced: limited battery life and constrained viewing angles. By combining action cameras with external batteries, extended running times could be achieved allowing for recordings of long fishing activities like extended trawl hauls or long soak times in passive gears. However, the issue of the limited angle of view remained: In case a camera was not mounted properly, i.e. the angle of view did not fit to what was intended to be recorded, recordings of one fishing activity might have to be discarded and redone. While the introduction of panoramic cameras addressed the issue of limited viewing angles with their often up to 360Â°recording capabilities, they lacked options for extending battery life.

In this study, we introduce a novel approach by combining a 360Â° camera with an external battery, enabling recording sessions up to 42 hours. As a practical application, we demonstrate the utility of this setup in investigating fish and crustacean behavior in pots but also animal behavior and habitat use around reef structures. This advancement not only opens doors to prolonged underwater observation, overcoming previous limitations and offering new insights into fisheries research and management, but also enhances the viewing experience through immersive virtual reality (VR) goggles. By utilizing VR technology, viewers can dive deeper into the recorded content, experiencing a heightened level of engagement and understanding of what is happening under the surface.

## (55) AI Catch - A pioneering concept with ultrasonic sonar sensors and a mechanical valve to optimize catches in beam trawl fisheries

Van Opstal Mattias[1], Van Vlasselaer Jasper[1] & Rommelaere Piet[2]

[1] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences - Fisheries, Jacobsenstraat 1, 8400 Oostende, Belgium*

[2] *MARELEC Food Technologies, Redanweg 15, 8620 Nieuwpoort, Belgium*

The European Landing Obligation intensified the relevance of minimising the discard rates within the discard intensive Belgian beam trawl fishery targeting sole. In recent years, the use of underwater cameras to optimize catches is gaining attention in fisheries worldwide. One of the challenges of beam trawling is the limited visibility underwater, which makes traditional camera systems ineffective. The AI catch system aims to overcome this challenge by using ultrasonic sonar sensors to detect fish in the net. Advanced imaging technology is developed to determine the length of fish, subsequently allowing software to determine whether the fish should be retained or directed towards an escape route through a valve positioned just in front of the codend. The system is

connected to the vessel by an electrical cable via a specially controlled winch. Operation of the system can be monitored live on screen on the bridge. First trials on board of a Belgian research vessel are promising. The system is able to distinguish legally sized from undersized fish, but further development is needed to distinguish between different species. The system still requires technical improvements before it can be implemented on board of commercial trawlers.

### (56) VISTools. Fishing vessels as automatic data-gathering platforms a win-win for fishers and scientists

Lancelot Blondeel[1], Femke Aers[1], Anthony Van De Sompele[1], Wim Allegaert[1], Els Vanderperren[1] & Hans Polet[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO)*

A skipper of a fishing vessel has access to various sources of information that help in managing his/her work. Conventional onboard equipment tracks the location (e.g., GPS), monitors fishing activity (e.g., towing force), measures fuel consumption and registers landed catch (i.e., via an electronic weighing scale). This equipment gathers valuable data, but none of that is of any use if data are not integrated, stored or processed.

By automating data collection from these sources and coupling this information with economic parameters (e.g. fish prices and fuel prices), the VISTools project developed (1) a reliable IoT solution for fishing vessels, (2) a business intelligence tool for fishers and (3) a framework for sharing data for research purposes. With this approach, fishers gain new insight into the economic performance of their fishery (up to tow level), while exchanging valuable high-resolution data with research institutes.

This increased insight could trigger behavioural changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. Additionally, the business intelligence tool incentivizes fishers to keep gathering information that has great scientific relevance and share this information under clearly defined conditions. Vessel owners can also share gear configurations on a trip-by-trip basis, allowing them to compare their performance per utilized gear type. The current system is operational on 21 vessels, with installations planned on 16 more vessels in 2024, amounting to 62% of the Belgian fleet. This coverage offers new avenues for research including precision fishery, high-resolution impact assessments of fishing gear, catch prediction and fuel-efficiency models. With these models, decision support tools can be developed that balance the trade-offs between the profitability of a vessel, and minimising fuel consumption and the impact on the environment.

## (57) Automatic 3D fish tracking to assess fish behavior inside trawls

Robin Faillettaz[1], Julien Simon[1], Dorothée Kopp[1], Matt Dawkins[2] & Thibault Pelletier[3]

[1] *DECOD (Ecosystem Dynamics and Sustainability), IFREMER, INRAE, L'Institut Agro, Lorient, France*

[2] *Kitware Inc., USA*

[3] *Kitware EU, France*

Understanding the behavior of fish inside fishing gears could help designing species-behaviour specific selective devices. Yet, observing behavior in situ requires both extensive sampling and data processing. Due to its time-consuming nature, the latter is the current bottleneck in handling imagery data. The project Game of Trawls aims at enabling active selectivity in trawl fisheries, and relies on stereoscopic cameras for species detection in front or inside the gear. Such cameras enable to measure the size of individuals but may also enable to reconstruct the 3-dimensional movements—and thus behavior—of fish at the scale of the individual. We achieved this by developing a pipeline based on the architecture of the open-source software VIAME. It allows to calibrate any stereocamera, train a Mask-RCNN detector and compute inference and tracking of left and right images separately. Then, the stereocamera calibration is used for computing stereo disparity (depth maps), pairing the detections from both images and reconstruct the 3D positioning of each individual, automatically. The quality of the stereo-tracker is strongly influenced by the robustness of the mask detector model and the stereocalibration of the camera. The model has been applied on sequences of pelagic fish swimming inside a trawl, revealing the 3D movement of fish in the available volume, offering estimates of distances, at least relative, between individuals. This tool will continue to be improved but can already be used to extract fish tracks from much larger dataset.

## (58) Sampling techniques and AI for fishing technology and fish behaviour introducing SNTech Catchcam and Seasensor products

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

Three years ago, SafetyNet Technologies (SNTech) launched CatchCam to the fisheries market. Designed with fishermen for fishermen, CatchCam sought to give commercial fishermen a tool to allow them to see their fishing gear in action.

Intended to be a tool for every gear type and all applications from the trawl doors to the codend and from the buoy line to the individual hook CatchCam, has delivered an agile

fit for purpose solution into the fishermenâ€™s and researcherâ€™s hands. The system offers multiple lighting solutions, configurable recording setting including timelapse with a battery life of up to 4 weeks. Robust enough to remain on a trawl tow after tow, the wireless charge and download systems make CatchCam ideal for use in such harsh environments. The user interface makes CatchCam a standout product for users, particularly the ability to review footage when the systems is on the deck during hauling, maximising precisions fishing and research time.

Building on the successes of CatchCam SNTech have developed an oceanographic multi-sensor for fishing applications. SeaSensor shares much of the CatchCam DNA, offering wireless charging and data transfer along with an intuitive App interface for configuration and accessing data. SeaSensor provides depth, temperature, turbidity, light intensity and 9axis accelerometer data. Salinity will be offered in 2024 and SNTech are working to provide a free port for specialist sensors such as O2 and pH.

Robustness and fit and forget applications are very important features in fisheries applications. SeaSensor uses many of the lessons learned while deploying CatchCam and both products can be deployed together, offering facilitating opportunities for layering data and extracting video for given conditions and providing digestible data for deep analysis. Both products lend themselves to machine learning especially given the breath and quantities of data that can be generated. Currently SNTech are working on â€œinterestingnessâ€ algorithms and hope to offer users the ability to filter out non-interesting content later in 2024. Further smart tools will be required to maximise the value of the data collected and SNTech are eager to work with the research community to research and develop these.

### (59) SmartFishing –stereo-camera system for trawl observation

Daniel Stepputtis[1], Nico Günzel[2], Mathis Mahler[1], Tim Dolereit[3] & Olaf Krüger[4]

[1] *Thünen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany*

[2] *Framework Robotics GmbH, Alter Hafen Süd 334, 18069 Rostock*

[3] *Fraunhofer IGD, Joachim-Jungius-Straße 11, 18059 Rostock*

[4] *FIUM GmbH & Co. KG, Institut für Fisch und Umwelt, Fischerweg 408, 18069 Rostock*

Camera systems play a crucial role in the investigation of living aquatic resources - especially in the vicinity of fishing gear, including trawls. The use of camera systems will also transform the harvest process and open up opportunities to sharpen the catch process to meet economic and ecological demands. The fundamental challenges here are robustness, ease of use and the most comprehensive possible spatial detection of the objects to be recognised.

We present a stereo-camera system that addresses these challenges by using 3D-printing techniques to achieve best possible size-factor and robustness of the system. Based on the design, the system can be easily mounted e.g. in a trawl to observe the catch. The system can be used in autonomous mode and in tethered/realtime mode to allow AI-driven image recognition in fisheries and fisheries science. The presentation will introduce hardware, software and application.

## (60) Commercially available technologies for monitoring fisheries efficiencies and impacts

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

The impacts of fishing on the environment are coming under ever greater scrutiny. Relatively speaking wild capture fish and fishing are some of the lowest impact food systems on the planet, however for some this is not enough and there is always room for improvement. Peter Drucker astutely observed that “if you can’t measure it, you can’t manage it.” In terms of fishing impacts on the seabed, very little is understood. There are however, well understood measures of efficiency, even if the fishing operation itself is not. The presentation will examine the methodology used in the UK FISP funded project - Assessment of seafloor fishing gear interactions and ecosystem response to disturbance. It will explain the technologies used in the study and demonstrate how these technologies will be used to benchmark the nephrops trawl gear. Further it will explain how these technologies can be used by commercial fishermen on a daily basis to evidence their impacts and enable fishermen to reduce their impacts while maintaining or improving their catch efficiency. The presentation will include several videos to demonstrate the technologies at work and show the ease of use of the technologies by the crews. Finally the presenter will discuss how these technologies can be used in fisheries certification and ecolabelling.

## (61) Active selection progress: improving *ActSel* systems and facilitating their application to reduce bycatch

Craig S Rose[1]

[1] *FishNExt Research*

The availability of real-time video of fish passing through trawls motivated development of a system to release unwanted fish by triggering temporary net changes. Rose and Barbee (2022) developed and demonstrated a prototype of such an active selection (ActSel) system, that used a hydrodynamic kite to move a net panel covering an escape portal during normal fishing. Moving the panel to release fish uncovered that portal and

funneled fish into it. Initial trials during commercial fishing were frustrated by inconsistent operation, failing to quickly identify effective kite adjustments. New and improved kite designs and adjustments were found through model trials, involving a team of fishery participants. The electromechanical actuator that adjusts the kite's control lines was redesigned around another underwater rotator that provided continuous position control and feedback. Subsequent field trials led to a configuration providing consistent and rapid panel shifts and useful insights for adapting the systems to new vessels. These will be applied to supporting 2024 ActSel deployments into relevant fisheries.

## (62) Open sesame: design of a moving escape gate and species-specific reactions to an active selection device in the aft of a trawl

Melanie J. Underwood[1], Emma G. Jones[1], Karl Warr[2], Steve George[1] & Charlotte Bodie[1]

[1] *National Institute of Water and Atmospheric Research, Auckland, New Zealand*

[2] *Better Fishing Ltd, Napier, New Zealand*

Many fisheries face the challenge of encountering multiple species, some of which may not be desirable or permissible to catch. The effectiveness of fishing methods in catching specific species and avoiding or releasing others depends on the shape, size, and behaviour of the targeted species. Understanding species-specific behaviour can help improve fishing selectivity and facilitating more targeted fishing practices, particularly in cases where certain species have restricted quotas. In this study, we investigated the behaviour of common New Zealand fish species, such as snapper and red gurnard, in a demersal trawl. We quantified their reactions to a moving escapement gate and evaluated the impact of behaviour on escape success. Furthermore, we discuss the advantages and challenges associated with using a moving gate to release non-targeted species at fishing depth during the capture process.

## (63) Technology-based precision fishing with real-time decision making in demersal trawl fisheries

Ludvig A. Krag[1], Mette M. Svantemann[1], Ercan Avsar[1] & Fletcher Thompson[1]

[1] *Technical University of Denmark, DTU Aqua*

Increasingly ambitious management plans and stronger public opinions on the ecological cost of bottom trawling force the industry to reduce unwanted bycatch, impact on the seabed, and consumption of fossil fuel to maintain access to fishing areas and market. Technology-based fishing has the potential to transform trawling from a

blind to an informed process. This transformation is a prerequisite for developing precision fishing as it enables the operator to actively make real-time decisions during the fishing operation. In recent years, DTU has developed a pipeline to digitize the catching process in demersal trawls. This pipeline consists of the use of a real-time camera, sediment suppressing system, and automatic catch description using machine learning. The ongoing development of real-time decision-making tools can help individual fishers to make the fishing operation with demersal trawls much more targeted, efficient, and transparent. We demonstrate examples of decision-making tools for different demersal trawl fisheries. These are established based on real-time image processing of the catching process using machine learning and involve automatic description and logging of the species and size composition inside the trawl. We show how this information can be presented to the individual fisher in the wheelhouse and, for example, be shared between vessels to obtain a comprehensive spatiotemporal understanding of the current and historical species and size distribution on the fishing ground. Finally, we discuss the state of the development of technology-based precision fishing as well as drivers and barriers for commercial up-take of the technology.

## (64) Abandoned, lost or otherwise discarded fishing gear (ALDFG)- Introducing MyGearTag Acoustic lost gear technology

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

Abandoned, lost or otherwise discarded fishing gear has long been an issue for the commercial fishing industry. The problem persists today however, awareness has increased inside and outside of the fishing industry and with this awareness has come scrutiny focus on finding solutions. The issue of ALDFG is a complex one with many causes and as such there is not one single solution. In recent years several products have come to the market that offer fishers tools to mitigate against losing fishing gear and aiding with its recovery. Succorfish, a UK technology company have now launched a product that provides a cost effect solution for locating lost gear even when it moves over long distances. The MyGearTag solution comprise of battery power acoustic beacons that are attached to the fishing gear and a deck unit that communicates with the beacons via an app. The dunk transducer comes in a Pelicase for easy storage and can be shared amongst several vessels as it is designed to be used only when gear is lost. The system range is 3km omnidirectional. Battery life is 60 days and the beacon is rated to 250m depth. The beacon costs are circa $500 and the deck system is less than $1,000. The system has been trialled in trawl and static net fisheries and trials and commercial deployments are underway outside the UK.

## (65) Spatial and temporal distribution of fish near wind turbines using underwater video cameras

Keith Hankowsky[1], Chris Rillahan[1] & Pingguo He[1]

[1] *University of Massachusetts Dartmouth - School for Marine Science and Technology*

Offshore wind is a burgeoning industry off the East Coast of the US. Offshore wind development will transform previously homogenous habitat into complex three-dimensional habitat with turbine structures. Understanding the spatial utilization of fish in the vicinity of a wind turbine structure and connectivity between structures is important in evaluating the overall impact of large-scale offshore wind development. Traditional survey methodologies like trawl surveys can be limited in their ability to detect change in fish abundance, population structure, and community composition directly adjacent to fixed structures due to navigational concerns and gear constraints. This project aims to investigate the effect of turbines on the spatial distribution of fish and invertebrates and seasonal changes in distribution. Benthic and pelagic baited stereoscopic video systems were deployed in four mooring systems at fixed distances from the turbines: close proximity to the turbine (0m), 100m, 200m, and 450m during daylight hours. Each camera was deployed for 1 hour. So far, 144 deployments have been conducted with another year of sampling to be carried out. Fish abundance, population structure, and community composition will be analyzed in relation to the distance from the turbine. Preliminary observations indicate that the turbine structures are utilized by a diversity of fish including black sea bass and scup. This project complements an acoustic tagging and monitoring component to understand the distribution, residence, and connectivity of fish between wind turbines in large wind farms.

## (66) Smart Buoy Technology for Gear Marking and Data Collection

Kortney Opshaug[1]

[1] *Blue Ocean Gear*

The open ocean presents challenging conditions for operating fishing gear, with fog, storms, and tidal or current forces all hindering the ability to locate gear during fishing operations. This causes significant fuel use spent searching for gear, as well as gear loss if it moves far from where it was set or becomes temporarily dragged under the surface. Lost gear leads not only to ghost fishing, but also increases the risk of marine mammal entanglement. In addition, other vessels may come into conflict with gear they cannot see, causing damage to their vessel as well as the equipment.

The marking of fishing gear that is active out on the water is a critical factor in preventing gear loss and improving fuel efficiency out on the water. Smart Buoy technology is

expanding in its adoption due to its ability to improve the efficacy of gear recovery by the end of a fishing season, as well as the benefits provided to fishing fleets. As an example, over 600 pieces of gear have been tracked for harvesters in three Canadian provinces this past spring, primarily for gear loss prevention. Discussion of these deployments will be presented to highlight the role of technology in enabling sustainable practices within the fleets while also providing economic benefits.

Beyond gear marking capability, additional sensors onboard the Smart Buoys provide an efficient means of gathering high-density oceanographic data from deployed gear in regions where this can be lacking. This information can be useful to the fishing industry, as well as shared (with agreement from the harvesters) with other entities. The development of technology that can create a bridge between the advantageous placement of fishing gear in coastal zones of economic importance and other ocean industries and research that rely on ocean condition information is key in expanding a relevant database with broad application.

# 3. Posters (A-Q)

### (A) Result of the fishing gear marking experience in Argentina

Ricardo R Roth[1]

[1] *National Institute of Fisheries Research and Development (INIDEP) – Argentina*

This work shows the variation on the condition of marks over almost a one-year experience through direct observation and photographic recording, made with marks placed on a bottom trawl net belonging to a vessel engaged in hake fishing. The number of hauls, towing time, and total catch of each fishing day, since the beginning of the experience was obtained from the F/V's fishing reports. Can be seen that from September 14, 2022, when the experience started, to June 13, 2023, when the last review of the marks was carried out, the vessel made 13 fishing trips, a total of 239 hauls, with a time of trawling time of 675 hours and a total catch of 3113.36 metric tons, mainly of common hake (*Merluccius hubbsi*). Because of the net is no longer used, due to its technical condition, and was dismantled, the wing tip markings were returned to the INIDEP Fishing Gear and Capture Methods Development Program. Different figures show the evolution of the marks condition used during the experience. It is concluded that there is the possibility of losing the marks due to snagging, as could be seen in the first review, that the location of the marks must be carefully studied and will depend on the type of fishing gear that is marked and the fishing operation that is carried out. Is made, that metal marks such as those tested, can last as long or longer than the gear where they are used, depending on the conditions of use and location. During the test no alterations or inconveniences were observed in the operation of the trawl gear. Friction of the mark with other elements, such as the seabed, can alter the information recorded on it. Therefore, the possibility of replacing the mark must be analysed, justifying its replacement, if its use is regulated as occurs in provision No. 4/2023 of the National Directorate of Fisheries Coordination and Supervision of Argentina, in which establishes a unique number for each fishing gear.

### (B) Spreading a bottom trawl without doors: a proof of concept using flexible foils

Paul Winger[1], Alex Gardner[1], Truong Nguyen[1] & Liam McGregor[1]

[1] *Fisheries and Marine Institute, Memorial University of Newfoundland*

This study documents an engineering proof of concept. We demonstrate that a deep-water bottom trawl targeting Northern shrimp can be spread without trawl doors using nothing more than flexible foils mounted near the wings of the trawl. A combination of numerical simulation, physical modeling in a flume tank, and full-scale sea trials were

used to optimize the trawl. Spacing between the kites and the angle of attack to the direction of tow were found to be important parameters. To our knowledge this is the first documented attempt to spread a bottom trawl entirely without doors, using only flexible kites.

**(C) Galvanizing crab traps: prolonging lifespan while maintaining snow crab catch**

Pete Brown[1], Tomas Araya-Schmidt[1], Terry Bungay[1] & Paul D. Winger[1]

[1] *Fisheries and Marine Institute of Memorial University of Newfoundland, P.O. Box 4920, St. John's, Newfoundland and Labrador, A1C 5R3, Canada*

Commercial harvesting of snow crabs (*Chionoecetes opilio*) began in Newfoundland and Labrador, Canada, in 1967. Today, the fishery consists of 2188 active fishing licenses and has grown into the province's most economically valuable fishery. Snow crabs are captured using conical traps consisting of a mild carbon steel frame, hard plastic entry funnel and a jacket of polyethylene netting. The frames of these traps corrode over time, which is expedited by being deployed in marine environments and stored on land near the ocean when not in use. As a result, there is interest within the community to increase the longevity of crab traps. One solution is to galvanize the steel frames prior to installing the funnel and netting. However, before harvesters transition to galvanized traps, two questions must be answered. Will the use of galvanized steel negatively impact catch rates? Will the life cycle of a crab trap be extended sufficiently to justify the additional cost of galvanizing? This study employed a generalized linear mixed model to evaluate the catch of legal-sized male crabs (CPUE) during the commercial fishery as a function of three trap frame treatments (old traditional, new traditional and new galvanized). We also assessed the economic viability of galvanizing trap frames by evaluating the life cycle cost (LCC) of traditional and galvanized traps to the harvester. The LCC was calculated over a range of inflation (0–6%) and discount (3–20%) rates. Our results found no significant difference in CPUE between new traps (traditional vs. galvanized) and concluded that except during instances of very high discount rates (12.9–19.9%), it is economically favourable to galvanize crab trap frames.

**(D) Should I stay or should I go?**

Peter Ljungberg[1], Joanna Haffling[1] & Andreas Sundelöf[1]

[1] *Swedish University of Agricultural Sciences*

For European lobster (*Hommerus gamamrus*), the conventional gear used is pots, which are typically designed to be efficient for fishing in exploited populations. Mesh size, escape gaps and entrances of the gear limit the size range of potential catch. In a

conventional lobster fishery, low selectivity/catchability of the largest individuals of lobsters has no practical effect on total catch as such individuals are extremely rare in exploited populations. However, in monitoring of population size and composition of recovering populations within no-take zones catchability of all sizes are relevant.

This study uses information on size dependent selectivity in combination with in-situ video to reveal size dependent behaviours in and around pots within a no-take zone. Behaviours include both dominant and submissive actions such as aggressions, avoidance, and guarding. Guarding typically occurs by individuals too large to enter the gear and dominant enough to guard the pot for sustained amount of time. In extreme circumstances, guarding may result in zero catch even in areas of high lobster density. In effect monitoring with a too selective gear will contain a strong bias of behaviour to total density estimates as well as the composition of different sizes.

### (E) Approaching single-species exclusion in mixed demersal trawl fisheries

O. Jonas Palder[1,2], Jordan P. Feekings[1], Shaun Fraser[3] & Valentina Melli[1]

[1] *Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua), DK-9850 Hirtshals, Denmark*.

[2] *Department of Fish Biology, Fisheries and Aquaculture, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Germany*

[3] *Shetland UHI – Scalloway Campus, University of the Highlands and Islands, Port Arthur, Scalloway, Shetland, ZE1 0UN, UK*

Under a discard ban, mixed fisheries must often reduce catches of low-quota species to allow the continuation of fishing activities. This has led to the development of a range of bycatch reduction devices (BRDs) that aim to exploit morphological and behavioral differences among species to facilitate escape of unwanted catch from the fishing gear. However, the exclusion of unwanted species from the catch is often only possible with concomitant losses of other commercial catches. This is the case for the Nephrops (*Nephrops norvegicus*)-directed mixed demersal trawl fishery, where BRDs aiming at the reduction of catches of cod (*Gadus morhua*) often lead to considerable losses of other valuable species. In this study, we developed and tested a BRD aimed at exclusively reducing cod catches without affecting catches of Nephrops, flatfish and other roundfish. The design, a bottom escape window, exploits behavioral traits that set cod apart from other species. We collected absolute selectivity data using a paired gears approach and estimated the combined retention of the bottom escape window and a 90 mm diamond mesh codend. The results demonstrated a low total retention of cod (33 %) in combination with high retentions of commercial catches of Nephrops (89 %), haddock (*Melanogrammus aeglefinus*) (76 %) and plaice (*Pleuronectes platessa*) (100 %), for the

populations encountered. This catch profile represents an important and novel achievement for Nephrops-directed mixed demersal fisheries. We compared the performance of this new BRD to one of the most used legal gears in this fishery (the SELTRA 270), demonstrated the new catch profile it can offer to the fishers, and discussed its management implications.

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**(F) CanFISH Gear Lending Program: a solution to whale closures in Atlantic Canada**

Kirklen Johnson1, Elizabeth Vezina1, Krystyna Urbancic1, Sahra Skripsky1, Hanna Vatcher1, Hannah Drake1 & Sean Brillant1,2

*1Canadian Wildlife Federation, Halifax, NS, Canada*

*2Dalhousie University, Halifax, NS, Canada*

To mitigate entanglement risk to the critically endangered North Atlantic right whale, the Canadian government has been implementing fishery closures since 2018. While effective in removing entanglement threat, this measure displaces fish harvesters, posing economic stress and hardship for coastal communities throughout Atlantic Canada. On-demand fishing gear has been shown to be a suitable method of commercially fishing without buoylines, but barriers to using this gear remain, such as cost, accessibility, training needs, and permitting. To alleviate these barriers, the Canadian Wildlife Federation established the CanFISH Gear Lending Program in 2022 to provide harvesters with on-demand fishing gear and the support required to fish with it in closed areas. CanFISH provides free access to the gear, on-vessel training, and continued on-call support to ensure safe and successful fishing. Pre-season training sessions as well as in-season, on the water demonstrations ensure that harvesters are confident with the technology before using it to fish. Because this gear type uses acoustic, mechanical, and electrical components, proper care and maintenance is essential to ensuring its ongoing success. CanFISH has a team of trained technicians who maintain, troubleshoot, and repair the inventory of 180 on-demand systems regularly. Maintaining a strong working relationship with the system manufacturers has been crucial to the program's success as it ensures the team is well-informed of system upgrades and maintenance procedures. To date, more than 200 harvesters have signed up to use CanFISH if they are impacted by a closure, and 12 harvesters have used the gear to fish commercially. Our comprehensive approach to industry training and gear maintenance ensures that on-demand gear can be an effective solution to whale closures in Atlantic Canada.

**(G) Behavioral ecology informs fishing gear design : The case study of Black seabream baited structure**

Marianne Robert[1], Robin Faillettaz[1], Aurore Cortay[1], Dorothée Kopp [1], Marie Morfin[1], Fabien Morandeau[1], Julien Simon[1], Jean Louis Deneubourg[2] & Sonia Méhault[1]

*[1] Ifremer, UMR DECOD (Dynamique et durabilité des écosystèmes : de la source à l'océan), F-56100 Lorient, France*

*[2] Université libre de Bruxelles, Center for Nonlinear Phenomena and Complex Systems, Avenue Franklin Roosevelt 50, 1050 Bruxelles, Belgium*

As a response to an increase demand for more sustainable production of marine proteins, there is a strong need for developing alternative fishing technics to trawling such as commercially viable baited pots. However, these fishing methods have low catch efficiency. Knowledge on animal behavior is a key element to understand and improve the capture processes. Advances in underwater video cameras systems have provided novel tools for researchers and facilitated the observation of species interacting with fishing gears in their natural environment. In this study, using a recently published methodology we quantitatively assessed the effect of external and internal factors on the ingress process of seabreams inside baited structures. Weibull distribution describes the distribution of residence times through time and allows testing the effect of fish length, number of congeners or pots design on ingress rate and the propostion of the population that eventualy enter the pot. We demonstrated size and social effects on ingress process of black seabream around baited pots and discussed how such findings can be useful to design and improve baited structures.

**(H) Enhancing sustainability in snow crab fisheries: collaborative solutions for improving size selectivity, catch efficiency, and mitigating ghost fishing**

Kristine Cerbule[a1], Tomas Araya-Schmidt[a2], Shannon M. Bayse[2], Paul D. Winger[2], Roger B. Larsen[1], Bent Herrmann[1,3], Rikke P. Frandsen[3] & AnnDorte Burmeister[4]

*[a] To be considered joint first authors*

*[1] UiT The Arctic University of Norway*

*[2] Fisheries and Marine Institute, Memorial University of Newfoundland, Canada*

*[3] DTU Aqua, Technical University of Denmark*

*[4] Greenland Institute of Natural Resources*

Snow crab is a commercially exploited species in cold-water areas in the Arctic Hemisphere using baited pots. Several sustainability challenges are common in the Arctic snow crab pot fisheries including low catch efficiency and unintended capture and

mortality of undersized crab, as well as problems associated with lost gear such as continuous capture of snow crab by lost pots (ghost fishing) resulting in unintended mortality. Our research aims to increase research collaboration to develop technical modifications for improving sustainability in these fisheries by improving catch efficiency and reducing unintentional snow crab mortality. This poster describes several ongoing laboratory experiments to: (1) assess the performance of side entrances added to traditional snow crab pots to increase the catch efficiency of commercial crabs and the escapement of undersized individuals, and (2) assess the use of escape gaps in snow crab pots as a potential mechanism to improve size selectivity.

**(I) Entanglement in fishing gear is one of the primary threats inhibiting the recovery of critically endangered North Atlantic right whales (NARWs)**

Genevieve Peck[1], Krystyna Urbancic[2], Paul D. Winger[1] & Sean Brillant[2]

[1] *Fisheries and Marine Institute, Memorial University of Newfoundland*

[2] *Canadian Wildlife Federation, Halifax, NS, Canada B3S 1A9*

Low-breaking strength (LBS) modifications are approved Canada for voluntary use in Canada and have been implemented and used in parts of the United States. Implementation of these has the potential to alleviate the severity of entanglements. However, the low tension threshold of 1,700 lbsf is a safety and economic concern for deeper and heavier fisheries, such as the commercial snow crab fisheries in Atlantic Canada, where loads regularly exceed 1,700 lbs. Time-tension line cutters (TTLCs) are a double-threshold LBS device implemented in the endline above a trap that accounts for both time and tension using a hydraulic piston system. Time represents how long a maximum tension of 1,700 lbsf must be sustained on the TTLC before it will cut the endline, allowing harvesters to retrieve gear for long durations at heavy loads without the risk of gear loss. Our study aims to evaluate the effect of varying temperatures on cut time for TTLCâ€™s through a series of temperature controlled experiments that reflect the conditions of commercial fisheries in Atlantic Canada. These experiments represent the first time TTLCs are tested and assessed for implementation and will demonstrate whether TTLCs are a suitable LBS solution for harvesters If suitable, the use of TTLCs in fisheries could satisfy the voluntary LBS measure, without gear loss or impacts to harvester safety.

## (J) Enhancing fisheries data collection through electronic monitoring and AI technology

Sander Delacauw[1]

[1] *ILVO*

Electronic monitoring is seen as a solution for addressing issues such as lack of observer coverage in terms of space and time, as well as challenges related to bycatch of sensitive species and adherence to policies. Currently, only a small fraction of the catch from Belgian beam trawl fisheries undergoes sampling for data collection. The objective is to rapidly expand this sampling using machine vision technology. To augment the existing observer program, ILVO has created a camera system capable of autonomously capturing images on vessels without requiring structural modifications for installation. This system, which can be easily implemented, has shown its ability to independently capture images. The next phase involves refining our recognition software to handle mixed catches, paving the way for its deployment in biological monitoring soon. Currently, this camera system can identify 19 different commercially valuable species with 97.6% accuracy. Future efforts will focus on expanding species recognition to include non-target species, especially Endangered, Threatened, and Protected (ETP) species, potentially through synthetic data generation. Furthermore, ILVO is researching the development and recommendation of AI-supported tools to provide stakeholders with data on catch volumes, compositions, and the fishing environment. The aim is to fully utilize technologies like electronic and genetic monitoring, along with AI-based species recognition via computer vision, to monitor discards and improve overall fisheries management. However, it's essential to acknowledge that technologies alone are insufficient. The integration of computer vision models, various data sources, and stakeholder needs and acceptance is crucial. Innovative monitoring, such as electronic monitoring, will also aid in developing prevention tools, like species distribution models. These efforts, represented by projects like VISIM, EveryFish, Marine Beacon, OptiFish, and CIBBRiNA, signify a significant advancement in fisheries management. By using advanced camera systems and machine learning, we can improve sustainability, mitigate bycatch, and contribute to the preservation of marine ecosystems.

**(K) Can pots be an alternative fishing gear to gillnets? A Mediterranean case study**

M. Virgili[1], A. Petetta[1], B. Herrmann[2,3,4], K. Cerbule[2,3], S. Guicciardi[1], G. La Manna[5,6], L. Malvarosa[7], D. Li Veli[1], G. Barone[1] & A. Lucchetti[1]

[1] *National Research Council (CNR), Institute for Biological Resources and Marine Biotechnologies (IRBIM), Ancona, Italy.*

[2] *The Arctic University of Norway (UIT), Faculty of Biology, Fisheries and Economics, Tromsø, Norway*

[3] *SINTEF Ocean, Fishing Gear Technology, Trondheim, Norway*

[4] *Technical University of Denmark, National Institute of Aquatic Resources, Hirtshals, Denmark*

[5] *Dipartimento di Scienze Chimiche, Fisiche, Matematiche e Naturali, Università di Sassari, Sassari, Italy*

[6] *National Biodiversity Future Center, Palermo, Italy*

[7] *Nisea Soc. cooperativa, Via Irno 11, Salerno, 84135, Salerno*

Mediterranean small-scale coastal fisheries often employ gillnets, a widely used gear worldwide. The disadvantages of gillnets in this fishery include high bycatch levels of unwanted species and consequent discards. Furthermore, gillnet depredation by bottlenose dolphin (*Tursiops truncatus*) reduces commercial catches and damages the gear, often resulting in considerable economic loss. Alternative, more sustainable and profitable fishing methods are being tested. This study investigated whether pots can ensure the sustainable harvest of mantis shrimp (Squilla mantis), a major target demersal species in terms of landings, in the Adriatic small-scale fishery and possibly replace traditional gillnets. A multidisciplinary approach was adopted to investigate the catch efficiency, biological impact and socio-economic effects of the two fishing methods in catching S. mantis. For the first time in this area, we also determined gillnet depredation using Passive Acoustic Monitoring technology. We found different species compositions in gillnet and pot catches. Gillnets yielded a greater amount of discards of species of no commercial value, whereas pots caught a greater amount of mantis shrimp. Finally, profit analysis indicated that the pot fishery has the potential to increase profit for the commercial fishing industry. This study suggests that pots provide a more sustainable fishing method both in terms of revenue and of environmental impact, while also reducing conflict opportunities between fishers and dolphins.

**(L) Enhancing durability and efficiency of purse seine: a study on variation in gear component strength and innovative design concept**

P.H. Dhiju Das[1], Saly N. Thomas[1] & Leela Edwin[1]

[1] *Fishing Technology Division, ICAR-Central Institute of Fisheries Technology, Cochin, India*

Purse seine fishing holds a significant place in Indian fisheries, by contributing the major share of pelagic fish landings in the country amounting to 1.98 million tonnes per annum (57% of the marine landings). In India, the purse seine fishery comprises of large mechanised fishing units operated by the industrial sector and the smaller units operated by the traditional sector. The small purse seines popularly known as ring seines were introduced by ICAR-Central Institute of Fisheries Technology, Cochin in 1985 to empower the traditional fishers against the increasing exploitation of the pelagic resources resulting in the sidelining of the traditional sector. Ever since, the gear has become immensely popular throughout the entire coast of India and has grown in dimensions. This gear made of polyamide muti-filament typically utilizes one to five tonnes of webbing per unit and has a life of only two to three years. Nevertheless, the different components of the gear necessitate frequent replacement due to wear and tear before the end-of-life of the gear.

This study aims to identify and analyse variations in durability across distinct gear components and suggest suitable options for increasing the life of gear. Webbing panels were exposed to natural marine weather conditions and simulated conditions (in accelerated weathering equipment) and residual strength of webbings estimated as per standard procedures (ISO 1806:2002). Besides, to study the strength retention in webbing after fishing operations, samples were collected from different locations of the gear every 100 m through the length and every 10 m through depth of the gear at periodic time intervals. Break load studies of ring seine sections shows that the sections with least strength retention are the areas adjacent to the bunt followed by front panel, bottom panel, top panel and end panel of netting. These areas showed unsuitability for use after 10 months of operation ie. 50% reduction in breaking strength, which is considered unserviceable as per Brandt (1959).Uneven durability poses significant challenges to fishers, as total replacement of the gear can result in substantial financial losses. Information about the durability across different segments of the gear, a concept for design of a ring seine with new generation material is proposed with materials like ultra high molecular weight poly ethylene (UHMWPE), bite resistant polyethylene etc. The theoretical weight of the proposed model is 45 % lesser sinking speed is found to be 62.6 % higher and carbon foot print 60.43% lesser than the conventional gear. Durability of the new gear is estimated to be 2-3 times more than the conventional gear.

**(M) Measuring weak breaking strength gear modifications before and after use in Atlantic Canadian fixed-gear fisheries**

K. Urbancic[1], S. Skripsky[1], H. Drake[1], E. Vézina[1] & S. Brillant[1,2]

[1] *Canadian Wildlife Federation, Halifax, NS, Canada B3S 1A9 (Krysu@cwf-fcf.org)*

[2] *Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4R2*

Fisheries and Oceans Canada (DFO) is promoting the voluntary adoption of low breaking strength gear modifications in fixed-gear fisheries in Atlantic Canada in an effort to alleviate entanglement severity for the critically endangered North Atlantic right whale. However, DFO is not approving or regulating how these gear modifications are implemented. Our study aimed to identify low breaking strength solutions that would meet established US standards for low breaking strength gear (i.e., 1700 lbf + 10%) and to evaluate their change in breaking strength following use in Canadian commercial fisheries. Our methods were informed by international and North American standards for testing fiber rope, and by testing protocols from the Northeast Fisheries Science Center, which currently approves gear modifications for US fisheries. Control samples consisted of 20 types of sleeves, links, rope, and other contrivances marketed as low breaking strength gear modifications or as having a load threshold of 1700 lbf or less. These samples were tested in new condition to determine if they meet this standard based on their average breaking strength. Of those 20 controls, 10 types were also tested after use in simulated fishing trials (≤ 13 hauls) and 5 types after use by harvesters for one fishing season (50-60 hauls). When new, 7 of these 20 types had breaking strengths above 1700 lbf + 10% (i.e., 65% passing rate). Notably, the breaking strengths of the modifications that were tested following use were all reduced, many to well-below safe working load limits. The next step of this study is to evaluate the use of knots and splices as a low breaking strength solution for inshore fisheries. These findings have implications for the implementation of weak breaking strength gear modifications in Atlantic Canadian fisheries, specifically regarding their safe-use and seasonal replacement rates.

**(N) Underwater observation plays a crucial role in fisheries technology, where the introduction of low-cost action cameras has significantly enhanced this aspect**

Peter Ljungberg[1], Andreas Sundelöf[1], Sara Berzosa[2], Andreas Hermann[2], Andrea Milanelli[2], Daniel Stepputtis[2], Hampus Södergren[3] & Thomas Noack[2]

[1] *Department of Aquatic Resources, Swedish University of Agricultural Sciences, Almas Allé 5, 756 51 Uppsala, Sweden*

[2] *Thünen Institute for Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany*

[3] *Hanö Torskrev, Bivägen 2, 294 36 Sölvesborg, Sweden*

Action cameras have found diverse applications in fisheries science, from recording animal behavior in and around fishing gear to evaluating gear performance and modifications. However, two primary challenges have traditionally been faced: limited battery life and constrained viewing angles. By combining action cameras with external batteries, extended running times could be achieved allowing for recordings of long fishing activities like extended trawl hauls or long soak times in passive gears. However, the issue of the limited angle of view remained: In case a camera was not mounted properly, i.e. the angle of view did not fit to what was intended to be recorded, recordings of one fishing activity might have to be discarded and redone. While the introduction of panoramic cameras addressed the issue of limited viewing angles with their often up to 360Â°recording capabilities, they lacked options for extending battery life. In this study, we introduce a novel approach by combining a 360Â° camera with an external battery, enabling recording sessions up to 42 hours. As a practical application, we demonstrate the utility of this setup in investigating fish and crustacean behavior in pots but also animal behavior and habitat use around reef structures. This advancement not only opens doors to prolonged underwater observation, overcoming previous limitations and offering new insights into fisheries research and management, but also enhances the viewing experience through immersive virtual reality (VR) goggles. By utilizing VR technology, viewers can dive deeper into the recorded content, experiencing a heightened level of engagement and understanding of what is happening under the surface.

**(O) Failures, no effects and lessons learned: an overview of unwanted results**

Van Vlasselaer Jasper[1] & Van Opstal Mattias[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences - Fisheries, Ankerstraat 1, 8400 Oostende, Belgium*

The way scientists communicate their work is by showing the successes, great results and astonishing data. Behind the fabulous presentations lies, more often than not, a long

winding road of dead ends, frustration and hours of fruitless effort. Based on our own experiences and experiments in fisheries research, we want to bring a presentation in which we show not our greatest successes, but our failures, unwanted results and what we learned from it. By showing that, other scientists can benefit from our mistakes and not repeat experiments with bad results, saving time and money. We hope that giving a presentation such as this one can spark our community to start sharing "failure" information on a regular basis, which can only improve the research in our field.

**(P) Fish and click: how participatory science help to describe the distribution of lost fishing gear**

Marie Morfin[1], Fabien Morandeau[1], Sonia Méhault[1] & Dorothée Kopp[1]

[1] *IFREMER, Fishing Gear Technology and Biology Laboratory, 8 rue François Toullec, 56100 Lorient, France*

Plastic pollution caused by fishing gear lost at sea is a major environmental problem since they remain for several hundred years in seawater, impacting marine life. Fishing gear accounts for almost a third of marine litter and are targeted by the recent European Directive on the reduction of the impact of plastics on the environment. In this context, a website and mobile application were developed under the participatory project "Fish & Click" to report lost fishing gears both at sea or on the shore in the English Channel area. These tools are dedicated to a wide public including divers, fishermen, boaters, on-board observers, naturalist associations, walkers. 2944 reports were recorded from May 2020 to June 2022 and 83% were associated to pictures. All the reports were checked and corrected if necessary (e.g. location, wrong gear categories or quantities), resulting in 2295 validated reports (90%). Fishing gears are well classified by citizens at 88% with most of the misclassifications for the categories 'other material' and whelk/shrimps/fish traps. At least 475 citizens participated with 5% of them being regular observers (>15 reports). So far, the database collected allow to inventory and map lost fishing gear by category. Most of the reports were done at the shore (83%) where all categories were detected but with spatial disparities. More nets, ropes and lines are found in Bay of Biscay, whereas other materials are more reported in the English Channel. At sea, 65% of the reports are due to scientific surveys, divers being the second source of information. Traps are reported exclusively in coastal seas whereas nets are found offshore. Results from this project will help to guide research on biodegradable fishing gear and to propose solutions for the management of lost gear.