1 Presentations and Posters

Abstracts for the 2025 annual meeting of the WGFTFB are listed here by session topic. Presentations are numbered (1-50) and posters are designated with a letter (A-V). The presentations are numbered in the order they will be presented during the meeting in plenary. The presenter is indicated with an asterisk after their name and a contact email is provided.

The presentations are grouped by the following session topics (with presentation numbers listed):

- Catch Welfare: 1-2
- Animal Behaviour: 3-9
- Indicators: 10-15
- ALDFG/ Gear Marking/ Plastic Pollution/ Gear Recycling: 16-25
- Multi-Use: 26-27
- Gear Design - Fish/ Invertebrate Selectivity: 28-31
- Gear Design - Mammal Selectivity: 32-34
- Gear Design - Catchability: 35-36
- Gear Design - Energy Efficiency: 37-39
- Innovative Tools: 40-45
- Human Dimensions: 46-50

Abstracts for the posters are also provided within topic session groups:

- Animal Behaviour: A
- Indicators: B
- ALDFG/ Gear Marking/ Plastic Pollution/ Gear Recycling: C-K
- Gear Design - Fish/ Invertebrate Selectivity: L
- Gear Design - Mammal Selectivity: M-O
- Gear Design - Catchability: P-Q
- Gear Design - Energy Efficiency: R-S
- Innovative Tools: T-U
- Human Dimensions: V

Presentations given during the Topic Groups, Focus Sessions, or Business Sessions are not included here, but will be included in the report.

1.1 Session 1: Catch Welfare

(1) Behaviour and activity of Atlantic bluefin tuna (*Thunnus thynnus*) during rod and line capture

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Stress during the capture of aquatic animals can impact negatively upon product quality. This is especially relevant for species whose market value is largely determined by their quality attributes. One such species is Atlantic bluefin tuna (*Thunnus thynnus*). Following the recent return of bluefin tuna to Norwegian waters, a recreational and commercial rod-and-line fishery has developed. Fish are caught individually by trolling artificial squid lures behind coastal powerboats. At present, the stress response of bluefin tuna to rod-and-line capture is poorly

understood. A behavioural study was initiated to quantify and, if necessary, mitigate capture stress to promote animal welfare and product quality. Fishing gear was instrumented with cameras and accelerometers. Data has been collected from seven capture events to date. All occurred during fishing for a scientific tagging program off the west coast of Norway. Consequently, best practice guidelines were followed to minimise fight times. Preliminary analysis indicates that camera recorded behavioural states generally concur with accelerometer recorded activity levels. Activity levels are typically extremely high during the initial strike. Activity then tends to reduce, with intermittent increases during retrieval. At the end of retrieval, activity levels are typically very low. There are indications that the accelerometer collected data will allow examination of fine scale behaviours such as tail beat frequency. In future, this work will be expanded to examine behaviour during recreational and commercial fishing. Physiological responses will also be correlated to capture behaviour and quality outcomes.

[Source: Norwegian Institute of Marine Research]

(2) Measuring codend dynamics and its impact on catch welfare

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Improvements to catch welfare in the capture phase of wild-capture fisheries can enhance flesh quality, prolong shelf life and address consumer concerns. In trawl fisheries, one of the factors contributing to injury of accumulated catches are oscillating movements of the codend, driven by vessel motion and waves. This study investigates whether externally visible injuries of beam-trawled flatfish, are correlated with codend dynamics, measured by custom-made accelerometer sensors. Data were collected during the demersal youngfish survey in Belgian coastal waters. A total of 148 individuals were collected from 11 different sampling sites during 4 days of fishing and assessed for bleeding and haemorrhaging injuries to the head, body, fins, damage to the fins, and scale/mucus layer abrasion: 90 common dab (*Limanda limanda*), 28 European plaice (*Pleuronectes platessa*), 19 European flounder (*Platichthys flesus*), and 11 common sole (*Solea solea*), with mean lengths ranging from 16.88 ± 3.11 cm to 24.84 ± 5.94 cm. Wave heights and average wave periods, ranging from 51 to 161 cm and 2.77 to 4.94 seconds, were recorded from buoy

measurements. The next step is to investigate relationships between i) vessel movement and wave heights; and ii) injury scores and their independence from other contributing factors through generalized and linear mixed-effects models. In a preliminary univariable analysis, significant relationships were found between injury location and wave conditions. Head and fin bleeding injuries were significantly correlated with average wave height and period. Additionally, total catch weight significantly impacted head bleeding injuries, while the percentage of injury-inducing species in the catch influenced fins bleeding injuries. Fish length was a determining factor for body and head bleeding injuries. The next phase of the analysis will include a Fourier analysis of trawl accelerations to identify peak amplitudes and dominant frequencies. If codend oscillations are identified as a major contributor to injuries, engineering solutions will be explored in a follow-up project to improve catch welfare.

[Source: M. Cockx]

1.2 Session 2: Animal Behaviour

(3) Herding of Antarctic krill (*Euphausia superba*) inside a trawl

Laura Diernæs[1], Bjørn A. Krafft[2], Ludvig Ahm Krag[1], Bent Herrmann[1], Stefan Neuenfeldt[3], Asbjørn Christensen[3], Junita D. Karlsen[*1]

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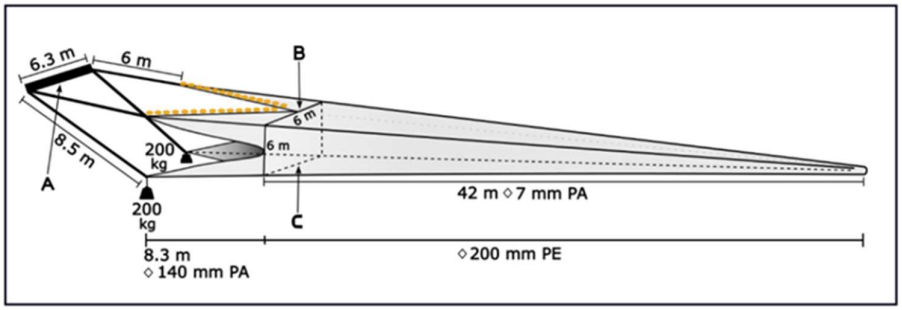
The catch efficiency of a fishing gear depends on the design and performance of the gear and the species-specific behaviour of the targeted species. This includes the responses target species have to stimuli from gear components and their ability and inclination to escape. The Antarctic krill (*Euphausia superba*) fishery is the largest in the Southern Ocean. The fishing fleet uses trawls that vary in design and mesh configuration. We placed a downward-facing 333 kHz and an upward-facing 70 kHz split-beam echosounder just behind the fishing circle in a scientific macroplankton trawl during fishing off South Orkney Islands (Fig. 1).

Figure 1. The Macroplankton survey trawl used during the experiment. WBAT echosounder system on the trawl beam (A). The 333 kHz transducer (B) and the 70 kHz transducer (C). The trawl was constructed of a 7 mm (PA) diamond mesh inner netting from the fishing circle to the codend with an outer 140 mm (PE) diamond meshes double 5 mm netting in the wings and 200 mm in 5 mm (PE) in the trawl body and codend for strength.

The two echosounders recorded acoustic observations of krill in the 6 m high trawl mouth alternately throughout six hauls. It was possible to track 264 and 237 individual krill from the 333 kHz and 70 kHz echosounder, respectively. We demonstrated that small-bodied krill of 3-5 cm body length were actively moving away from the netting panels of the trawl during towing while krill movements in the centre of the trawl body were random. The response patterns were consistent for both the upper and lower half of the trawl and are in line with a herding effect that leads to lower krill densities close to the netting panels. The swimming direction of the krill was the determining variable for this herding effect. Their swimming speed was similar irrespective of their swimming direction. Our findings indicate that there is potential of increasing mesh sizes of the gear designs using small-meshed trawl bodies to reduce the carbon footprint of the fishery for krill in Antarctica. The detailed description of the behaviour obtained for the small-sized krill highlights the potential of using split-beam acoustics to gain knowledge of fish responses to fishing gear and selective devices in dark and turbid waters where camera observations are limited.

Figure 1



[Source: Laura Diernæs (modified from Krafft et al., 2023)]

Figure 2

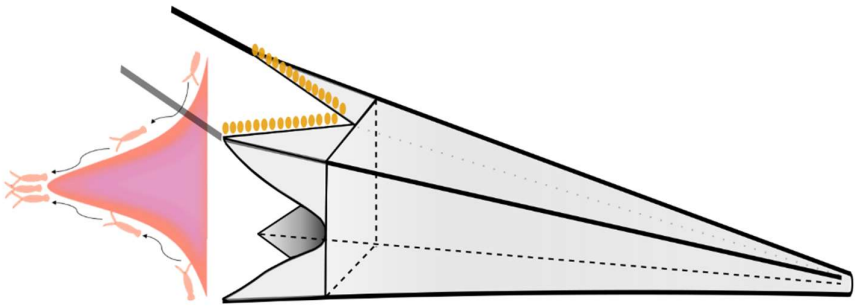


Figure 2. Movements leading to a herding effect in Antarctic krill and consequently a higher biomass in the centre of a macroplankton trawl mouth off South Orkney Islands. [Source: Laura Diernæs]

(4) Lighting the path to sustainable passive shrimp fisheries

Francisco Flores*[1], Thomas Noack[1], Juan Santos[1], Sara Berzosa[1], Annika Brüger[1], Andrea Milanelli[1], Daniel Stepputtis[1]

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Trawl fisheries, particularly those targeting brown shrimp (*Crangon crangon*), are one of the main contributors to bycatch in the North Sea, capturing vast amounts of juvenile fish and other non-target species. This, combined with the high consumption of fuel and political limitations, highlights the need for a more sustainable alternative. Pots, with their many advantages, have been proofed useful to target other shrimp species in different parts of the world, and although traditionally this form of passive gear has not been used to catch *C. crangon*, several European initiatives are currently investigating their potential and different ways of optimising them.

Following up some promising results from ILVO, in which the potential of light as an attractor for brown shrimp was unveiled, our research now aims at expanding our knowledge about the specific components of their behaviour, and using this information to determine which adaptations pots would need to facilitate the access. Lab experiments including video monitoring of live shrimp in different controlled environments were performed by the end of March and April. The obtained results improve our understanding of *C. crangon* behaviour and serve as foundation for further trials at sea.

[Source: Francisco Flores Cano, Germany]

(5) Why am I retained? Understanding fish behaviour in relation to sorting grids

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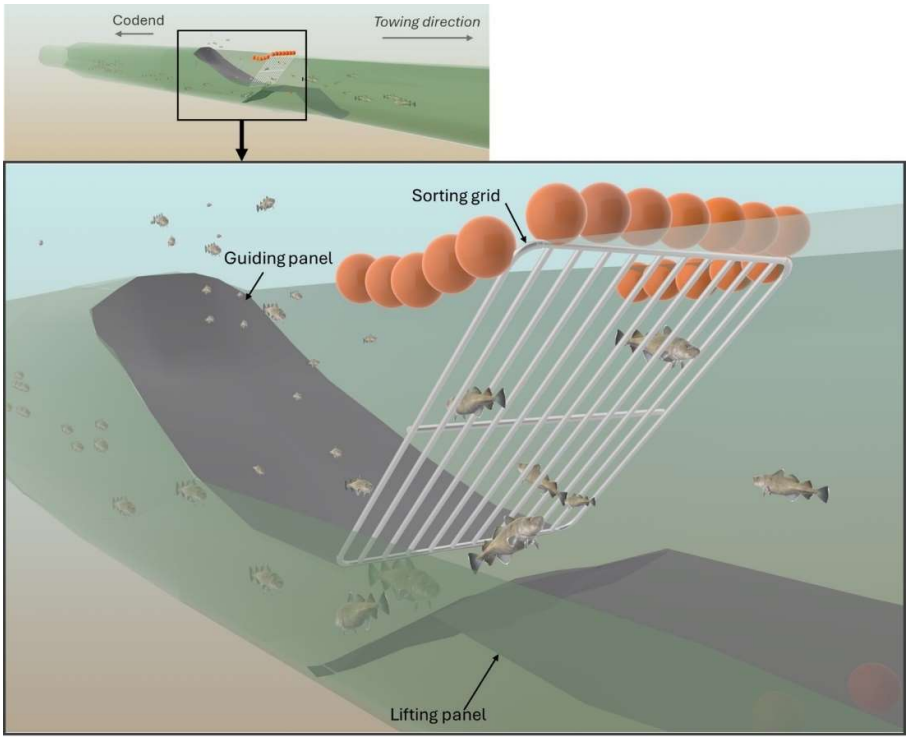
Fish behaviour and morphology are important factors that can determine the selective efficiency of sorting devices in trawls such as rigid sorting grids. One such fishery where this device is mandatory is in the Barents Sea demersal trawl fishery. Here, the currently used grid design does not perform optimally due to that it often releases large proportions of target sized fish while also retaining undersized fish. Two studies were conducted that aimed to deepen our understanding of, in particular, the behavioural component affecting the grid sorting efficiency. One such study used experimentally obtained grid size selection to infer on behavioural and morphological properties of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and redfish (*Sebastes* spp.) using indirect methods. The second study applied direct assessment methods in the form of underwater recordings to extract and quantify key aspects of the behavioural processes involved in grid selection. The two different approaches helped us to obtain a better and more detailed understanding of the interaction of fish with sorting grids, advancing our knowledge of fish behaviour and morphology to ultimately improve the design of fishing gears.



[Source: N. Jacques, NO]

(6) Evaluating the effectiveness of Nordmøre grids to release skates (family Rajidae) in a shrimp trawl

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

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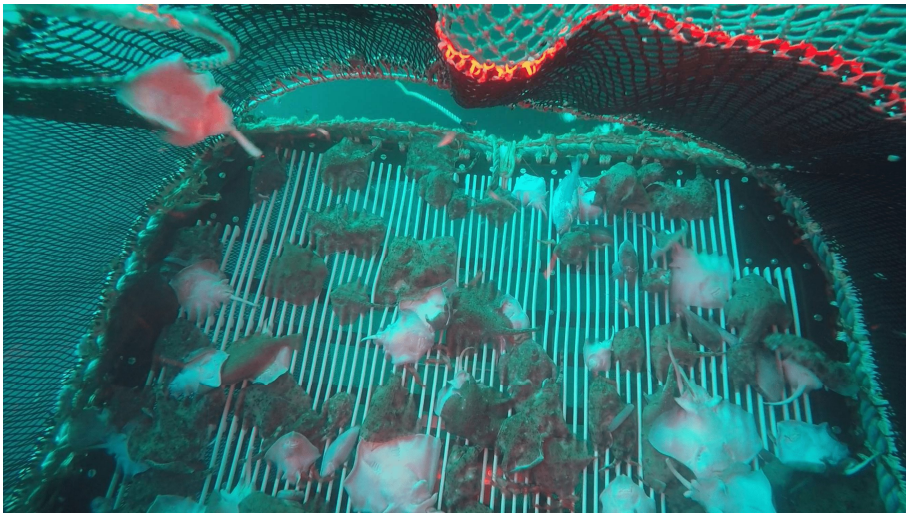
Skates (Rajiformes) are generally susceptible to post-release mortality from commercial fisheries and are frequently captured as bycatch in northern shrimp (*Pandalus borealis*) trawl fishery. Despite bycatch being reduced in the fishery via Nordmøre grid use, how effective grids are in allowing skate escape and reducing post-release mortality remains unknown. This study used underwater videos to assess the effectiveness of Nordmøre grids as a bycatch reduction device for skates. The study focused on how skates interacted to a narrow (2.0 m^2) and a wide (5.1 m^2) grid, focusing on their time to escape (Tesc) and capture fate considering observed behaviours, interactions and vitality. A total of 261 and 143 skates interacted and frequently contacted the narrow (n=253) and wide grids (n=134), respectively. Skates contacting the grids had a significantly delayed escape than those not contacting both narrow (odds=156.2:1; p<0.001) and wide (odds=4.8:1; p=0.003) grids. Skates were frequently observed swimming, turning (changing head direction), and performing hedgehog posture (body contraction into a ball shape) when approaching and contacting the grids and escaping. Skates were also frequently observed sliding over the grid when making contact. After contact, skates that performed at least one behaviour when engaged with the narrow grid (mean; min-max 95% confidence interval (CI)) were 56% more likely to escape faster (8.8 s; 5.6-12.7 s) than skates that did not perform any behaviour (31.2 s; 8.1-59.4 s). There was no effect on Tesc for any observed behaviour for skates at the wide grid or for any skate that slid for both grids. Skates that did not contact the grid and escaped had an

apparent high vitality, while those that did not perform any behaviours or did not slide had poor vitality. The Nordmøre grid effectively released skates. However, enhancing its design to better align with skate behaviours could facilitate a quicker escape.



[Source: S. Andrade, CA]

(7) Stuck in first gear: investigating how to get large, slow-swimming Greenland sharks (*Somniosus microcephalus*) out of a trawl

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The bycatch of Greenland shark (*Somniosus microcephalus*) in Canada may become a barrier to the Greenland halibut (*Reinhardtius hippoglossoides*) and northern shrimp (*Pandalus borealis*) trawl fisheries to maintain Marine Stewardship Council certification. Thus, potential solutions to limit bycatch or facilitate the escape of Greenland shark during the exclusion process have been ongoing. The capacity of current technology to release Greenland shark is challenging given their large size and poor swimming ability. Additional concerns are associated with apparent damage they receive during the escape process from contact with mesh panels and the grid. Post-release mortality is poorly understood. Here, we use underwater video footage to describe how large Greenland shark interact with a Nordmøre grid in a shrimp trawl. Twelve Greenland sharks that were estimated to be between 2.5 and 4.0 m were observed interacting with a Nordmøre grid system. Each Greenland shark escaped, however, escape times were often protracted and involved a lot of contact with the guiding panel, surrounding mesh panels, and grid.

(8) Physical condition and behaviour of fishes in the Mediterranean bottom trawl codend

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Knowledge on fish behaviour is essential to develop more effective and selective fishing gears. There is a lack of studies on this topic in the Mediterranean Sea. The present work examines fish behaviour in the bottom trawl codend aiming to gather information that can support the improvement of bottom trawl selectivity and the minimization of unwanted catch. GoPro cameras were used for underwater observations of fish behaviour. Three codend configurations (with 40mm diamond, 40 mm square and 50mm diamond meshes) were examined. Four categories with various criteria were applied to categorize fish behaviour (including physical condition, activity, interaction with net, space occupancy). Observations were made for 32 taxa. Some taxa exhibited good physical condition, dynamic activity and higher effort for escape activity (*Sardina pilchardus*, *Engraulis encrasicolus*, *Mullus* spp., *Pagellus* spp., *Trachurus* spp.), while others the opposite (e.g. *Lophius budegassa*, *Parapenaeus longirostris*). Some positioned themselves in the upper area of the codend, while others in the bottom or side area. The majority of individuals had no contact with the codend net. The higher number of observations for escaping occurred in the 40mm square codend. The results can help identify bottom trawl modifications depending on the species selectivity that is needed to be improved.

(9) Laboratory testing of side entrances in snow crab (*Chionoecetes opilio*) conical pots

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The snow crab (*Chionoecetes opilio*) fishery is crucial to the livelihoods of coastal communities in Newfoundland and Labrador and contributes significantly to the global seafood supply. While pot fisheries are generally considered to have lower environmental impacts compared to other fishing methods, further reducing these impacts is essential for sustainable fisheries. One approach to reducing environmental footprints in quota-based fisheries is to enhance pot efficiency, leading to a reduction in fishing effort, associated CO2 emissions and bait usage. Additionally, the discarding of undersized crabs at the surface causes fishery-induced mortality, which remains largely unquantified. This study explores the effectiveness of a new snow crab pot design with four side entrances to increase catch efficiency and reduce bycatch of undersized crabs (<95 mm carapace width). We conducted a series of laboratory experiments to compare the performance of traditional conical pots against experimental pots equipped with side entrances. Crabs were held in tanks and their behaviour was assessed using survival analyses, including their time to first contact with the pot, time to entry, and time to escape events. We also conducted fall-through experiments to assess the geometric selectivity of the new pot design. Results demonstrated that the experimental pots, with side entrances, significantly improved both crab entry and escape efficiency compared to traditional pots. Our findings suggest that adopting such a pot design, within the current regulatory framework, could enhance the sustainability of the snow crab fishery by reducing fishing effort and bycatch of undersized crabs. This, in turn, could lead to a decrease in undersized crab mortality, reduced bait usage, and lower CO2 emissions, further contributing to the overall environmental sustainability of the fishery.

[Source: Fisheries and Marine Institute of Memorial University]

(Poster A) Preliminary results on fish behaviour in the mouth of a deep-water shrimp (*Pandalus borealis*) trawl

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In pioneer studies of the behaviour of different fish species to a trawl gear, qualitative descriptions were based on observations from an optic camera operated by divers from an underwater vehicle. New, acoustic technology enable detailed observations of animals in deep, dark and turbid waters. In contrast to high-resolution multibeam sonars, split-beam echosounders provide data in three dimensions and at a larger range. Thanks to software like the Large Scale Survey System (LSSS), single targets, i.e., individual animals, can be identified and subsequently tracked with the available tracking algorithms.

We mounted a Wideband Autonomous Transceiver (WBAT, Kongsberg Discovery) behind the headline of two commercial deep-water shrimp (*Pandalus borealis*) trawls (Fig. 1). It was connected to a 120 kHz transducer (Kongsberg Discovery) that with an 18-degree beam angle was looking across the trawl mouth towards the seabed area just ahead of the groundgear. Data was collected in March and September 2024 in both day and night hauls. The body lengths of the caught deep-water shrimp and fish were measured for groundtruthing.

The fish catch consisted of groups of species with (mainly gadoids and herring) and without (flatfish, elasmobranchs) a swimbladder. Over 30.000 tracks of individual fish were identified from 11 hauls (Fig. 2). Tracks for analysis contained on average 7 pings (range: 4 â€“ 200 pings). The mean depth range was 0.59 m (range +8 to -8 m). Most individuals had an upward movement from the start to the end of the track (89.2%). Preliminary results from explorative investigations will be presented. The overall movement patterns in the data will be discussed in relation to the species-specific descriptions given in the pioneer studies. Some of the opportunities that arise from tracking a large number of individuals in 3D will be highlighted.

Figure 1. The commercial shrimp vessels used during the trial in March measured 24 m LOA. The other vessel (not shown) measured 28 m LOA. [Source: Kjetil G. Thorvaldsen]

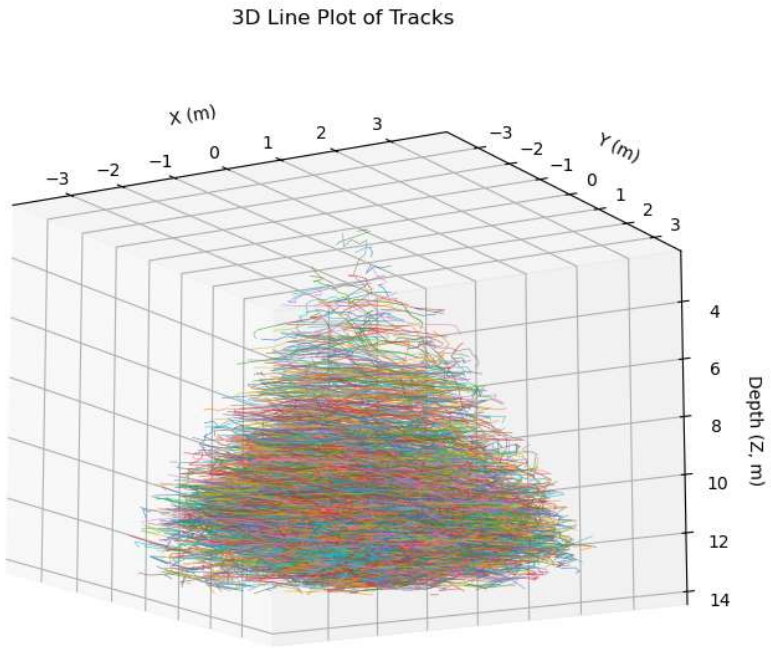

Figure 2. Over 30.000 tracks (lines) of individual fish (different colors) identified within the acoustic beam of a 120 kHz 18 degree transducer overlooking the mouth of a commercial deep-water shrimp trawl in 3D (x: alongship, y: atwardship, z: depth). [Source: Kjetil G. Thorvaldsen]

1.3 Session 3: Indicators

(10) A framework for assessing the influence of bottom trawl gear configuration on catch size composition and community metrics: insights from surveys in the Central Mediterranean

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Understanding the effect of fishing gear configuration on the size distribution of caught species is essential for both sustainable fisheries management and ecosystem-based approach to resources exploitation. The size structure of marine populations plays a fundamental role in ecological processes, influencing species interactions and population dynamics of fish stocks. Fishing gears, particularly bottom trawl nets, exert strong pressure on fish populations by affecting their size spectra.

This study investigates the differences in size heterogeneity and spectra among commonly caught species using data from two bottom trawl surveys (GRUND and MEDITS) carried out in the same area in Central Mediterranean Sea. These surveys employed distinct net configurations, such as differences in rigging, mesh size, vertical and horizontal opening. The study also aims to evaluate whether these nets capture different species composition and size and how this affects community-level metrics. The data were analyzed using multivariate statistical approaches, including PERMANOVA and PERMDISP, to assess variability across depth strata (shelf: 10-200m and slope: 200-800m) and net configuration.

As novel approaches to provide valuable insights into the effects of different fishing gears on catches we investigated two size-based indicators: the Gini coefficient which quantifies the inequality in size distribution, and the lambda of size distribution, which reflects the difference in proportion between small and large individuals. Differences in net configuration resulted in divergent selectivity patterns, capturing distinct portions of the fish population. This is particularly relevant in multispecies fisheries, where gear selectivity may influence the abundance and composition of commercial and non-commercial species.

Specifically, our results indicated that while the Gini coefficient did not show significant differences between net configurations, suggesting an overall homogeneity in the size distribution of the caught species, the lambda coefficient revealed a significant effect, implying the capture of different size ranges. This effect can be observed in both depth strata, with variations particularly marked for demersal species closely associated with the seabed. For instance, *Raja clavata* exhibited larger catch sizes in the GRUND survey (Fig. 1). These differences are likely attributed to variations in vertical net opening and the adherence to the seabed of the fishing gears. This effect is also reflected in differences in abundance composition between the two nets in slope. The MEDITS gear, having a greater vertical opening, captures a larger number of species with more pelagic behavior, such as *Trachurus* spp. (Fig. 2). Furthermore, community-level indicators, including species richness, diversity indices, and total biomass, remained stable between the two net configurations, reinforcing the robustness of these metrics despite gear differences. Depth was a significant factor influencing species richness and total catch biomass. Overall, integrating size-based approaches with community metrics enhances our understanding of fishing gear selectivity and catchability and its implications for ecosystem monitoring and management strategies.

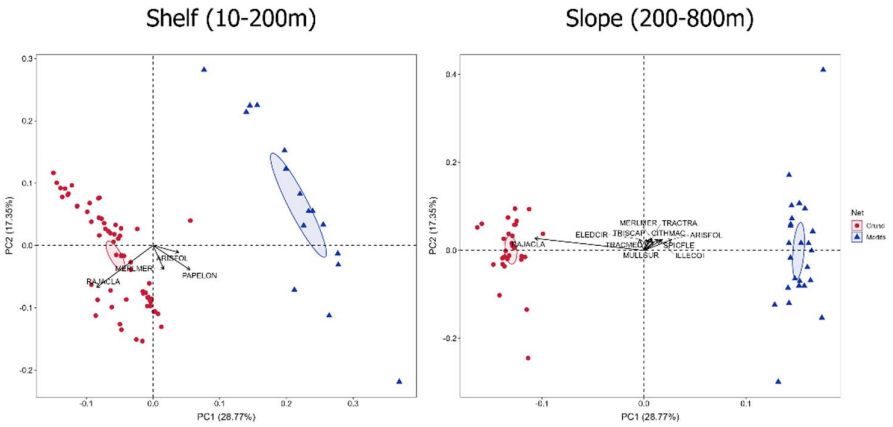

Figure 1. Principal Component Analysis (PCA) ordination plot of sampled hauls based on size distribution coefficient (lambda) composition across the two depth strata (Shelf and Slope). The direction of species axes indicates their relationship with the principal component axes, while their length represents their relative importance. Only species contributing more than 5% to the variation of at least one of the two principal components are shown. Species code: ARISFOL = *Aristaeomorpha foliacea*; CITHMAC = *Citharus linguatula*; ELEDCIR = *Eledone cirrhosa*; ILLECOI = *Illex coindetii*; MERLMER = *Merluccius merluccius*; MULLBAR = *Mullus barbatus*; PAPELON = *Parapenaeus longirostris*; SPICFLE = *Spicara flexuosa*; TRACMED = *Trachurus mediterraneus*; TRACTRA = *Trachurus trachurus*; TRISCAP = . *Trisopterus capelanus*. [Source: Institute for Marine Biological Resources and Biotechnology (IRBIM), National Research Council (CNR), Mazara del Vallo, TP, Italy]

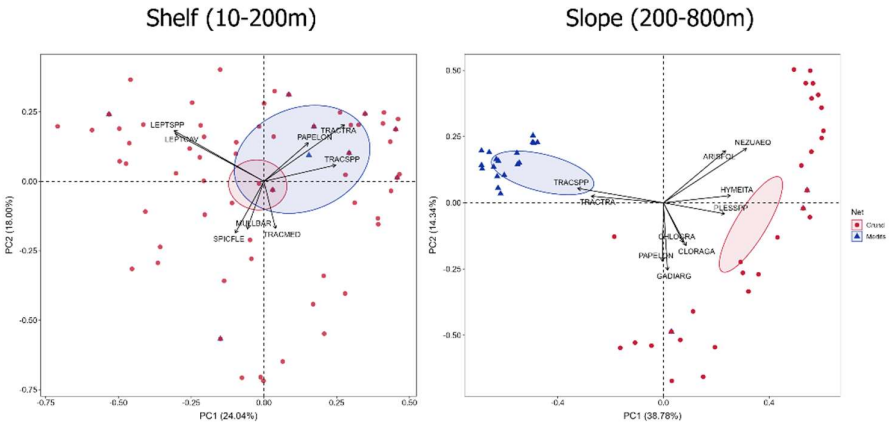

Figure 2. Principal Component Analysis (PCA) ordination plot of sampled hauls based on species abundance composition across the two depth strata (Shelf and Slope). The direction of species axes indicates their relationship with the principal component axes, while their length represents their relative importance. Only species contributing more than 5% to the variation of at least one of the two principal components are shown. Species code: ARISFOL = *Aristaeomorpha foliacea*; CHLOGRA = *Chlorotocus crassicornis*; CLORAGA= *Chlorophthalmus agassizi*, GADIARG = *Gadiculus argenteus*; HYMEITA= *Hymenocephalus italicus*; LEPTCAV = *Lepidotrigla cavillone*; LEPTSPP = *Lepidotrigla* spp.; MULLBAR = *Mullus barbatus*; NEZUAEQ = *Nezumia aequalis*; PAPELON = *Parapenaeus longirostris*; PLESSPP= *Plesionika* spp., SPICFLE = *Spicara flexuosa*;

TRACMED = *Trachurus mediterraneus*; TRACSPP = *Trachurus* spp.; TRACTRA = *Trachurus trachurus*. [Source: Institute for Marine Biological Resources and Biotechnology (IRBIM), National Research Council (CNR), Mazara del Vallo, TP, Italy]

(11) Exploring the selectivity performances of the sorting grids in the Mediterranean Sea bottom trawl fisheries

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Bottom trawling is widely recognized as an impactful fishing technique due to both habitat damage and a high amount of discards. This feature is exacerbated by the multi-specific nature of the Mediterranean trawl fisheries catching species with very different maximum and maturity sizes. In recent years, to mitigate the problem, growing attention has been given to the application of sorting grids (SGs). Although they seem a very promising innovation to improve trawl selectivity and are already mandatory in the North Atlantic Sea, SGs are not yet used in the Mediterranean commercial trawling. In this context, the present study aims to preliminarily overview the previous studies testing SGs during trawling to draw general patterns of their effect on the catches. The review, based on 20 papers published from 2004 to 2024, showed a high variability in size at 50% capture (L50) of similar sized grid of some species (Fig. 1). Furthermore, despite with some variability, most of the stocks are still been fished below their length at first maturity (LFM) and the minimum conservation reference size (MCRS) (Fig. 2). Given the multispecies nature of the Mediterranean fisheries, it is suggested the implementation of generously planned surveys to investigate the SGs performances across a wide range of operating conditions and covering different fishing grounds. These surveys should aim at investigating selectivity devices capable of improving the L50 of most of the species exploited to a value close to the LFM/MCRS. Establishing a collaborative network of stakeholders, from local fishermen and researchers to national and international organisations, involved in the research will facilitate the effective transfer of the most sustainable and appropriate fishing gear from research to commercial fisheries.

Figure 1

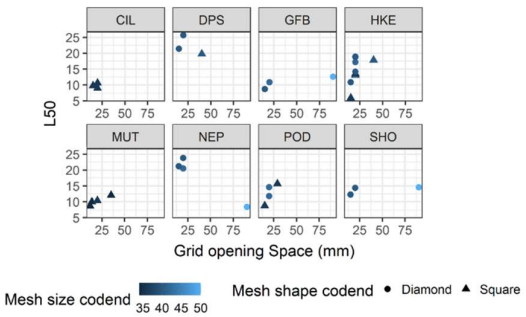
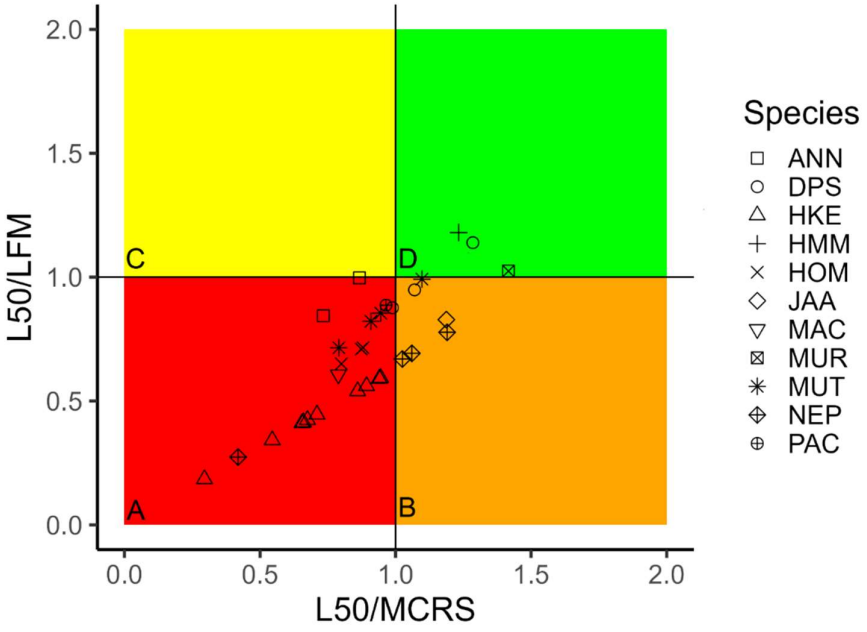


Figure 2



[Source: CNR-IRBIM- Mazara del Vallo, Italy]

(12) Increasing soak time improves size selection and harvesting patterns in common whelk (*Buccinum undatum*) pot fisheries

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Common whelk is a neo-gastropod that is intensively fished on the west and east temperate Atlantic with baited pots. The UK hosts the largest Whelk fishery contributing 10 â€“ 15 % to the national Shellfish landings, worth 15 - 27 million Â£ a year. However, scientific information quantifying the size selectivity for pots used to catch common whelk and to what extent the soak time applied affects it is limited. Therefore, experimental fishing trials were conducted to fill this knowledge gab. The results obtained demonstrated that soak time significantly affected the size selectivity for the pots. Specifically, it was found that only 75% of the whelks would be size sorted if soaking time for the pots was as short as 18 hours while with an extended soaking time to 46 hours practically all whelks entering were size selected by the escape gaps in the pots. Therefore, soaking time needs to be considered to obtain an efficient size selection at the seabed of the whelks entering the pots.

[Source: M. Eichert]

(13) Bycatch and discards in mid water nets for Anchovy off Argentine coasts

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Off argentine coasts, some trawl fisheries are currently going to sustainability certification process, like Marine Stewarship Council MSC. Among them, midwater trawling for anchovy *Engraulis anchoíta* may cause the higher rates of incidental mortality of marine mammals and seabirds, along with the discards of anchovy juveniles. Although the fishing effort seems to be low and the levels of anchovy biomass extracted are very below their allowable levels, these incidental catches and discards represent a challenge for fisheries in order to achieve the certification. In this region, two stocks of southern anchovy are distinguished, orthern/bonaerensis and southern/patagonian, separated by latitude 41°S. Two different fleets operate on these stocks, one operates from Mar del Plata harbour (39°S) fishing on the northern stock, and another from Rawson harbour (43°S) fishing on the southern. Both fleets are conformed by ice-chilling coastal and highsea vessels, using mid-water nets, hauls are performed during diurnal hours, and trips last few hours. Two fisheries are defined, and each one is undergoing separate evaluation and

certification processes. However some vessels from Mar del Plata harbour (vessels > 20mts) can move southwards sporadically and fish on the southern stock.

Here we present a review about discards and bycatch in midwater nets targeting anchovy, species affected and catch levels, along with conservation status of populations affected, highlighting data gaps and current limitations for well assessing the impacts on populations, habitat and ecosystem sustainability. We reviewed available information and data from articles, reports, thesis, presentations at conferences and congresses, reports on evaluation or preevaluation processes, as well as own data gathered by authors themselves through on board observers. Available data cover the period 2011-2024.

Both fisheries show unwanted catch of anchovies and discards, due to smaller size than commercial standard. Annual maximum discards were 29% in the north, and 12% in the south. The only mitigation strategy currently used is to "move-on", with an efficiency of 38% and a moving distance up to 100 km in the north, and 100% and a distance up to 28 km in the south. Main bycatch species include fishes, seabirds and marine mammals. Some of bycaught fish species are catalogued as vulnerable or threatened, however catch rates are very low and no mitigation measures have been adopted. Among marine mammals, two dolphin species (*Lagenorhynchus obscurus* and *Delphinus delphis*) and southern sea lions *Otaria flavescens* are incidentally caught by the northern fishery, while only southern sea lions bycatch is reported in the southern fishery. All these species are classified as least concern, and mortality events show a high inter annual variability. Entanglement of seabirds include endangered, treatened or protected species as Black-browed albatross (*Thalassarche melanophris*), White-chinned petrel (*Procellaria aequinoctialis*), Magellanic penguin (*Spheniscus magellanicus*) and sooty shearwater (*Ardenna grisea*). Additionally, other sources of injuries and mortality due to interactions of seabirds with cables (net or sounder) have been detected. At present some mitigation strategies were tested in the northern fishery like the use of reflective buoys, acoustic devices and the manipulation and liberation of seabirds caught alive. However, experimentation effort is still insufficient to achieve conclusive results and any mandatory measure was adopted.

[Source: Private Observers Programme]

(14) Seabed Stories: tracks from bottom-towed fishing gears

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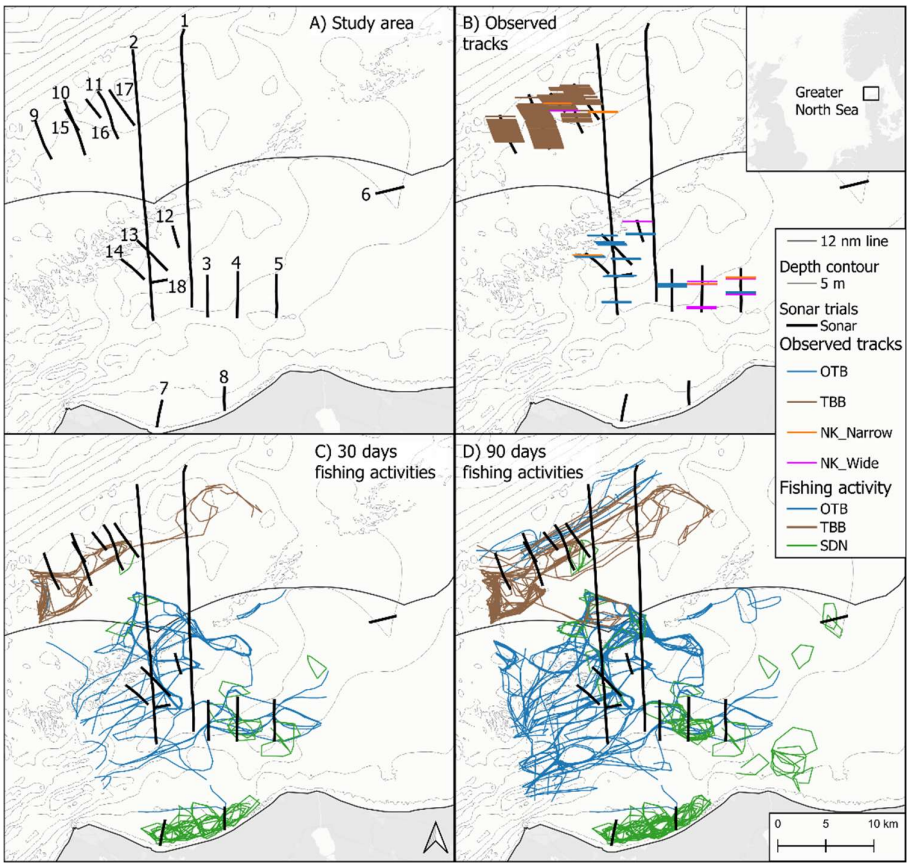
Bottom-towed fishing gear, including trawls and seines, is among the most widespread anthropogenic activities impacting seabed habitats. Depending on the gear type, towing intensity, sediment characteristics, and habitat type, these gears impact seabed morphology, resuspend sediments, and disrupt biogeochemical processes. They also cause significant ecological impacts, including mortality of benthic organisms, biodiversity loss, and shifts in species composition.

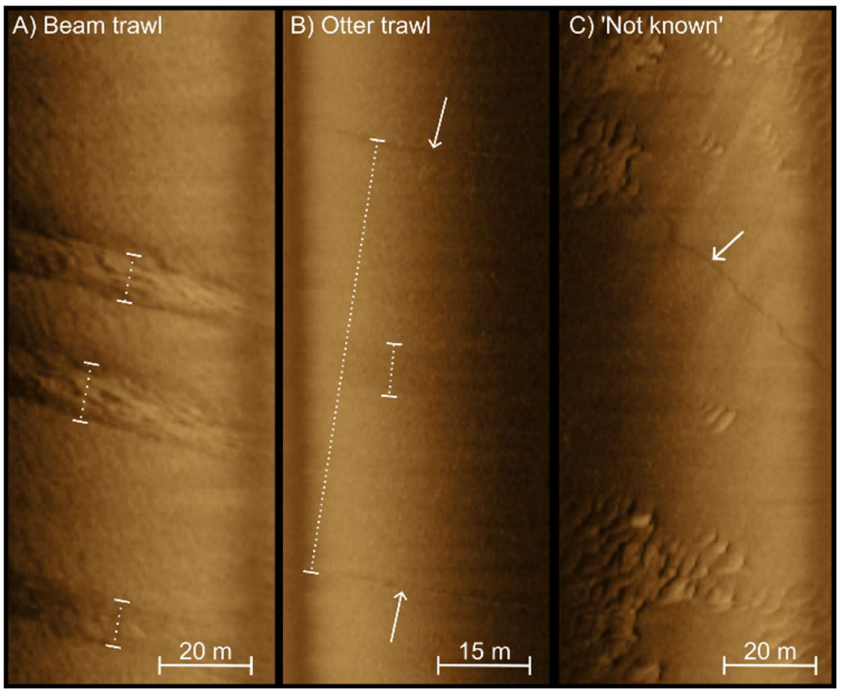
This study uses and combines AIS data and side-scan sonar track observations to examine fishing gear impacts on seabed features in the North Sea. AIS data identified 20 active fishing vessels of beam trawlers, otter trawlers, and Danish seiners, totalling 808 fishing activities in the study period. Sonar surveys covered ~110 km across 18 trials, detecting fishing gear tracks in 14 trials. Beam trawl tracks were the most frequent, characterised by paired depressions, while otter trawl tracks featured parallel furrows and clump marks in a few cases. Danish seine tracks were not confidently observed. Overall, 38% of beam trawl AIS fishing activities were observable tracks using the sonar and only 5% of otter trawl fishing activities.

Tracks appeared at different depths, with beam trawl deeper than otter trawl tracks, but both depths correspond to the average depth of their fishing activities. Longevity analysis revealed that beam trawl tracks persist for up to 30 days while otter trawl tracks for up to 7 days. Combining AIS and sonar data highlighted that beam trawls sweep the largest subsurface area, while Danish seine covers the largest surface area. Hourly swept area rates align with these findings, with beam trawl having the largest subsurface impact and Danish seine dominating surface impacts.

This integrative approach provides insights into gear-specific seabed impacts and temporal footprints. Applying only sonar data would minimise the effects of Danish seines, which sweep a large area of the surface sediment, potentially causing sediment resuspension and impacting the marine fauna. Otter trawl and beam trawl effects would be less at the surface level, but based on the sonar, the subsurface impact would appear with implications for fauna recovery. The longevity of the beam trawl also indicates that the tail of fishing activity disturbance exceeds the natural disturbance, which can cause ecological changes due to new conditions.

Funded by the European Maritime, Fisheries and Aquaculture Fund (EMFAF) and the Ministry of Environment and Food of Denmark under the project FIBEHA (Grant numbers EFMVM-23-0029).





[Source: A.F. Irlind, DK]

(15) Testing flexible gear choice: insights from a case study in the common sole fishery

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In many fisheries, limited knowledge of actual catch compositions has led to rigid technical measures that restrict how fishers can operate to meet their quotas. The fishery for common sole (*Solea solea*) is one of the most economically important demersal fisheries in Denmark. However, it remains highly inefficient for the target species due to a mismatch between the mandatory minimum mesh size (90 mm) and the species' minimum conservation reference size (MCRS). This mismatch forces fishers to increase fishing effort, leading to higher fuel consumption, greater seabed impact, and longer working hours. Furthermore, the small mesh size required to capture sole efficiently results in very high catch rates of undersized bycatch species, namely european plaice (*Pleuronectes platessa*) and common dab (*Limanda limanda*). A previous evaluation suggested that gear regulations may become redundant if catches are fully documented using electronic monitoring (EM) cameras. Therefore, we tested the potential effects of relaxing gear regulations by allowing fishers free gear choice while documenting their catches with EM. This was undertaken using an iterative approach, first to optimise catches of the main target species, then to improve overall catch compositions by reducing unwanted catches. Here, we describe the process and present the preliminary results from the trials. Although this study was conducted in the fishery for common sole, it contributes to broader discussions on whether more flexible, results-based management, enabled by EM and fully documented fisheries, can improve both economic viability and sustainability objectives in fisheries.

[Source: S. K. Bertelsen, Denmark]

(Poster B) Estimating exploitation indicators for escapees, landings and discards using selectivity data: a case study for two economic important crustacean species in the Mediterranean trawl fishery

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The bottom trawl fishery is a fishing technique that leads to the capture of important commercial species as well as large amounts of unwanted bycatch and discards. To provide information about the efficiency of this gear and the behaviour of fishers at releasing and retaining individuals below and above MCRS in the fractions of escapees, discards and landings, we created exploitation indicators for these processes, based on the exploitation indicators mentioned for first time by Wienbeck et al. (2014). The implementation requires (a) a three-fraction sampling design for the selectivity data, partitioned into escapees, discards and landings, (b) the escape, discard

and landing probablilities, estimated according to the overall selection model of Mytilineou et al. (2018), and (c) the mean size structure of the population entering the trawl codend. The case study refers to the estimation of the exploitation indicators for two crustacean species, *Neprhops norvegicus* and *Parapenaeus longirostris*, in the Mediterranean bottom trawl fishery using different configurations in the codend in order to predict the percentage of individuals that are below or above the MCRS of these species in the fractions of escapees, landings and discards in relation to the total population entering the trawl codend as well as the percentage of individuals below the MCRS in the fractions of escapees, discards and landings.

1.4 Session 4: ALDFG/ Gear Marking/ Plastic Pollution/ Gear Recycling

(16) Multi-stakeholder perspective to devise indicators to enable sustainable and circular management of fishing gears: a case from Norway

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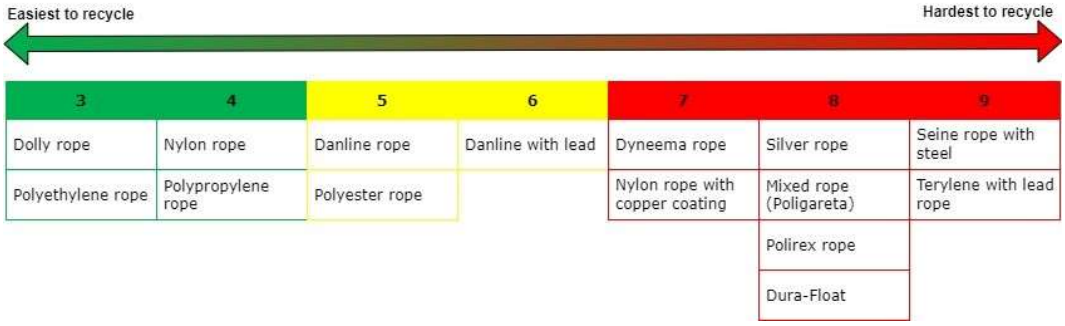
Marine plastic pollution is an escalating global concern, impacting both marine and terrestrial ecosystems. In Norway, a fishing-intensive nation, plastic pollution from discarded fishing gear (FG) and ropes is particularly problematic, with fishing ropes often incinerated, landfilled, or lost at sea, contributing to ghost fishing. Addressing this challenge requires robust indicators to track plastic waste pathways and assess circularity potential.

This study presents a static material flow analysis (MFA) based on six years (2016-2021) of data collection to quantify plastic mass flows from commercial fishing in Norway.

Key indicators were developed through surveys of local fishers, regional waste collectors, and recycling and incineration companies to evaluate fishing gear management practices, disposal rates, and recycling feasibility. The indicators include the typical lifespan of FGs, repair and replacement frequencies, loss rates upon deployment, and recyclability potential.

Findings indicate that approximately 383 tons of fishing ropes and about 400 tons of FGs are lost annually in Norwegian waters, posing a significant threat to marine biodiversity. Additionally, only one-third of the 15 analyzed rope types can be efficiently recycled with current technologies, underscoring the need for enhanced circular economy strategies. The MFA, combined with an inventory-based ranking approach, demonstrates strong potential as a decision support tool for policymakers and industry stakeholders.

The development of these indicators aligns with EN 17988 standards and upcoming Extended Producer Responsibility (EPR) schemes, facilitating the transition toward sustainable FG resource management. Moreover, insights from Norwegian fisheries can inform broader global sustainability efforts, ensuring more responsible fishing practices worldwide.



[Source: Deshpande P., C., 2023: Link:https://www.sciencedirect.com/science/article/pii/S0025326X2301233X]

(17) The FAO Global ALDFG Survey

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Over the past decade, awareness has grown concerning the increasing problem of ocean plastic pollution, some of which originates from abandoned, lost, or discarded fishing gear (ALDFG). However, the extent of plastic and ghost gear resulting from ALDFG remains poorly quantified. This knowledge gap underlines the necessity for comprehensive data to estimate the fishing industry's annual losses and to inform effective mitigation strategies. The Food and Agriculture Organization (FAO) has launched the FAO Global ALDFG Survey to systematically collect data from fishers worldwide.

A standardised questionnaire was developed to ensure that the information gathered is comparable and representative across all types of fishing gear used in various fisheries. The primary strength of the FAO Global ALDFG Survey lies in its ability to compare fisheries from any country or region participating in the survey. To date, the survey has been conducted in 15 countries through 40 separate sessions, garnering nearly 4,000 responses from fishers. Today, several countries, NGOs and research institutes are running FAO surveys to collect responses and input the data into the FAO ALDFG database. By the end of 2025, the database is expected to contain data from 20 countries.

While the objective of a globally acceptable estimate of annual ALDFG rates is not yet achieved, as data from more countries and regions is still missing, data collected so far already provides an evidence-based overview of the issue in selected fisheries in those 15 countries. Preliminary findings indicate that significant yearly rates of ALDFG contribute to marine plastic litter and other associated impacts with variations linked to regional differences in gear types, onboard management and recovery practices, and regulatory frameworks. Selected results will be presented, along with an explanation of the methods employed to run and analyse the FAO Global ALDFG Survey results.

[Source: H.Einarsson, Iceland]

(18) The unnoticed impact of marine plastic debris on trawl fishery

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Marine plastic debris is a growing universal issue with serious ecological, social, and economic consequences. While recent research has been focused on its various impacts, a complete understanding of its broad implications is still lacking. This study quantifies the bycatch of marine benthic debris in a coastal trawl fishery and its impact on capturing small-sized organisms and codend selectivity. The bycaught marine debris during the routine fishing by two beam trawlers in Tachibana Bay, Nagasaki, Japan was collected and analyzed in the laboratory from April to September 2023 and 2024. Any marine organisms found within the debris were identified and measured. The selectivity experiments were conducted in October 2024, adding 5 plastic bags (45 x 32 cm) inside the codend (33.7 mm mesh size) for experimental tows and without plastic bags for control tows. The codend selectivity for the experimental and control tows was estimated either using logistic or contact probability models. Over two years, 1,249 pieces of marine debris, weighing 45.02 kg, were collected, with plastic accounting for more than 94% by both number and weight. There were 250 organisms representing 23 species found trapped inside plastic debris. A positive correlation ($r = 0.712$, $p<0.001$) was found between marine benthic plastic debris and bycatch. Selectivity parameters were estimated for three species, *Metapenaeopsis barbata*, *Acropoma japonicum* and *Nuchequula nuchalis*. The contact probability model was a better fit for experimental tows, while the logistic model fits better for control tows, for all three species. The estimated contact probabilities were 0.38, 0.52, and 0.41, respectively. The selectivity curve indicated that smaller fish had higher retention probabilities in nets with plastic debris. This suggests marine debris negatively impacts codend selectivity by blocking mesh openings and reducing fish escape opportunities.

(19) Characterising Benthic Macro Plastics: Degradation, Pervasiveness, and Pathways

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The deep sea is one of Earth's largest ecosystems, harbouring high biodiversity, carbon sequestration, and provides a wealth of resources. The seafloor is hypothesised to be the final sink for over 70% of plastic litter entering the marine environment. However, due to historic accessibility restrictions, the characteristics of benthic plastic litter remain poorly understood. These knowledge gaps pose risks to benthic ecosystems and the commercial fishing vessels operating over the seafloor; contributing to the abundance of ALDFG residing in the ocean.

This study collaborated with commercial twin-rig trawler fishers participating in The Local Authorities International Environmental Organisation (KIMO)'s Fishing for Litter (FFL) scheme to investigate the types of plastic and other materials passively recovered through trawling. Samples were collected over six sampling sessions between September 2024 to January 2025 from depths of 60-120 metres deep, six miles off of the west coast of Cornwall. Across approximately 168 trawls covering 2,520 miles of seafloor, a diverse, representative set of benthic macro plastic litter was sampled; including ALDFG items entangled in operational fishing gear.

Fourier-Transform Infrared Spectroscopy (FTIR) and X-ray Fluorescence (XRF) identified the chemical and polymer composition of the plastic litter recovered, including ALDFG plastic items, whilst Scanning Electron Microscopy (SEM) examined degradation indicators to evaluate the longevity of plastic in the benthic environment. Predominantly negatively buoyant polymer types (e.g. PET, PVC), were identified, supporting the hypothesis that these materials dominate benthic plastic litter.

Unlike previous studies, the abundance of ALDFG recovered in this study was limited, which may be attributed to the improved disposal practices. The main ALDFG items that were recovered included buoys and leaded rope, which were largely comprised of both buoyant and negatively buoyant polymer types (ABS, PBS, and PA). ALDFG can damage operational fishing equipment, occupy valuable net capacity, and limit deck space during recovery. The limited presence of ALDFG in the trawls is considered to be a good indication of minimised impacts from this litter type on the fishers operating in the region surveyed.

However, the litter sources identified in this study were primarily plastic packaging, homeware items, and Navy-derived debris (e.g. sonobuoys).

This study provides critical, novel insights into the composition of benthic litter, which will aid future research, infrastructure, and policy development for the mitigation of benthic litter and ALDFG accumulating on the seafloor.

[Source: F. Read, UK]

(20) An industry perspective on fishing gear recycling and circularity - current practices and future challenges

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The introduction and availability of end-of-life (EOL) pathways for fishing gear disposal has proven a powerful tool to enforce and support the rules and regulations that target fishing gear as a source of pollution. This has given captains and vessel owner a direct way to dispose of their gear into a recycling value chain. Around this value chain an dedicated recycling industry has developed that strives to achieve circularity for the major components of aquatic netting and ropes. The major polymer groups used in modern fishing gear, PA (nylon), HDPE, and PP, have all achieved full scale recyclability. In turn a marked has developed for raw material made from recycled fishing gear. There are also projects under way to improve the quality of input and output streams in the recycling process to achieve full circularity at scale to reintroduce recycled materials in the production processes for fishing gear. This presentation will provide a structured overview about current practices and technologies that enable EOL solutions.

Several challenges remain that require cross industry and stakeholder involvement to make those collection and recycling practices applicable across all regions and fisheries. Those where highlighted by the TOR Recycling and Circularity of the ALDFG topic group at the 2024 FTFB meeting. Those challenges center around material selection at the design stage, waste management practices, economic incentives and policies, regional political considerations as well as needed investments in infrastructure and technology.

(21) From catch comparison to 3D printing: in the hunt for biodegradable materials suitable to passive gears in commercial conditions

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Biodegradable materials have the potential to address the challenge of ghost fishing and microplastic pollution from commercial lost fishing gears in the marine environment. To be an interesting alternative to standard material for fishers, the new biodegradable materials must be resistant enough to last the entire fishing season without loss in catchability or selectivity but degrade sufficiently quickly in seawater if lost.

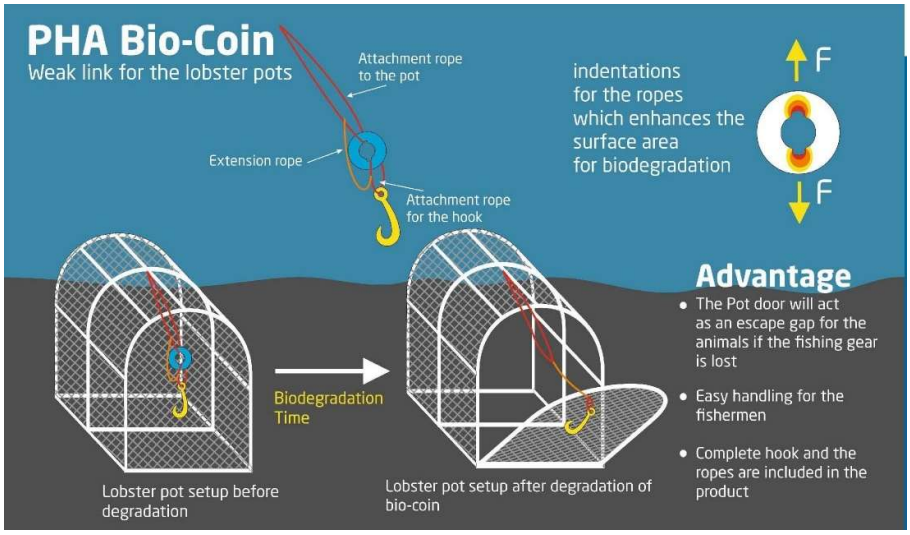
We present a summary of our research efforts for biodegradable materials in gillnets and pots in natural and controlled conditions, including methodological recommendations for further studies.

Biodegradable nets made of polybutylene succinate-co-adipate-co-terephthalate (PBSAT) were tested against polyamide (PA6, nylon) for cod and plaice in Skagerrak. Testing at sea showed that the biodegradable nets started breaking and fish could push their way through just a couple of weeks into the season. We did not observe significant differences in breaking strength, stiffness and strain at break between the effects of physical strain due to the interactive effect of gear operation and degradation, and degradation only.

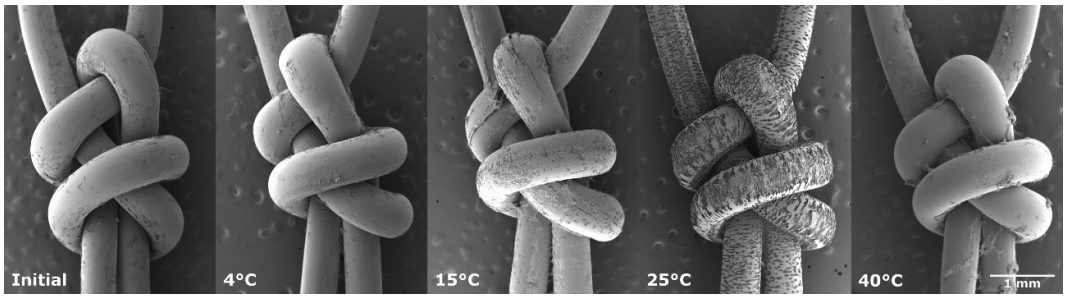
We investigated further the degradation processes for PBSAT immersed in seawater at different temperatures. The degradation was accelerated in the knot, suggesting that the durability of the knot is critical for successful development of a biodegradable polymer in gillnets. We found specific bacterial taxa gathered at the knots, which could be responsible for the degradation of the material.

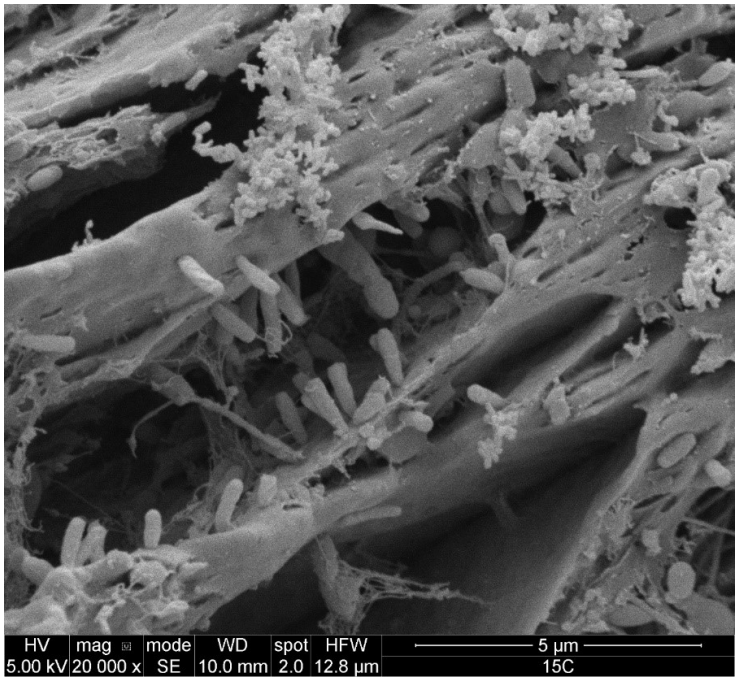
Mechanical testing at monofilament, knot, and net scales, in addition to steric exclusion chromatography, scanning electron microscopy and X-ray tomography suggest that the durability of the knot is critical for successful development of a biodegradable polymer for application in gillnets. While testing the whole net panel is not necessary, it is however important to test at the knot and not the monofilament scale.

We also present a prototype ("Bio-Coin") in 3D printed Polyhydroxyalkanoate (PHA) as a complete product of a hook with a weak link for the pot door to act as an escape gap in the commercial lobster fishery. Current developments are focused on better understanding of the tensile strength properties of PHA in different 3D printing configurations.



[Source: DTU Aqua]





[Source: IFREMER]

(22) A Framework for the risk assessment for the marking of fishing gear

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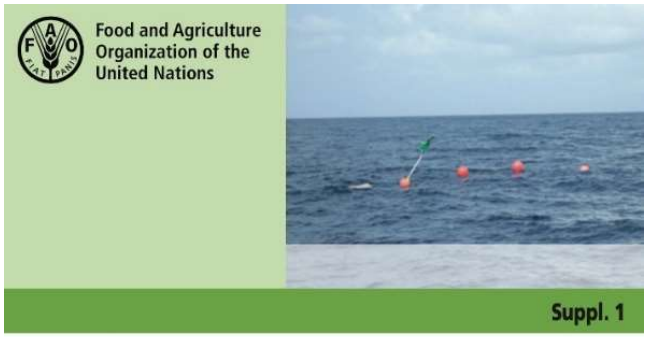
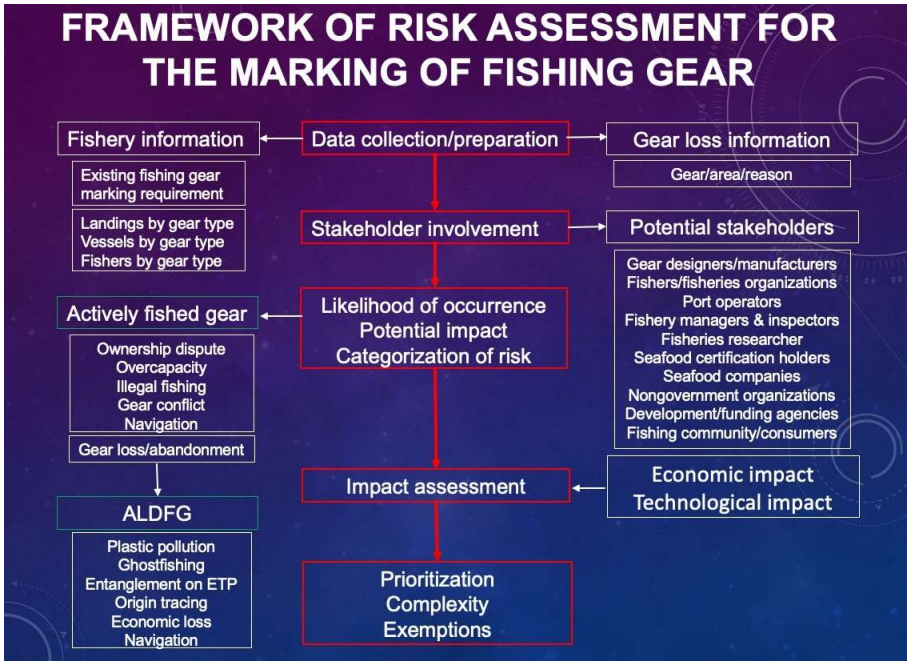
The marking of fishing gear contributes to sustainable fisheries, improving the state of the marine and freshwater environments by combatting, minimizing, and eliminating abandoned, lost or otherwise discarded fishing gear (ALDFG). It also facilitates the identification and recovery of such gear. In addition, fishing gear marking supports fisheries management and can be used as a tool in the identification of illegal, unreported and unregulated (IUU) fishing activities. The Food and Agriculture Organization (FAO) of the United Nations developed the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) through an Expert Consultation and Technical Consultation, and approved by FAOâ€™s Committee on Fisheries in 2018. The VGMFG stipulates that a risk assessment should be carried out when implementing a system of fishing gear marking. This presentation describes a framework for conducting a risk assessment. The development of the framework was based on principles outlined in the Annex of the VGMFG. It was also guided by the results of a pilot project on risk assessment on the marking of fishing gear conducted by FAO in Grenada. The framework may assist fisheries managers, fishing gear manufacturers and the fishing industry to meet relevant international, regional or national obligations for gear marking. More specifically, it may help comply with the specific gear marking requirements outlined in the FAOâ€™s Code of Conduct for Responsible Fisheries as well as the international instruments and agreements.



VOLUNTARY GUIDELINES ON THE MARKING OF FISHING GEAR

A framework for conducting a risk assessment for a system on the marking of fishing gear



[Source: FAO]

(23) Tackling abandoned, lost and otherwise discarded fishing gear (ALDFG) in inland waters: example of Lake Victoria, Eastern Africa

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This presentation summarizes research that has been done so far to understand the ALDFG challenge in inland waters using Lake Victoria as a case study. First, analyses of the current national fisheries and aquaculture policies, plastic pollution, solid waste, water, and environmental protection laws and regulations highlighted weaknesses in the legislative, regulatory, and policy frameworks in relation to the management of ALDFG as plastic pollution from capture fisheries and aquaculture. Secondly, a review and synthesis of available literature regarding the status and extent of ALDFG in inland fisheries globally, and in particular in Africa inland waters, between 1970-2023 found only 16 studies regarding ALDFG in inland fisheries globally, with only one study from Lake Victoria. Due to the paucity of data on ALDFG in Lake Victoria and other African inland waters, a survey of ALDFG and its cause is planned with a pretest survey carried out recently. The pre-survey involved administration of the FAO data collection tool with a small set of respondents to test the readiness of the tool and have an initial assessment of ALDFG quantity, causes and management options while providing a critical baseline for the upcoming full-scale survey. Results from the pre-survey showed that severe weather, vessel traffic and

vandalism are the leading drivers of gillnet loss. Fishing gear is marked as a way of preventing ALDFG although there is no laws or regulations for marking and there is no publicly available facilities to manage or dispose end-of-life fishing gear. There is therefore an urgent need by stakeholders to create awareness of the negative impacts of ALDFG, design policies for its effective management and enhance research towards determining sources, causes, levels, rates, impacts, preventative measures, knowledge gaps, and research priorities.

KEYWORDS: Inland fisheries; ALDFG policy; conservation challenges; ALDFG drivers

Fig. 1 Geographic locations for original studies reviewed. Each study focused on gear types denoted by the following symbols. Gillnets: +, traps: X, longlines: *, trotlines: Y, trawls: T and various: o

[Source: Ssempijja et al 2024; https://link.springer.com/article/10.1007/s11160-024-09843-5]

[Source: D. Ssempijja, Uganda]

(24) Investigation on the performance of ALDFG recovery devices using tank simulation and orthogonal testing

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In response to the pollution mitigation requirements for abandoned, lost, or otherwise discarded fishing gear (ALDFG) in the highly heterogeneous seabed environments of the Yellow and Bohai Seas, this study employs a mixed orthogonal experimental design and tank towing simulation test to systematically evaluate the effects of seabed quality (mud, sand, rock, mud-sand, and mixed mud-sand-rock), retrieval device configuration (four types of hooks in single or double hook setups), towing speed (0.1~ 0.25 m/s), and netting parameters (polyethylene and nylon monofilament, netting ranging from 10 to 20 cm, and mesh size between 1 and 2 cm) on retrieval efficiency. The results indicate that: (1) small and sharp hooks performed best in both single and double-hooks experiments, significantly outperforming other devices ($p<0.05$); (2) retrieval efficiency was the highest in sandy and muddy seabed and the lowest in rocky seabed; (3) mixed seabed (e.g., mud-sand-rock) exhibited the lower efficiency; (4) larger netting size and mesh size were associated with higher retrieval success rate; (5) although towing speed did not have a statistically significant effect on retrieval efficiency, 0.25 m/s (0.49 knots) was identified as the optimal speed under this testing conditions. This study provides insights into the seabed-device compatibility mechanism, offering an optimized retrieval device configuration with high adaptability and a technical framework for ALDFG pollution mitigation in the Yellow and Bohai Seas.

(25/ Poster C) Dolly Ropes from problem to solution

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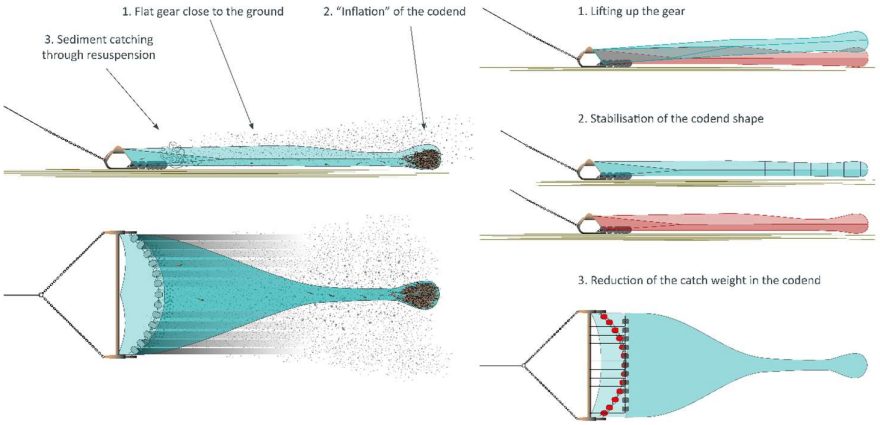
Beam trawls are towed very close to the seabed due to their design. To reduce chafing of the lower panels of these nets on the seabed, mats of polyethylene rope cardels are often placed there. These ropes are known as "dolly ropes". A large part of the dolly rope material is released after a short time at sea. This results in the following problems:

- ecological problem, e.g. due to plastic entering the ecosystem and the food chain
- aesthetic problem, e.g. for tourism at the North Sea
- problem for fisheries and shipping, e.g. due to fibres cutting into motor shafts and fishing gear
- possible legal problem due to violation of MARPOL Convention 1, which prohibits any dumping of plastic in the sea
- possible/probable deterioration of the size selection of the trawl nets by closing the meshes, thus an increase of unwanted by-catch

The presentation will give a systematic overview about the causes and the problem, as well as present a technical solution toolbox to be applied (and if needed adapted in different fisheries). Additionally, a proposal for legal regulation to avoid marine litter due to the use of dolly ropes and other chafing gears will be presented.



[Source: Thünen Institute of Baltic Sea Fisheries (Schütz/Stepputtis)]

(Poster D) Dsolve - Centre for Research-based Innovations - development of biodegradable materials for application in fisheries and aquaculture

Roger B. Larsen*[1], Ravindra Chowreddy[2], Christian Karl[3], Jørgen Vollstadd[4], Claire Armstrong[1], Cecilia Askham[5], Hilde Rødås Johnsen[6]

[1] *Uit the Arctic University of Norway, 2 Norner AS, 3 Sintef Industry AS, 4 SINTEF Ocean AS,*

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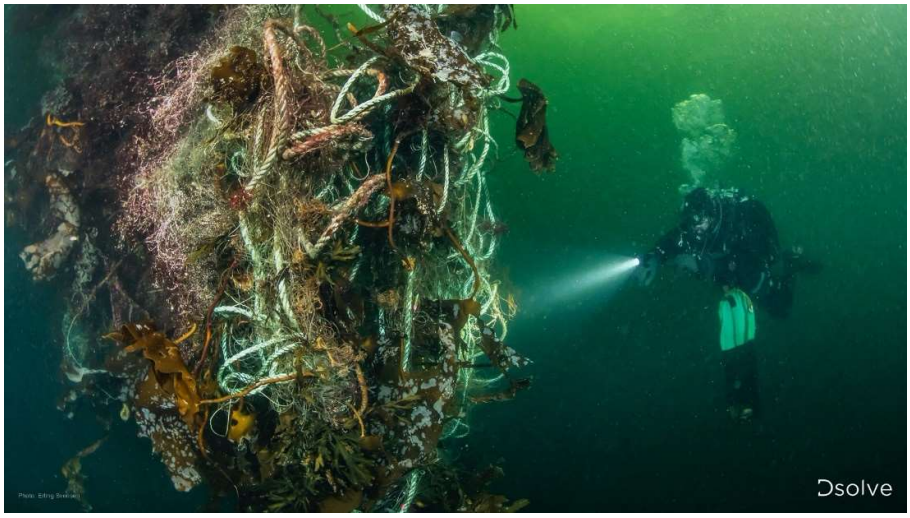
Dsolve (2020-2028) is a centre for research-based innovation - development of biodegradable materials for applications in fisheries and aquaculture. Our research aims to reduce plastic litter and associated problems such as ghost fishing, macro and microplastic caused by the fishery and aquaculture industries. The goal is that new biodegradable materials can replace traditional plastics in these sectors.

Dsolve is divided into six research areas led by national research partners UiT Arctic University of Norway, Norner AS, SINTEF Industry, SINTEF Ocean, Norsus AS and SALT Lofoten AS/UiT. The centre include research from DTU Aqua (Denmark), Thünen Institute of Baltic Sea Fisheries (Germany) and the University of Split (Croatia). Dsolve involves 18 industry partners, several NGO's, public organisations and research institutions.

The conceptual structure of Dsolve is: Product-orientated areas represent a value-chain perspective, while policy goals connect to the total value-chain. The iteration processes for research and development constitute a stepwise approach, from basic research to full-scale testing of prototype applications.



[Source: Erling Svendsen/SALT Lofoten AS]

(Poster E) Removing, researching, and recycling derelict fishing gear in Hawai'i: a multi-pronged approach to marine debris management

Jennifer M. Lynch[1,2], Mafalda de Freitas*[2], Katherine A. Stevens[2], Cara Megill[2], Mandy-Tanita Brinkmann[2], Eric Kingma[3], Nikolai Maximenko[4], Eileen Nalley[5], Darren Lerner[5]

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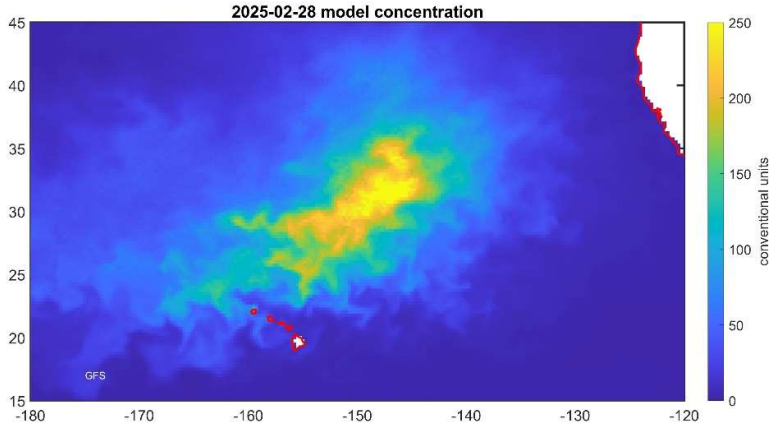
The Hawaiian Archipelago has become a global hotspot for derelict fishing gear (DFG) accumulation due to its proximity to the North Pacific Garbage Patch (NPGP). This accumulation continuously threatens critical marine life, fisheries, and coastal communities. To address this, the Center for Marine Debris Research (CMDR) has developed a comprehensive approach to accelerate DFG removal, characterize and source, and mechanically recycle to create long-life, locally necessary, infrastructure products.

Today, we incentivize offshore retrieval by compensating commercial fishers for at sea removal to prevent nearshore coral reef damage, and further collaborate with local fishers and NGOs to retrieve DFG once it reaches shorelines across the Hawaiian archipelago. Together with our local

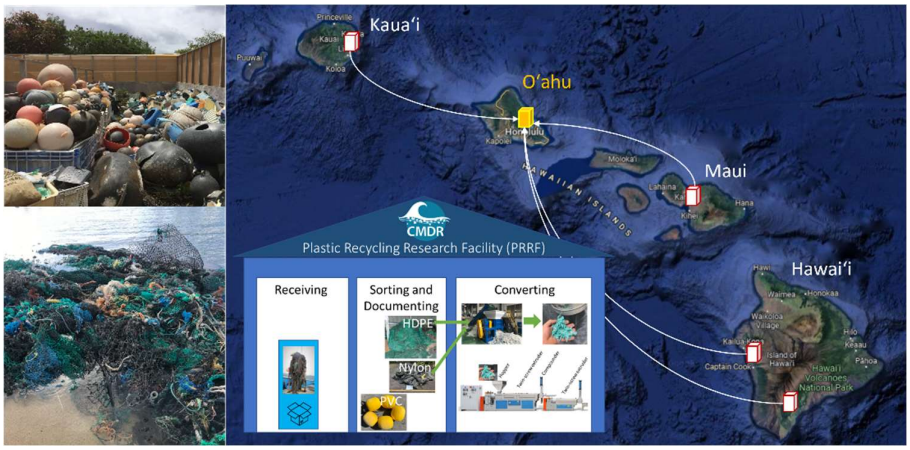
partners, we aim to recover 200 metric tons of DFG annually. Polymer analysis shows that ~75% of collected debris is DFG, with high-density polyethylene (HDPE) trawl netting making up ~20%. While nylon is less prevalent in recovered debris, we have partnered with the Hawaiian longline fleet to recycle spent monofilament lines. Our sourcing studies have further shown that DFG found in Hawai'i originates from multiple countries around the Pacific Rim, emphasizing the need for international discussions and collaborations to address this issue.

To advance sustainable solutions for DFG removed, we established the Plastic Recycling Research Facility (PRRF) on O'ahu, where HDPE and nylon debris are processed into long-term infrastructure materials such as plastic lumber and asphalt components for road pavement.

By integrating removal, research, and recycling, this project provides a model for DFG management. Through collaboration with fishers, researchers, and industry, we aim to drive global innovation in marine debris mitigation and circular economy solutions. This presentation will share our goals and key findings, challenges, and opportunities for further collaboration.



[Source: N. Maximenko - open-access model repository]



[Source: J. M. Lynch, USA]

(Poster F) Ghost fishing impacts in Norwegian waters and the Northern Adriatic Sea

Dorian Vodopia[1*], Francesca Verones[2], Cecilia Askham[3], Roger B. Larsen[1]

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Norwegian waters and the Northern Adriatic Sea, renowned for their fisheries-related economic importance and biodiversity, are impacted by ghost fishing, the capture of marine life by abandoned, lost, or discarded fishing gear (ALDFG). However, comprehensive data on ghost fishing catches in these regions remains scarce. To address this knowledge gap in Norwegian waters, we analyzed six years (2018-2023) of ALDFG retrieval data and two in-situ ghost fishing trials from 2000-2001 and 2022. An additional in-situ ghost fishing trial was conducted between December 2023 and April 2024 in the Northern Adriatic Sea. Yearly reported gillnet losses captured approximately 3000 tons of fish and scavenging invertebrates in Norwegian waters, while pre-escape mechanism king crab and snow crab pots caught over 70 tons of crabs. Ghost fishing catch in derelict king crab pots was notably reduced by escape mechanisms. During the 133-day trial period in the Northern Adriatic Sea, derelict gillnets caught 151 kg / ALDFG unit, while fish traps caught 4 kg / ALDFG unit, both primarily affecting fish and scavenging invertebrates. Annual losses of gillnets and fish traps in the Northern Adriatic Sea remain unknown, preventing estimation of the total yearly ghost fishing catch from these gear types. While derelict fishing gear primarily caught commercial species, it also affected cetaceans, elasmobranchs, and a pinniped species in Norwegian waters, as well as elasmobranchs and a seabird species in the Northern Adriatic Sea. These results underscore the significant impact of ghost fishing in Norwegian and Northern Adriatic marine environments, along with the effectiveness of escape mechanisms in reducing ghost fishing catches in derelict pots.

~~(Poster G) Ghost fishing efficiency in swimming crab (*Portunus trituberculatus*) pot fishery~~

~~Mengjie Yu*[1], Yanli Tang[1], Bent Herrmann[2,3], Kristine Cerbule[4]~~

~~[1] *Fisheries College, Ocean University of China, 266003 Qingdao, Shandong, China*~~

~~[2] *UiT The Arctic University of Norway, Tromsø, Norway*~~

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

~~[4] *Heriot-Watt University, Edinburgh, United Kingdom*~~

~~Contact: yumengjie@ouc.edu.cn~~

~~Abandoned, lost, or otherwise discarded fishing gear (ALDFG) is a global challenge that negatively affects marine environment through plastic pollution and continued capture of marine animals, so called "ghost fishing". In different pot fisheries, ghost fishing related to ALDFG is of concern, including pot fishery targeting swimming crab (*Portunus trituberculatus*), which is one of the most important fisheries along the Chinese coast. In this study, we quantified the ghost fishing efficiency by comparing it to the catch efficiency of actively fished baited pots and evaluated the self-baiting effect on ghost fishing efficiency. The results showed that the ghost fishing affects both target and bycatch species. On average, the ghost fishing pots captured 12.53 % undersized crab and 15.70 % legal-sized crab compared to the actively fished pots. Ten other bycatch species were also captured by ghost fishing pots. Further, the self-baiting effect improved the relative catch efficiency of ghost pots for undersized and legal sized swimming crabs to 13.72% and 21.59%, respectively. The results of this study emphasized the need to develop new~~

~~management strategies for reducing marine pollution by ALDFG and associated negative effects in this pot fishery.~~

(Poster H) Pot losses and associated implications in Barents Sea snow crab (*Chionoecetes opilio*) fishery

Kristine Cerbule[1,2*], Roger B. Larsen[3], Astrīda Rijkure[2,4]

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Snow crab (*Chionoecetes opilio*) is considered an invasive species in the Barents Sea with first observations dating back to 1996. The Norwegian commercial fishery for snow crab has been increasing since it first commenced in 2012. This fishery adopted conical baited pots, similar to other fisheries targeting snow crab. During the last decade, different management measures have been implemented to ensure sustainability in this relatively new fishery. One central challenge is pot loss during deployment caused by challenging weather and operational conditions. Lost snow crab pots can have a considerable potential for continuous capture of crabs, so-called "ghost fishing" which has been documented during lost gear retrieval and experimental trials. This study considered different scenarios of snow crab pot losses and associated economic implications. The results show that given the substantial number of pots used on snow crab fishing vessels, even small variations in pot loss rates (0.5 – 3.0% pot loss) can result in considerable differences in ghost fishing and associated environmental and economic effects. The estimated ghost fishing in this study ranged from 11.5 to almost 70 thousand kg ghost fished crabs during a 3-year period assuming 0.5 – 3.0% pot loss scenarios, resulting in significant differences in ghost fishing expressed in amount of snow crab and value of ghost fished catch. These results highlight the importance of all incentives and technical measures that can reduce pot losses and associated ghost fishing time.

(Poster I) Trials of radio frequency identification tags (RFIDs) for marking pearl oyster aquaculture nets and trawl nets

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Fishing gear marking is important not only to prevent abandoned, lost or otherwise discarded fishing gear (ALDFG) in the event of loss, but also to manage the period of use of fishing gear and materials to prevent damage and subsequent loss. We investigated the performance of radio frequency identification tags (RFIDs) and tested their durability in Japanese pearl aquaculture and bottom trawls.

Two types of TPU (Thermoplastic Polyurethane) water-resistant RFID tags (large and small tags, hereafter written as L-tag and S-tag) are tested. To investigate their performance, a water pressure test was conducted by submerging them in the ocean with a depth logger. The reading tests

were conducted under different conditions, such as different tag types, distances between the tag and the reader, tag orientation, reader output power, and whether the tags were immersed in water.

We attached L-tags to pearl aquaculture nets, a trawl net of the university training ship, and commercial small trawl nets, and checked whether they could be read from time to time.

The tags were able to be read even after being suspended for 30 minutes at a depth of about 150m. The type of tag, orientation, output power, and presence or absence of water all significantly affected the probability of being read. The L-tag had a higher probability than the S-tag, but for all tags, the probability was almost 100% up to a distance of 2m. Beyond that distance, the probability of being read decreased with distance.

Since May 2024, we have attached tags to 13 pearl nets, of which five have been recovered to harvest pearls, and all remain readable. We attached eight tags to various parts of the training ship's trawl net and towed it five times at a depth of about 150m, but there were no losses or damage, and all were readable. The survey on attaching L-tags to various parts of three commercial small trawls is still in progress.

(Poster J) Marking fishing gear

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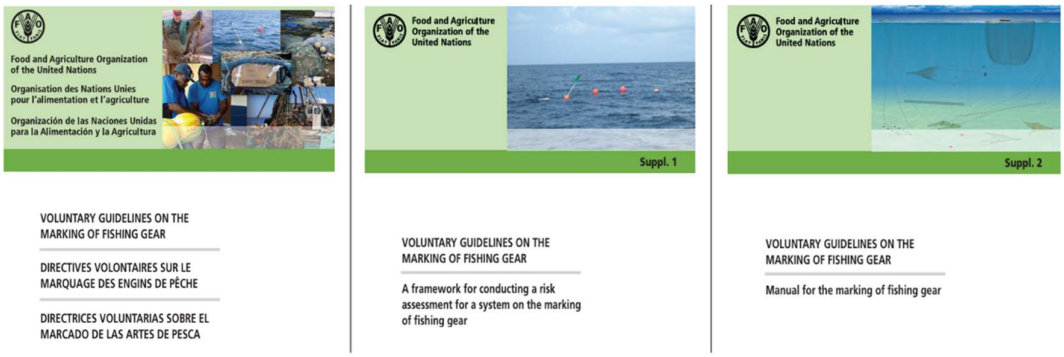
Since the early 1970s, international organisations have emphasised the importance of marking fishing gear, not merely as a tool for surface identification of stationary gear but as a comprehensive system using traceable tags to verify ownership of any fishing gear type. This approach enhances fisheries' management and supports measures to prevent illegal, unreported, and unregulated (IUU) fishing. With modern gear predominantly made from durable synthetic materials, persistent plastic in marine environments poses serious ecological, economic, and navigational hazards. Linking traceable tags to fishing gear registration in use and a registration system for gear loss offers a critical means to mitigate these risks. By enabling the efficient recovery of lost fishing gear, this system can substantially reduce the long-term impacts of ALDFG on marine ecosystems and coastal communities.

The need to mark fishing gear is gaining global recognition and momentum for implementation, as supported by the FAO Voluntary Guidelines on the Marking of Fishing Gear (VGMFG, 2019). FAO provides further support through the development and publication of tools to facilitate the implementation of the VGMFG, including a framework for conducting a risk assessment for a system on the marking of fishing gear (He, P & Lansley, J. 2023), a manual for the marking of fishing gear (Einarsson, et al, 2023), and an operationalisation guidance of the VGMFG for the Indian Ocean Tuna Commission (IOTC) area of competence (He, P. & Lansley, J. 2022). Regulation of gear marking is progressing. Marking of commercial fishing gear has been mandatory for EU Member States since at least 2009 (Control Regulation 1224/2009). However, it is unknown to what extent EU Member States have been able to implement gear marking on all gears effectively. The Control Regulation has been subject to review, including gear marking requirements, and new rules for a reinforced control system are due to enter into force in early 2024. However, progress has been slow, and the earliest estimated timeline for gear marking coming into force is currently the end of 2029. This timeline assumes that a proposal for amendment of MARPOL

Annex V will be submitted to the sub-committee Pollution Prevention and Response in 2026 (PPR13) and will be finalised at PPR 14 (in 2027) for adoption at the MEPC in 2028. Sixteen months after the adoption, the amendment would enter into force.

Even though gear marking must align with international fisheries' management frameworks, individual countries may implement it in phases or at varying levels of technical complexity:

- Passive Regulations: Require traceable marking without detailed guidance on tag content. This approach discourages ALDFG but does not yield data on the total amount of fishing gear in use.
- Guiding Regulations: Establish basic standards for tag design and labelling while requiring fishing gear registration. This will facilitate the recording of lost gear and its retrieval.
- Comprehensive Registration System: Maintains a full inventory of all active fishing gear and its materials, supporting end-of-life recycling and fostering a circular approach to fishing gear management.



[Source: FAO]

(Poster K) Towards a more sustainable longline fishery

Anja Alvestad*[1,2], Roger Larsen[2], Jørgen Vollstad[1], Julie Grønlund[1]

[1] *SINTEF Ocean, Trondheim, Norway*

[2] *UiT The Arctic University of Norway, TromsÃ¸, Norway*

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Longline fishing has long tradition in global fisheries and it is considered an environmentally friendly fishing method with a relatively low carbon footprint, supporting economic activity in coastal communities. Modern longline fisheries contribute to marine pollution through loss of plastic-based components, particularly branch lines (snoods) and connecting ropes between line-sections used in mechanised longline fishing (autoline). These components, typically made from polyester (PES) and nylon (PA), degrade slowly in the marine environment.

In Norwegian longline fisheries alone, several hundred kilometres of snoods are replaced annually due to damage, wear and tear. Lost or discarded snoods, and cut-offs from ropes connecting line-sections, entering the marine environment eventually degrade to micro plastics, contributing to pollution of the food-web contradicting the perception of longline fishing as an environmentally responsible practice. To uphold the industry's reputation and sustainability, there is a pressing need to develop alternative materials reducing plastic pollution.

The primary goal is to create, evaluate, and refine alternative materials for snoods in coastal and deep sea mechanized fisheries and optimising their mechanical properties to ensure they match conventional PES and PA snoods. The research follows a systematic approach, including

material development, laboratory testing including measurements of abrasion resistance and tensile strength, and full-scale field trials.

By the time of the WGFTFB-conference in May, I hope to be presenting some preliminary results from this study. I will have completed two trials on board commercial vessels (one coastal line fishing vessel and one autoliner), looking at snood-loss ratio and fishing efficiency of traditional snoods in relation to biodegradable snoods developed for this project. In addition, I will have tested both materials for tensile strength in laboratory settings, both new materials as well as materials used during commercial fishery, as well as strength testing of materials exposed to degradation testing in seawater for four months. In addition, potentially, some preliminary results from UV-degradation experiments.

[Source: Anja Alvestad, SINTEF Ocean, Norway]

1.5 Session 5: Multi-Use

(26) The significance of fish behavior in understanding the coexistence of offshore wind energy and fisheries practices

Chris Rillahan*[1], Keith Hankowsky[1], Michael Decker[2], Pingguo He[1]

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The next decade will bring unprecedented changes to the offshore environment along the East Coast of the United States due to numerous operating and proposed offshore wind (OFW) projects. Many of these projects overlap with traditional fishing grounds. While concerns have been raised about the loss of fishing access in these areas, little attention has been given to the role of fish behavior in the coexistence of these two industries. This talk will focus on two recent projects that examine the spatial and temporal distribution of fish in and around offshore wind lease areas. To understand broad-scale distribution patterns, a demersal trawl survey has been conducted in the Southern New England Wind Energy Area since 2019. Catch data reveals a highly dynamic area with seasonal variations in the distribution and abundance of most commercially important species. Similarly, a fine-scale study of fish distribution around offshore wind turbines using baited remote underwater video systems (BRUVs) documented the seasonal residence of several important commercial species. During the summer months, abundance and community composition were observed to change swiftly at distances from the turbine, indicating a strong reef effect. However, this distribution pattern shifted seasonally, showing a lower affinity for the turbines in spring and fall. The data from both studies highlight the complexity of understanding the impacts these structures will have on fishing access due to species-specific differences in life history and seasonal phenology. The data also present challenges for interpreting and incorporating survey trawl catch in stock assessment.

(27) Participatory mapping of small fishing vessel activities for marine spatial planning

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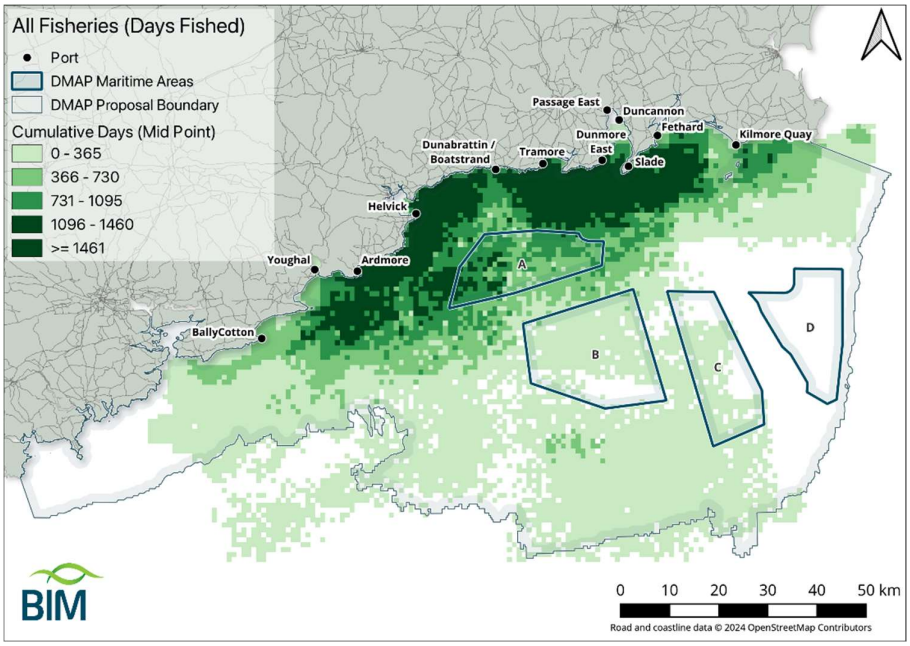
Under 12-meter vessels are an important component of the commercial fishing industry globally, yet they often lack robust spatial data on their activities. These data are needed for effective marine spatial planning (MSP) decisions in the light of increased competition for space from offshore wind farm developments and marine protected areas. Here we present a digital, geographically feature-rich, fisheries participatory mapping application and methodology to enable skippers on < 12m vessels to provide data on their fishing activities. Surveys were carried out in summer 2024 with skippers based in the Southwest coast of Ireland, in the government's Designated Maritime Area Plan (DMAP) area for offshore wind farm developments. Some 78 skippers were interviewed on board their vessels resulting in 244 yearly fishing activities across 8 gear types and 19 target species recorded. Lobster, crab and shrimp potting were the three main fisheries and accounted for 78% of the total days fished and the greatest numbers of vessels in the DMAP area. We used vessel plotters to validate data on spatial activities. The majority of participants had vessel plotters on board their boats, which we used to validate the information

provided during the interviews. A Bayesian analysis of validation scores showed a high level of certainty across most of the study area. Combined fishery maps were made publicly available for MSP purposes. This approach enabled real-time digitization and validation of spatial fisheries activities and engendered a strong sense of willingness from survey participants. Study outcomes and potential application of this approach to other MSP challenges are discussed.



[Source: Bord Iascaigh Mhara Ireland's Seafood Development Agency]

1.6 Session 6: Gear Design - Fish/ Invertebrate Selectivity

(28) 20 years of progress in the Swedish *Nephrops* fishery and the development of a size selective grid

Linnea Morgan*[1], Mikael Ovegård[1]

[1] *SLU Aqua, Swedish University of Agricultural Sciences, Lysekil, Sweden*

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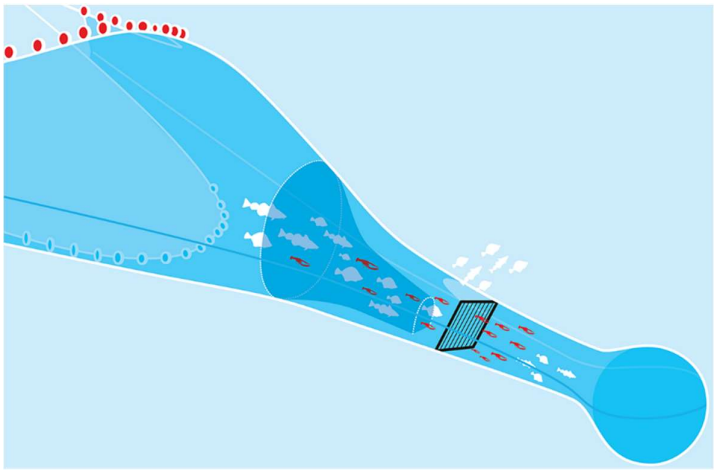
The Swedish grid was introduced in the Swedish Nephrops fishery in 2003 as a tool to decrease the amount of unwanted catch, especially cod (*Gadus morhua*). Uptake was initially high due to incentives such as quota regulations and gear-based effort restrictions, but use decreased with the introduction of the Common Fisheries Policy in 2017. Throughout this time, the Secretariat for Selective Fishing at SLU Aqua has been working alongside fishers in the Kattegat to further develop the grid to improve its selectivity. Three projects have been done since 2014 where a size-selective split grid has been tested with various selective codends, where the goal is that Nephrops norvegicus under minimum conservation reference size (MCRS), as well as smaller bycatch, will be sorted out of the catch. The two projects done in 2014-15 and 2022 looked at relative selectivity of the split grid compared to the standard grid used in the fishery, whereas the project done in 2024-25 looked at absolute selectivity by comparing the split grid to a 70mm diamond mesh codend. At the time of writing this abstract, the data collected in 2024-25 had not yet been analysed, however, the data from the previous projects showed that the split grid decreases the amount of Nephrops under MCRS (significant decrease under 40mm carapax length)

as well as significant decreases in flatfish (specifically plaice (*Pleuronectes platessa*), dab (*Limanda limanda*), and long rough dab (*Hippoglossoides platessoides*)). There was also a slight, but not significant, decrease in the catch of cod. The Nephrops fishers in Kattegat see potential in this type of gear and continue to drive their development forward.



[Source: Secretariat for Selective Fishing, SLU Aqua]

[Source: L. Morgan, Sweden]

(29) Size selection in the Norwegian demersal seine haddock fishery at fishing depth, surface and total seleckton

Olafur Arnar Ingolfsson*, Odd-Børre Humborstad, Manu Sistiaga

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This study investigates the selection process in Norwegian demersal seine fisheries (snurrevad) with a focus on cod and haddock under different conditions. Over a period from May 9 to 22, 2024, fishing trials were conducted on the Finnmark coast using a 44.8-meter long vessel equipped with conventional square-mesh codends and polyethylene net extensions. The study aimed to assess the size selection of fish both on the seafloor and at the surface, as well as the total selection occurring in the demersal seine during the whole fishing process. Three trial types (setups) were carried out: control hauls with a small-mesh bag, standard hauls without a release mechanism, and trials with a release mechanism designed to minimize surface selection by releasing fish into a small mesh codend at around 30 meters.

A total of 47,348 haddocks and 7,563 cods were measured. For haddock, 80.8% of the catch was below the legal size in control hauls, with size selection at the seabed reducing the number of undersized fish to 55.0%, while surface selection further reduced it to 38.5%. Size selection parameters (L50 and SR) for haddock were calculated, revealing a total L50 of 41.5 cm, a seabed L50 of 40.5 cm, and a surface L50 of 37.2 cm. For cod, 86.2% were undersized in control hauls, with seabed selection bringing it down to 61.2% and surface selection to 29.7%.

The results suggest that the use of codend extensions significantly impacts size selection, particularly by increasing the retention of small fish. This study provides important baseline data for improving size-selective fishing practices and offers insights into the impact of extension nets on fish size composition in commercial trawling operations.

(30) Assessment of four-panel T90 codends with shortened lastridge ropes in Irish demersal seine-net fisheries

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BIM is working with the Irish Fishing Industry to reduce unwanted catches, optimise quotas and improve operational and energy efficiency.

Irish demersal seiners participating in mixed fisheries face rising costs.

Optimising catch size profile is one way to improve operational efficiency and yield from available quota.

Irish seiners typically utilise a 100 mm T90 codend due to reductions in unwanted catches, increases in wanted catches and improvements in catch quality.

To improve the selective properties of a standard 100 mm T90 codend we constructed it from 4 panels and fitted it with shortened lastridge ropes.

A 4-panel codend has 2 extra selvedges and is considered more stable than a standard 2-panel codend. Shortened lastridge ropes attached to each selvedge help to stabilise codend mesh openings.

We carried out 3 trials using this gear with the following general findings:

• Substantial increases in catches of larger more valuable round fish and flat fish

• Reduced catches of smaller less valuable round fish

• Almost no retention of undersize fish

• Increased catch quality and price differentials

• The gear has major potential to further improve the environmental and economic sustainability of the Irish demersal seine-net fishery.

[Source: Damien Turner, Ireland]

(31) Understanding flatfish escape behavior in diamond-mesh codends: does mesh orientation matter?

Juan Santos*[1], Tim Taege[1], Zita Bak-Georgsen[2], Daniel Stepputtis[1], Bent Herrmann[2], Valentina Melli[2]

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

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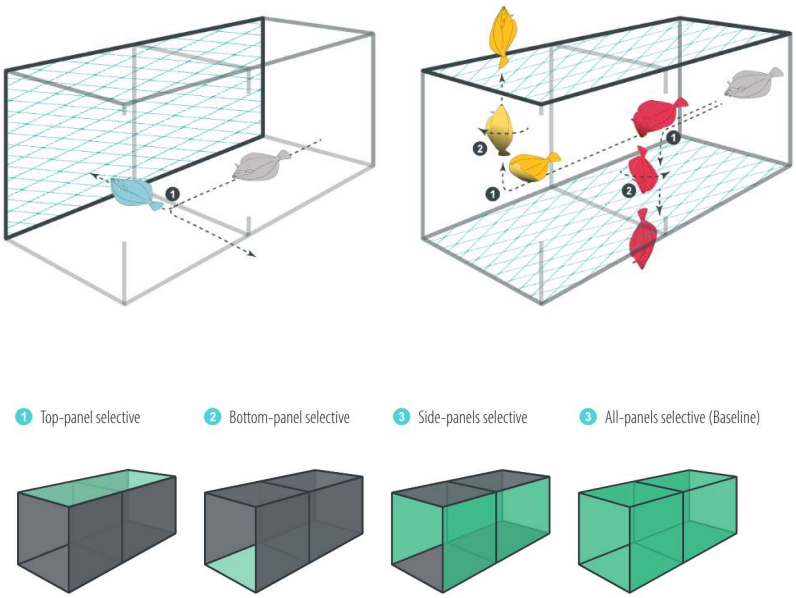
Size selection in trawl codends is largely determined by mesh characteristics such as mesh size and mesh shape. It is generally regarded that diamond meshes provide better escape possibilities for flatfishes than other mesh shapes, due to the pronounced compressed body morphology of

flatfish species. However, it is reasonable to assume that the benefits associated with attempting to escape through a diamond-mesh opening will only be realized when an optimum contact is achieved (i.e. when the fish approaches the mesh perpendicularly with respect to the wider axis of the mesh opening). This can require demanding swimming maneuvers for the fish depending on orientation of the mesh with respect to the towing direction. Therefore, in the context of size selection, it can be hypothesized that optimal contact with the codend meshes is more often achieved when it requires fewer body rotations and expose the fish to the lowest hydrodynamic dislodgment. To test this hypothesis, we conducted a codend cover experiment to evaluate the selectivity of four different configurations of a rigid four-panel codend with fixed mesh geometry. The selectivity of the baseline codend was unrestricted, while the remaining three configurations were achieved by blanking specific codend panels and therefore differed in the positioning of the available selective mesh panels (bottom panel, top panel, side panels, all panels). Analysis of the selectivity catch data and video recordings obtained from this experiment support our hypothesis, and previous theoretical investigations highlighting the relevance of contact angle of attack on the size selection of flatfish species. The results of this study contributes to a better understanding on flatfish escape behavior in trawls, and thus can be helpful for designing selectivity devices in demersal trawl fisheries where flatfish are caught.



[Source: Thuenen Institute of Baltic Sea Fisheries]

(Poster L) The pelagic excluder - increasing selectivity and hidden mortality

Mikael Ovegård*[1], Linnea Morgan[1], Hans Nilsson[1]

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Since 2020 the industrial fishery targeting lesser sandeel (*Ammodytes tobianus*) in the Northeast Atlantic has tested and increasingly implemented a sorting system called the 'Excluder'. The Excluder is an all-net section with an inner selection tube that is inserted as an extension piece in front of the codend in the non-tapered part of the trawl. To reach the codend, fish must pass

through the meshes of the inner selection tube. Catch not passing through the meshes of the selection tube is released from the trawl trough an opening in the end of the Excluder. This innovative fully net based solution is particularly beneficial for net drum users, as it ensures that the sorting device can be easily reeled onto net drums, enhancing both operational efficiency and safety compared to a grid sorting system. However, much is still unknown about unwanted catches in this fishery and the effect on these by the introduction of this new sorting system solution. In this study, we compile and analyse catch data and underwater video observations collected on board fishing vessels participating in the lesser sandeel fishery in the Northeast Atlantic during two fishing seasons. The results show that the introduction of the Excluder is an improvement in species selectivity but could also lead to high mortality rate in parts of the released unwatched catch.

1.7 Session 7: Gear Design - Mammal Selectivity

(32) How not to catch a seal: a look into New Zealand fur seal (*Arctocephalus forsteri*) mitigation technology

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Fishing activities, including trawling, set nets, and longlining, pose risks to New Zealand fur seals (*Arctocephalus forsteri*) through accidental entanglement, injury, and mortality. This study identifies areas where New Zealand fur seals and fisheries overlap and evaluates strategies to reduce these interactions, while balancing conservation and fishing needs. In trawl fisheries, Seal Exclusion Devices (optimized for New Zealand fur seals), net binding during shooting, and net constriction during hauling have been trialled, with the main challenge being the larger size and poorer swimming ability of one of the main target species, hoki (*Macruronus novaezelandiae*). Additionally, there is growing interest in acoustic devices for set net fisheries, designed to elicit a startled response in fur seals. We will discuss the mitigation methods currently used by New Zealand fishers and emphasize the need for further research to develop and refine techniques specifically for New Zealand fur seals.

(33) MiniSeine fact sheets – small nets, big insights

Thomas Noack*[1], Daniel Stepputtis[1], Lotte Kindt-Larsen[2], Kristin Öhman[3], Sven-Gunnar Lynneryd[3], Peter Ljungberg[3], Sara Königson[3]

[1] *Thünen Institute of Baltic Sea Fisheries, Rostock, Germany*

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Many small-scale fishers in the Baltic Sea face increasing challenges with one of the most severe being interactions with seals that damage catches and destroy fishing gear. To address these issues, the MiniSeine has emerged as a promising alternative. As a scaled-down version of demersal seining, it retains key advantages, including high selectivity, fuel efficiency, and low

seabed impact, while reducing seal interactions along with the bycatch risk for protected species like marine mammals and seabirds. MiniSeine trials conducted in Sweden, Denmark, and Germany have explored its feasibility in different fisheries, revealing both benefits and practical challenges. To systematically capture and compare these experiences, we developed fact sheets summarizing technical details, operational conditions, and trial results. This approach facilitates direct comparisons across target species and areas, and provides a structured foundation for further development. By compiling this knowledge, the fact sheets serve as a valuable resource for evaluating the MiniSeine's potential as an alternative fishing gear in other regions and fisheries, with the overarching goal of facilitating its implementation by fishers.

[Source: DTU Aqua/T. Noack]

(34) Developing an AI-Based acoustic deterrent: a new approach to mitigating dolphin-fishery interactions

Alessandro Lucchetti*[1], Benedetta Castagna[2,3], Rocco De Marco[1], Francesco Di Nardo[2], Daniel Li Veli[1], Giovanni Novelli[2,3], Andrea Petetta[1], Laura Screpanti[2], David Scaradozzi[2,3]

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The interaction between dolphins and fishing activities creates both economic and ecological challenges, with depredation being the most significant issue. Traditional pingers, though widely used, raise concerns such as dolphin habituation, acoustic pollution, and limited battery life. To address this, a new AI-based acoustic deterrent device was developed, comprising a low-cost hydrophone, an AI system for dolphin recognition, an emitter, and a battery pack, all designed to be compact and affordable (under €500). The device uses convolutional neural networks (CNNs) to detect bottlenose dolphin presence through whistle analysis, achieving an overall accuracy of 90%. The recognition of other types of emissions is currently around 60%, but CNNs is working to improve this part as well. It processes data from underwater recordings, applying spectrogram analysis to enhance signal quality and reduce noise. The values of AI model's F1-score were close to 90%, showcasing the effectiveness of deep learning for classification. Once a dolphin is recognized, the device emits tailored acoustic signals to deter it. Unlike traditional pingers, this technology offers greater interactivity by varying the signals to prevent habituation and minimize oceanic noise. The device is also versatile, featuring a low-cost hydrophone for sound recording, with potential for future upgrades, such as phone messages or alarms. Developed through the European Life Delfi and the National Biodiversity Future Center

projects, this device offers a promising solution for protecting marine species while meeting the needs of the fishing industry.

[Source: CNR IRBIM Ancona]

~~**(Poster M) Closing the buffet: whale depredation triggers a fishery to switch from longlines to pots**~~

~~Colin Frank*[1], Shannon Bayse[1]~~

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

~~Contact: colin.frank@mi.mun.ca~~

~~Because toothed whale depredation in demersal longline fisheries has significantly increased along the Northeast Pacific Ocean, the Quinault Indian Nation (QIN) of Washington state is establishing a gear switch from demersal longlines to collapsible pots. This research is in collaboration with the QIN Sablefish (*Anoplopoma fimbria*) fishers to determine the fished populations being exploited (sizes, sexes, etc.) with each gear type. A planned catch comparison study will compare the catch per unit effort, size selectivity, sex ratios, and bycatch composition between gears. Previous studies in other locations for sablefish show that collapsible pots significantly reduce bycatch and improve the quality of the target catch over longlines, in addition to reducing toothed whale depredation. This information can help inform fishers and managers about the relative performance between each fishing gear and any exploitation difference.~~

(Poster N) Systematic approach to evaluate pinger's effectiveness in the reduction of dolphin bycatch in the pair trawl fishery in the Bay of Biscay

Elsa Cuende*[1], Leire Citores[2], Mikel Basterretxea[1], Iñigo Krug[1], Esteban Puente[1]

[1] *AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Txatxarramendi ugartea z/g, 48395 Sukarrieta, Bizkaia, Spain*

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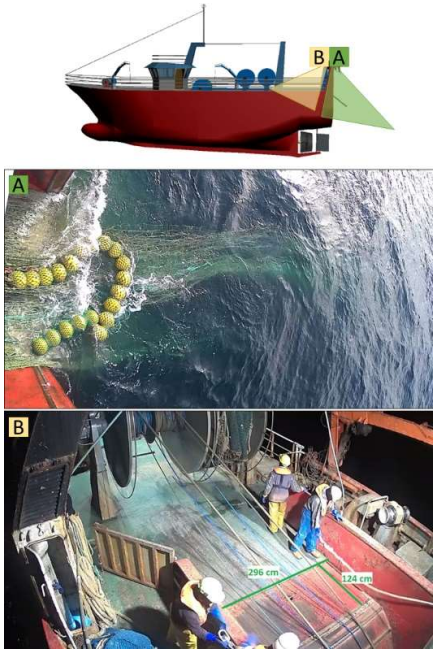
The use of pingers in trawl nets in the Bay of Biscay is mandatory. Several studies have investigated their effectiveness in reducing common dolphin bycatch, but low bycatch rates and lack of statistical significance make assessment challenging. In this study, we used two bottom trawlers operating as a single unit to systematically test the effectiveness of various types of pingers in reducing dolphin bycatch. One boat used pingers while the other served as a control; and remote electronic monitoring (REM) was employed to achieve a high number of experimental replicas. We tested three types of pingers: (1) high-intensity, wide-range frequency with shorter battery life, (2) low-intensity, narrow-range frequency with long battery life, and (3) interactive high-intensity, wide-range frequency with intermediate battery life due to intermittent emissions. Each pinger was tested and the bycatch of any cetacean registered, on average, during 405 fishing hauls in a high bycatch period of different years, respectively. Results showed that Pinger 1 and Pinger 3 reduced dolphin bycatch by over 90% and 85%, respectively, while Pinger 2 showed no significant difference. The experience with Pingers 1 and 3 highlighted the importance of proper use, particularly their placement in the net and maintaining a full battery charge. Despite its lower effectiveness, Pinger 2's lack of need for periodic recharges made it more convenient for fishermen. Finally, the REM system proved to be an effective and cost-efficient tool for studying cetacean bycatch in trawl gears, and the alternating hauls of the pair trawlers ensured a robust experimental design for evaluating pinger effectiveness. This work advances our understanding of pinger effectiveness and supports optimized strategies for marine conservation and sustainable fishing.



[Source: AZTI]

(Poster O) Development of a double threshold Weaklink (MF2S)

Eloïse Lemaire*[1], Montagnac Valentin[1], Tremblay Michel[1], Jaballah Olah[2], Barka Nourredine[2], Laurent Jérôme[3]

[1] *Merinov*

[2] *UQAR*

[3] *Axelys*

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More than 80% of right whales have become entangled in fishing gear ropes at least once in their lives. Traps, cages, nets, etc., any gear with vertical ropes in the water column represents a threat to endangered species. In Gaspésie, snow crab fishing accounts for 54% of landings. From April to June, thousands of traps are deployed, representing as many traps for these large cetaceans. Since January 1, 2017, the United States has adapted Marine Mammals Protection Act (MMPA) regulations by applying them to seafood imports. Fisheries wishing to export to the U.S. will have to minimize their impacts on marine mammals, according to standards comparable to those governing U.S. fisheries. Snow crab fishing is a major commercial activity in eastern Quebec. In the absence of adequate measures, Canada could be prohibited from exporting its marine products to the U.S. market, under the MMPA. Objective: To develop a double-threshold weak link, resistant to the stresses exerted by fishermen and yielding to the stresses exerted by an entangled marine mammal.

[Source: Merinov]

1.8 Session 8: Gear Design - Catchability

(35) Optimizing beam trawl design for sustainable sea star fishery using hydrodynamics

Cristina Fernández-García*[1], Valentina Melli[1], Bjarke Eltard-Larsen[2], Camille Saurel[3], Finbarr G. O'Neill[1]

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[2] *DTU Aqua, Technical University of Denmark, Department of Civil and Mechanical Engineering, Section for Fluid Mechanics, Coastal and Maritime Engineering, 2800 Kgs. Lyngby, Denmark*

[3] *DTU Aqua, Technical University of Denmark, National Institute of Aquatic Resources, Danish Shellfish Centre, Section for Coastal Ecology, 7900 NykÃ¸bing, Denmark*

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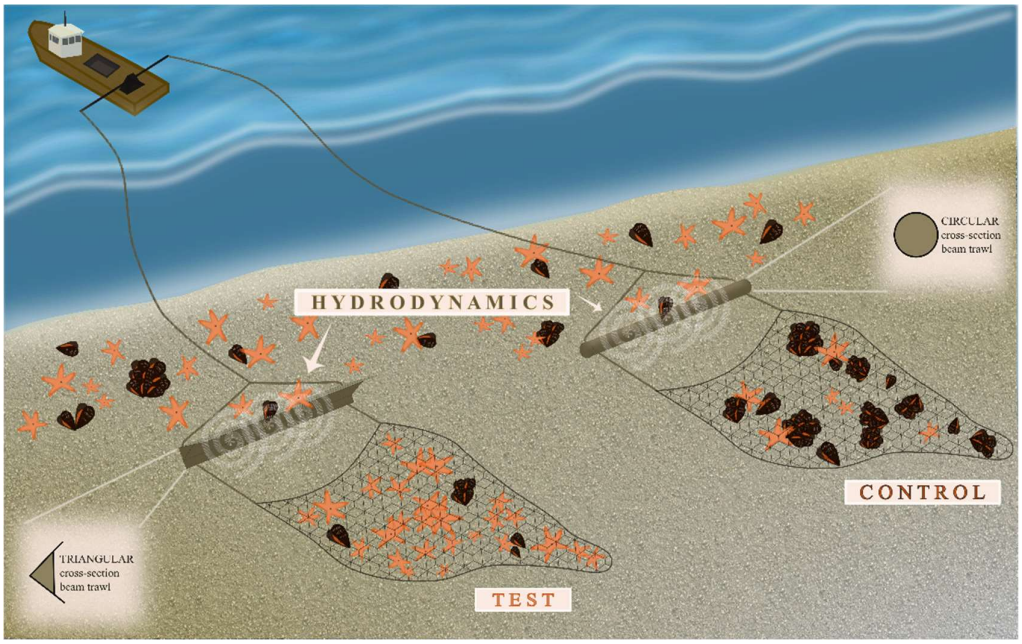
The sea star fishery (*Asterias rubens*) in the Limfjord, Denmark, uses a small (< 2m), light (< 50 kg) beam trawl to target sea stars. Previous research has demonstrated that modifying beam trawl design could use hydrodynamics to enhance the fisheries sustainability. The findings indicated that the turbulent wake generated by towing the beam could lift sea stars from the seabed, reducing the need for direct contact. Our study here aimed to optimize and validate these findings by refining key design parameters, specifically beam shape, beam height, and the distance between the beam and the fishing line (netting distance), in the sea star fishery in the Limfjord (Denmark).

The fishery takes place on two types of grounds, on cockle beds, where catches are generally 'clean' sea stars, and on mussel beds, where it is used as a predation control measure, but where there is often an appreciable mussel bycatch. Through trials on both of these grounds, we tested whether an alternative beam cross-section could improve sea star catch efficiency while reducing the bycatch of blue mussels (*Mytilus edulis*) and cockles (*Cerastoderma edule*). Specifically, the performance of a beam with an angular cross-section, (like a capital A on its side) was evaluated against a beam with a circular cross-section (control). The new design was tested at the four combinations of two beam heights (5.2 and 12 cm) and two netting distances (58 and 117 cm).

The results show that the lower test beam position with a shorter netting distance yielded the highest sea star catch efficiency on both the cockle and mussel beds. This configuration made no difference to the cockle bycatch on the cockle beds but there was a significant increase of the mussel bycatch on the mussel beds. When increasing the netting distance for both beam heights, there was no increase in sea star capture on cockle beds but there was a significant decrease of cockle bycatch. However, when the beam was set at the higher position and the netting distance increased, on mussel beds there was a significant increase of the sea star catch but no increase of mussel bycatch.

Our study confirms that the test beam can improve the catch efficiency of sea stars and that the optimal beam height and netting distance will depend on the grounds being fished and the specific objectives of either maximizing sea star catch or minimizing bycatch. It also highlights the possibility of using hydrodynamics to increase efficiency, improve selectivity and reduce the environmental impact of towed gears in other demersal fisheries.



[Source: C. Fernández-García, DK]

(36) Fish pot design: when details make the difference

Sara Berzosa*[1], Thomas Noack[1], Juan Santos[1], Daniel Stepputtis[1]

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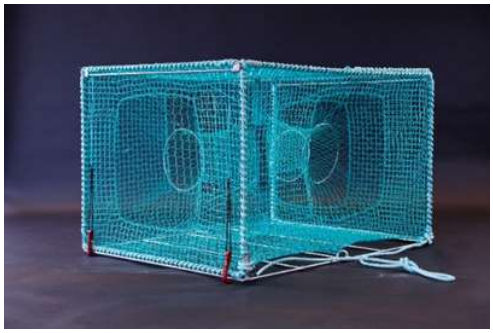
Rising energy costs and growing awareness of the environmental impact of bottom fishing have increased interest in passive fishing gear. However, some of these gears, such as gillnets and longlines, present challenges of bycatch of endangered, threatened and protected species (ETP), leading to temporary fishery closures. Additionally, these gears are susceptible to predation by marine mammals, resulting in significant costs to coastal fishers due to lost catch and gear damage. Fish pots could be an alternative as they present a lower bycatch risk and can be designed to reduce marine mammal predation. Despite these advantages, the low catchability of pots in some fisheries, such as the Baltic Sea cod pot fishery, has hindered their implementation. Multiple studies have focused on how pot design affects catchability, identifying pot entrances as critical bottlenecks in the capture process.

In previous trials, we investigated the effects of pot entrance design on cod catch rates. Despite systematically evaluating individual design parameters, our results showed that commercial pots outperformed our experimental designs. To better understand this discrepancy, we developed intermediate pot designs bridging commercial and experimental versions, aiming to identify key design features that influence catch efficiency.



[Source: A. Schütz, Thünen-Institut, Germany]

[Source: S. Berzosa, Thünen-Institut, Germany]

(Poster P) Size matters? – A case study of gear development targeting the invasive round goby (*Neogobius melanostomus*)

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The round goby (*Neogobius melanostomus*) is invasive to the Baltic Sea. Starting off in a national project now extending into a trans-Baltic we investigated the impact of round goby in Swedish waters. Further, we develop and tested new methods for decreasing the negative effect by reducing dispersal and reduce the population along with the potential to capitalize on 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.

By compiling data in country-specific gear and regulations we aimed to cross validate catch methods between countries. We have then improved and tested a range of passive gear types in order to increase catchability of the species where it is novel to the industry. Our aim has been on targeting both round goby in combination with other common target species, this in combination with minimizing the bycatch of non-target and protected species as the European eel (*Anguilla anguilla*). Despite that round goby has been shown to be caught in greatest numbers using large static bottom set trap nets, where increasing size of the traps' opening seem to have an increasing effect on catching efficiency. Our results show how we with minor twists in already existing smaller sized gear may allow for increased catches of the round goby while non-target species may be released during the catch process.

(Poster Q) Ecosystem interaction with Scottish creel fishery targeting brown crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and velvet crab (*Necora puber*)

Elisabete Rodrigues*[1], Bill Sanderson[1], Kristine Cerbule[1]

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The creel fishery targeting different crustacean species in Scotland, UK has been essentially inshore in nature, encompassing coastal waters between 6nm and 12nm. This creel fishery has been growing over the past 30 years. However, gear improvements and more modern fishing vessels allow fishers to target areas that have not been previously exploited.

Nowadays, fishing occurs throughout the year. In Scotland, this fishery is mostly regarded as a mixed species fishery with target species being brown crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and velvet crab (*Necora puber*). This is a relatively recent seasonal fishery, and these species are heavily exploited and highly valuable in the market.

Over the years, creel fishing effort has been increasing mainly because of the high market value of the targeted species. However, little is known about the interaction's creel fishing has on the local coastal habitats. The aim of this study is to estimate seasonal variations and spatial distribution of main target species in this creel fishery to understand the dynamics of the fishery and the reasons for the observed population decline. The results will demonstrate case study estimations in creel fishery around Orkney and the spatial distributions around these coastal fishing areas.

1.9 Session 9: Gear Design - Energy Efficiency

(37) Off-bottom trawling for mixed-demersal fish in the Celtic Sea

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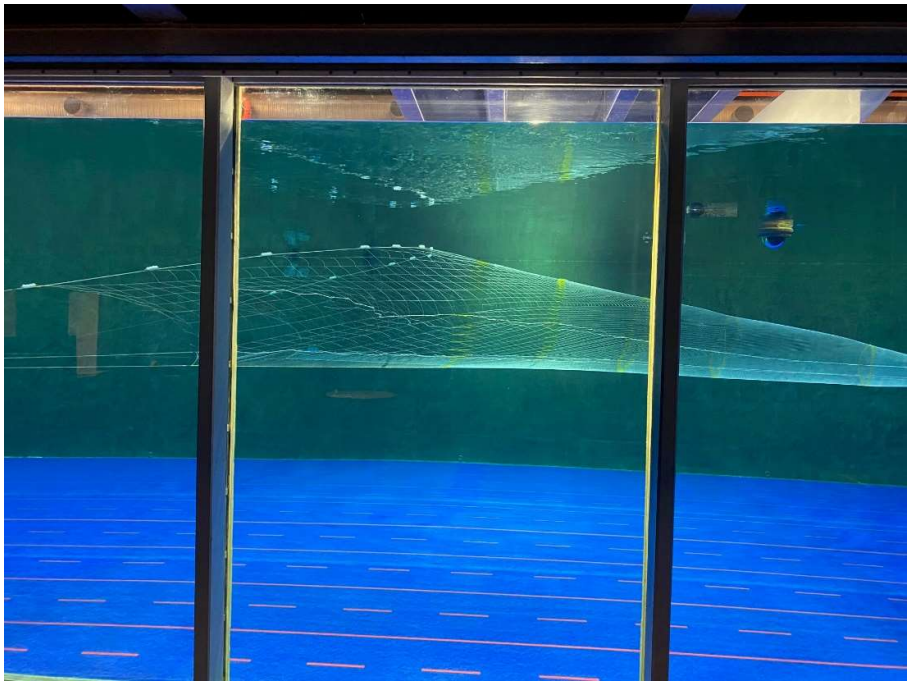
BIM is developing methods to improve energy efficiency and reduce seabed impact in the Irish mixed-demersal trawl fishery. Fish reactions to bottom and semi-pelagic trawls are likely to differ with more options to escape capture in the semi-pelagic gear. BIM is collaborating with the Irish net maker Swan Net Gundry (SNG) and fishing industry on the development an off-bottom trawl which will address some of these fish behavioural issues.

To date, the development process has included a workshop with the skippers and owners of several Irish demersal vessels to discuss potential gear modifications. Next, we assessed a standard semi-pelagic trawl which performed well operationally but catch rates were low. Consistent with previous BIM research, artificial lights on the headline did improve catches in semi-pelagic trawl but fish were generally scarce during the trial. Findings suggest that greater fish abundance on the grounds and significant changes in fishing tactics are needed to achieve commercially viable catch rates.

The semi-pelagic work fed into testing and tweaking of candidate off-bottom net models at the Hirtshals flume tank facility in May 2024. This included extending the mesh forward into the bridles to optimise fish herding in the trawl mouth. The finalised full scale off-bottom trawl is due to be tested in spring 2025.



[Source: BIM, Ireland's Seafood Development Agency]

(38) Assessment of enlarged top sheets in a *Nephrops* trawl

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The Irish Nephrops fishery is one of Ireland's largest, with Nephrops typically one of the top two economically important species. A trial was completed with enlarged mesh in Nephrops trawl top sheets to reduce hydrodynamic drag and improve fuel efficiency. The study compared enlarged 300 mm against 160 mm top sheets in the Western Irish Sea Nephrops fishery. In trawls with the 300 mm mesh top sheets there were increased Nephrops catches by 38% and significant reductions for whiting < 20 cm. The twine surface area was reduced by 8% compared to the nets with 160 mm top sheets. While it was not possible to assess fuel consumption during this trial, another vessel also fitted 300 mm top sheets and reported a fuel saving of around 10% over several trips. The increased Nephrops catch is a surprising result and may be due to the trawlâ€™s improved ground contact associated with increased water flow. The significant reduction in undersize whiting is an important finding due to poor stock status and requirements to improve whiting selectivity. This gear development has major potential to become a management measure supporting the sustainable development of the Irish Nephrops fishery and will be evaluated further.

[Source: Ireland's Seafood Development Agency]

(39) Catch efficiency using a semicircular spreading gear in demersal trawls

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In demersal trawls ground gears are fixed to the fishing line for protection against the seabed. Rockhoppers (RH) are among the most applied types of ground gears in trawls, especially in fisheries where the seabed can be rough. However, their use has earlier been associated to low catch efficiencies due to substantial loss of catch under the fishing line. A new ground gear concept based on semicircular modules (SCSG) has been documented to reduce this loss, but the catch efficiency of RH and SCSG gears has never been directly compared in a systematic trial. Using a twin trawl configuration, the present study compared the catch efficiency of two equivalent RH and SCSG gears using both size selective and non-selective trawls. Eighteen hauls were conducted in the Barents Sea demersal trawl fishery where cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) are target species and where redfish (Sebastes spp.) is an important bycatch species. The results showed that for cod and haddock the catch efficiency of the SCSG was significantly higher than for the RH gear for length classes between 10 - 88 cm and 10 - 70 cm, respectively. However, the range of length classes with significant differences in catch efficiency was substantially reduced in the trials conducted with selective trawls. The results for redfish were less conclusive due to the low numbers and limited size range of the individuals caught. Size-integrated performance indicators showed that on average, the SCSG caught

significantly more cod and haddock above the minimum size (MS) than the RH gear. However, it also caught significantly more fish under MS than the RH gear. This increased catch of undersized fish and the significant increase in discard ratio in the non-selective trawls illustrate the importance of size selectivity devices, especially if the use of the SCSG is widely adopted by the industry.

[Source: Tore Ringstad (Mørenot Fishery AS) (Left); and Jostein Saltskår (Institute of Marine Research) (Middle and Right)]

(Poster R) Reducing fuel consumption in the Mediterranean bottom trawl fishery: a case study in the Aegean Sea

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In the context of the carbon neutrality in EU by 2050, it is important that the fishing fleet should move to renewable and low-carbon energy sources as quickly as possible. Decarbonising the fishing fleet is therefore a priority target. In the framework of the DECARBONY-T project (EASME/EMFF/2020/OP/0021), a pilot study was conducted in the Eastern Mediterranean within GSA22 (Aegean Sea). The primary objective was to compare the fuel consumption, greenhouse gas (GHG) emissions, and catch composition of an experimental trawl with the conventional gear commonly used in the Greek bottom trawl fishery. The key modifications in the experimental trawl were the incorporation of Dyneema netting (1 mm thickness) in the forward sections of the gear (i.e., wings, square, and upper belly) and semi-pelagic doors with no seabed contact, thereby reducing the gear's footprint on the seafloor and decreasing the overall drag. A total of 15 hauls were performed for each gear in October 2024 under comparable fishing conditions using a commercial trawler. The experimental gear demonstrated a 16.6% reduction in fuel consumption per fishing hour. However, a reduction of 33.8% was observed in the amount of landings per hour with this type of gear. GHG emissions were also measured during fishing operations (fishing, hauling) for both gears.

(Poster S) An initial assessment of the effect of reducing the carbon footprint of the bottom trawl fishery for the giant red shrimp (*Aristaemorpha foliacea*) in the Central Mediterranean Sea

Michele Luca Geraci[1], Mohamed Khalil Besbes[1,2], Vincent Georges[1,3], Giacomo Sardo[1], Fabio Falsone[1], Fabio Fiorentino[1,4], Savina Gjoni[1,5], Gabriele Di Bona[1,5], Monica Calabrò[1], Sergio Vitale[1,5]

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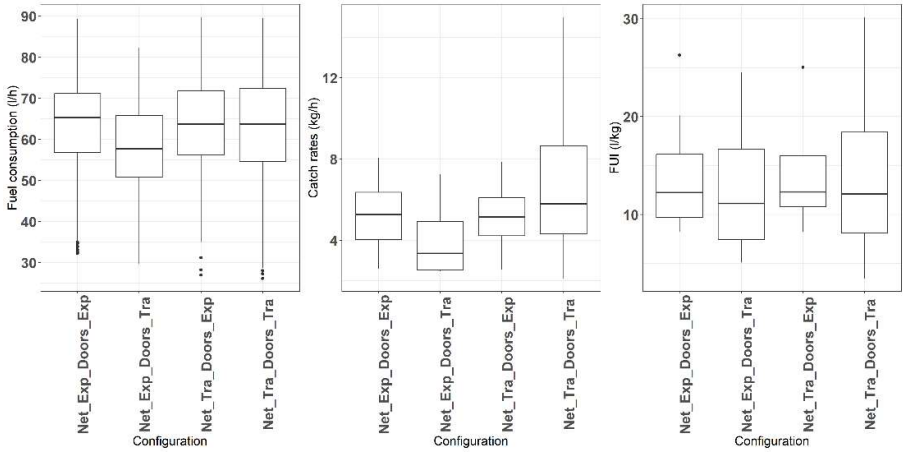
The EU fisheries sector is still highly dependent on fossil fuels. To achieve carbon neutrality in the EU by 2050, it is important to find solutions for fishing fleets to reduce such dependency and move to renewable and low-carbon energy sources as quickly as possible. In the framework of the EU project DecarbonyT, two surveys of five days each were carried out in the Central Mediterranean to investigate how to reduce the fuel consumption during the bottom trawl fisheries targeting giant red shrimps (*Aristaemorpha foliacea*). The sampling design applied was the alternate hauls method, where an innovative net made with high strength material and lighter doors was contrasted with conventional (traditional) gear. Sensors for measuring fuel consumption were installed to the vessel engine. In addition, electronic dynamometers were used to measure the tension to which the warps were subjected during fishing operations. A total of 40 hauls were carried out at depths ranging from 510 to 680 meters, with systematic recording of catch rates for target species, commercial bycatch, and discards. Fuel consumption monitoring revealed that the lowest recorded median value corresponded to the experimental trawl net paired with traditional doors, about 58 liters per hour (Fig. 1a). Median catch rates (CPUE [kg/h]) and fuel use intensity (FUI) index did not vary among gear configurations, with the combination of the experimental net with traditional doors recording the lowest median value (Fig. 1b, c). Before drawing definitive conclusions on the efficiency of the experimental net, these preliminary findings should be further evaluated, taking into account key environmental factors (e.g. water currents, fishing ground, depth strata) and skipper skills, which may influence the observed performance.



[SOURCE NEEDED]

1.10 Session 10: Innovative Tools

(40) Using glmmTMB to estimate how mitigation and other factors affect bycatch rates

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Studies of bycatch differ from studies of size selectivity in many aspects, one of them being that the collected data is not binomial. Bycatch per unit effort is often observed as count data if it's an ETP species or, if it's a commercially caught species, it might be biomass or a proportion of the catch. Therefore, we need different software to analyze the data from bycatch studies as opposed to size-selectivity studies. A broad framework of modeling that can handle count data, proportion data, and biomass data is known as generalized linear modeling and is implemented in the R package glmmTMB. In this talk I will present some examples of glmmTMB being used to estimate how bycatch rates change with factors such as mitigation devices and other covariates.

(41) Understanding size selectivity and hydrodynamic performance in commercial zooplankton trawls

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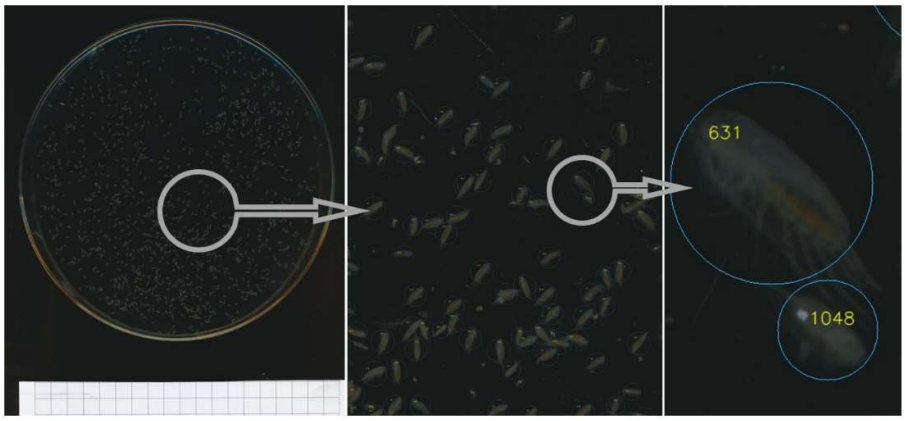
The aquaculture sector is in pursuit of sustainable and high-nutrition raw materials for feed, and the copepod *Calanus finmarchicus* is a marine zooplankton species that is of commercial interest because of its high abundance in the North Atlantic. The diminutive size (< 5 mm) of this Calanus species necessitate the use of fine-meshed trawls to harvest them efficiently. However, such fine-meshed trawls lead to high drag and thus energy demand. Therefore, it is important to know the effect of mesh size on the capture efficiency of Calanus, and specifically to quantify which sizes of those that can be harvested effectively depending on the mesh size in the trawl. We investigated the effect of two important trawl net design parameters, i.e. mesh size and taper angle and identified which values provide the optimal trade-off balance between gear drag and catch efficiency. We used an image and AI-based specially built and trained acquisition method to rapidly measure the size of large numbers of Calanus to prepare the catch data for size selectivity analysis. We tested various trawl designs with different mesh sizes (250, 500, 750, 1000 μm) and taper angles (5°, 10°, 15°, 20°, 30°). Results show that 500 μm mesh nets with a 5° taper angle provided the best trade-off between minimizing the drag and maximizing catch efficiency. Additionally, the results demonstrated a clear size selection process of Calanus in the nets with the mesh sizes that is considered for this fishery. Specifically, the size selectivity results in a catch loss of 10%, 45% and 99% of Calanus if the trawl has a mesh size of 500, 750 and 1000 μm, respectively.



[Source: Original image, no copyright]

(42) Utilizing computational fluid dynamics to optimize water jet stimulation in flatfish trawling

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Various alternatives to the tickler chain beam trawl for targeting North Sea sole have been developed. Among these, the pulse trawl proved to be the most effective before its ban by the European Union. However, other alternatives have yet to fully match the effectiveness of the traditional tickler chain beam trawl. One of these, the water spray gear, was extensively tested at sea with set water jet parameters. Our recent work on water jet dynamics, focusing on velocities and pressures at the seabed utilizing an advanced experimental setup and a computational fluid dynamics (CFD) model, shows that the jet parameters for the sea trials could not have resulted in an effective stimulus.

With the selection of appropriate jet parameters, the water jet still demonstrates significant potential due to its capacity to deliver localized stimuli. When combined with flatfish detection technology—already proven successful in laboratory settings and currently being scaled for application—it offers the prospect of substantially reducing bed disturbance. In our continued study, we will quantify the bed disturbance in sand. By linking the fluid dynamics of water jets and bed disturbance, we are able to predict the disturbance for large ranges of jet parameters. Simultaneously, research partners in the same project on new stimulation techniques at Wageningen University & Research (WUR) will study the reactive behavior of sole and plaice to water jets. The overall aim of this research is to develop a predictive bed disturbance model utilizing water jet CFD simulations and fish behavior observations for optimization of the water jet stimulus. The outcomes will serve as input for the development of operational gear.

(43) Designing trawl gear for the crustacean *Metanephrops challengeri*: The New Zealand scampi

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The New Zealand scampi (*Metanephrops challengeri*) fishing industry has grown into a profitable commercial sector since its emergence in the late 1980s. Scampi are fished primarily by small vessels (20-40 m) using light bottom trawl gear with small mesh sizes around 55 mm. However, this small mesh size can lead to higher rates of bycatch, including juvenile fish species, which remains a significant concern within the industry. Scampi can also become damaged in the conventional codend during long tows of up to 7 h which is not desirable. Using computational fluid dynamics and scaled models trialled in the Plant & Food Research Flume, a full-scale FloMo unit (formerly Modular Harvesting System), previously only utilised in finfish fisheries, was designed for scampi. Factors considered for the new FloMo design include the size of the scampi, scampi behaviour within the codend and liftbag section, by-catch species behaviour, size and composition. Fishing trials suggest that during the tow, caught scampi were comfortably sitting on the bottom of the liftbag area and that selectivity of scampi size is possible. In addition, the scampi catch is cleaner in the FloMo gear and damaged tails were reduced. By-catch of species such as seaperch can be significantly reduced as well as larger fish such as hoki and ling. Pressure data suggests that the FloMo codend also sits slightly higher than the conventional codend, reducing contact with the seafloor. From a handling perspective, gear is easy to manage on deck and an additional positive of the gear was the support and enthusiasm from the crew who initially dismissed the gear. The FloMo unit designed for the scampi fishing industry with a low damage capture environment at the end of the codened delivered a clean and minimally damaged catch of crustaceans and a reduction in by-catch. The scampi FloMo therefore has the potential to drive positive outcomes for the industry.

(44) Automatic detection of catch densities and size distribution in the Northern shrimp (*Pandalus borealis*) trawl fisheries

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The Northern shrimp (*Pandalus borealis*) fishery is an economically important industry in the cold waters of the North Atlantic, North Pacific, and Arctic Oceans. The primary fishing method involves otter trawling with large, small-meshed gear. However, Northern shrimp distribution varies throughout the year, and they cannot be effectively detected using standard fish-finding equipment. Currently, shrimp trawlers can tow for 6 to 12 hours without real-time insight into the catch inside the gear, making the process inefficient, costly, and a challenge to both the economic and environmental sustainability of the fishery.

This study aims to take the first steps toward describing the spatiotemporal densities and size distribution in a Northern shrimp catching process using an underwater camera combined with supervised machine learning. We will apply species detection and tracking techniques to achieve count, along with stereo reconstruction, to further estimate the sizes of the shrimp. We will moreover work towards achieving this as close to real-time as possible to provide fishers with live estimates of the catch.

(45) Non-invasive sampling and better catch control with in-trawl cameras

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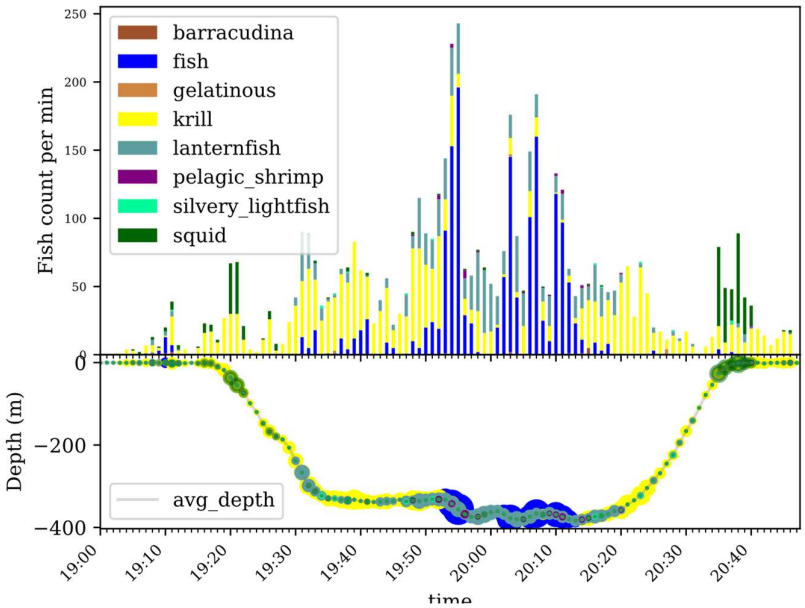
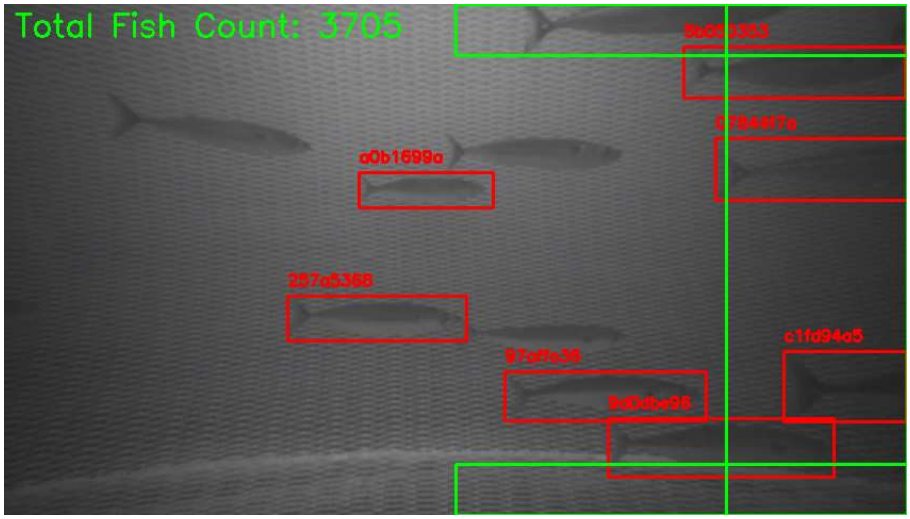
In-trawl camera systems can make commercial and scientific trawling more efficient, sustainable and improve catch welfare. Trawl image data can inform about species and size-specific catches and their behaviours with a high temporal and spatial resolution. IMR in Norway has an ambition to implement camera systems for scientific sampling in all trawl stations. To support this, the CRIMAC centre for research-based innovation is developing image-based sampling systems both for commercial fisheries and scientific surveys. We have developed a data pipeline where images from the in-trawl camera system are automatically downloaded, processed, analysed and combined with acoustic data. We use deep learning algorithms to detect and identify a range of different species and are currently improving the count estimates and developing automated length measurements. The next step is to develop automated open-close codend mechanisms and real-time data processing and transfer.

In this presentation we will show examples of how image data can improve acoustic target classification by combining image and acoustic data. We will also present results from automatic monitoring of mackerel length distribution and density during trawl hauls. Real time species and size information can be highly valuable to optimize commercial catches. Trawl-image based sampling in scientific surveys also requires a good understanding of species and size dependent behaviour in the trawl.





[Source: Institute of Marine Research Norway]

(Poster T) Progress on an intelligent discard chute with optical imaging and machine learning to revolutionize the electronic monitoring program for New England groundfish fishery

Chris Rillahan*[1], Ming Shao[1], Rick Usher[2], Isaac Davison[2], Peter Melanson[2], Josh Wiersma[3], Jeff Douglas[3], Pingguo He[1]

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To improve the monitoring and accounting of fisheries discards, the New England Fisheries Management Council recently adopted a plan to increase the current at-sea observer coverage to 100% of groundfish trips. However, financial and labor constraints have limited the application of this policy. To address these issues, focus has been placed on the adoption of electronic monitoring technologies. This presentation reports the design, construction, and performance of an intelligent discard chute that incorporates optical imaging and machine learning to automatically detect species and measure the sizes of discarded fish. Images from a camera inside the chute are integrated with other deck cameras and streamed via StarLink satellite service to the cloud for processing and auditing. Algorithms for video image analysis using artificial intelligence and machine learning are being developed to document species and measure the size (length) of fish being discarded. These systems have been installed on two commercial fishing vessels. Comparative analysis of discard reporting between at-sea and remote observers documented a 99.6% (range: 98.4 - 100%) correspondence in species identification and no significant difference in fish length. Initial integration of AI algorithms has documented significant progress. This project is a collaborative effort among an electronic monitoring enterprise, an at-sea observer company, 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.

(Poster U) Theoretical development of a hydrodynamic float: first steps

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This study presents a theoretical analysis of the hydrodynamic forces generated by a float featuring a hydrodynamic profile, intended to replace the traditional buoy used in trawl nets in Argentina, with the aim of improving the fishing operations. Hydrodynamic principles were employed to assess the drag forces associated with both spherical and wing-shaped float. In order to determine the hydrodynamically generated lift force, the principle of conservation of energy was applied.

Through the calculations carried out, it can be seen that resulting hydrodynamic force is directly related to the differences in speeds generated on the faces of the designed profile. In addition, it can be seen that a small error in determining these speeds influences variations in the calculated lift force, which could exceed 100%. On the other hand, it is shown that the ratio of resistance to advance, with respect to the hydrodynamic lifting force, remains constant, therefore, the use of floats with a hydrodynamic profile would improve the vertical opening efficiency of trawl nets.

Due to the variation in the calculated lift force due to the possible errors mentioned above, it is recommended to carry out practical experimentation with different profile models, in order to determine the most suitable for the different operating speeds of the Argentine trawl fleet.

In conclusion, it was found that spherical bodies, being symmetric in relation to the direction of movement through a fluid, generate no hydrodynamic lift. As a result, their efficiency decreases with increasing speed due to the exponential rise in drag forces.

1.11 Session 11: Human Dimensions

(46) Developing a decision tree for managing emerging fisheries: the case of silver scabbardfish (*Lepidopus caudatus*) in the Central Mediterranean Sea

Fabio Falsone[*1,2], Vita Gancitano[1], Germana Garofalo[1], Michele Luca Geraci[1], Valentina Lauria[1,2], Danilo Scannella[3], Sergio Vitale[1,2], Fabio Fiorentino[1,4]

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Effective fisheries management is crucial for ensuring the long-term sustainability of marine resources. When fisheries operate without appropriate regulations, stocks can become overexploited, leading to severe declines of their productivity and the economy of the fishery sector. A recent example of the consequences of unregulated fisheries is the case of the silver scabbardfish (*Lepidopus caudatus*) in the Mediterranean, as documented by Falsone et al. (2021).

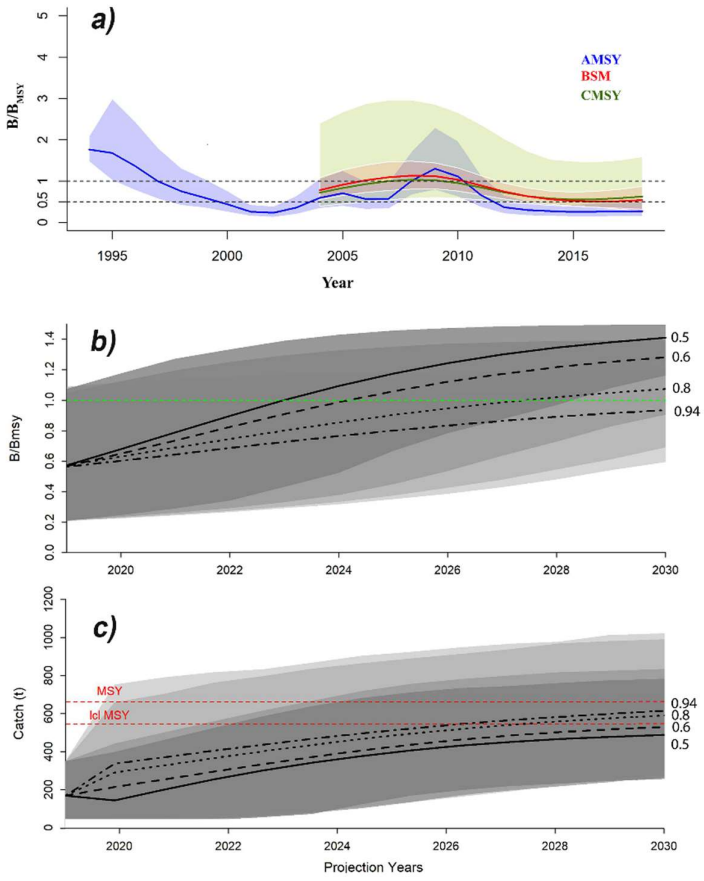
The silver scabbardfish is a mesopelagic predator inhabiting continental shelves and slopes, reaching depths of up to 600 meters in temperate marine ecosystems worldwide. In the Mediterranean Sea, this species is traditionally captured using longlines, following a strong seasonal pattern. During the early 1990s, fishermen started to exploit this resource in the Strait of Sicily (central Mediterranean) utilizing a specialized semi-pelagic trawl known as the "spatolara." This fishing gear, specifically designed to operate at mid-water depths, differs from traditional bottom trawls as it allows the capture of schooling scabbardfish without direct contact with the

seafloor, reducing bycatch and habitat disturbance. With a vertical opening ranging from 5 to 8 meters, this gear enables the capture of large quantities of the target species, as silver scabbardfish, despite being demersal, tend to occupy higher positions in the water column. The fleet employing the spatolara expanded from just one vessel in 1993 to ten in 2007, with total catches peaking at 1,200 tons in 2011. However, the lack of specific management measures and the uncontrolled increase of exploitation, resulted in a sharp decline in its landings. By 2018, total catches had dropped to 169 tons, with only one vessel remaining active. The availability of catch data and biomass indices from MEDITS trawl surveys since the onset of the spatolara fishery provided information for the first stock assessment of L. caudatus in the central Mediterranean (GFCM Geographical Sub-Area 16), applying data-limited methods. The Catch-Maximum Sustainable Yield (CMSY) and Bayesian State Space Schaefer Model (BSM) were implemented using landing data and abundance indices from 2004 to 2018, while the Abundance-Maximum Sustainable Yield (AMSY) model was applied to survey data spanning 1994 to 2018, covering almost the entire development of the fishery. The BSM model estimated biomass levels just above 50% of BMSY, whereas AMSY indicated a stock status below 50% of BMSY (Fig. 1a). Projections from the BSM suggested that, under current fishing conditions, recovery to sustainable biomass levels would take over a decade, while a reduction in fishing mortality to 80% of FMSY could accelerate stock rebuilding within 5â€“8 years, with minimal losses in yield (Fig. 1b,c).

This case study highlights the risks associated with unregulated fisheries, demonstrating how the rapid growth of new fishing practices—in this case, the spatolara fishery—can lead to stock depletion when not properly managed. To deal with similar situations a Decision Tree framework is proposed to regulate emerging single-species fisheries before unsustainable levels are reached. The framework would involve:

- monitoring landing trends to identify sudden increases that may indicate changes in fishing effort or the emergence of a new targeted fishery;
- investigating fishing patterns to assess whether sudden increases are due to natural stock fluctuations or changes in fishing gear and strategies;
- conducting a frame survey to verify the existence of new fishing practices and collect detailed data on their impact;
- implementing early management measures to establish fishery authorizations, effort controls, and quota regulations before the fishery expands uncontrollably;
- performing continuous assessment and adaptation to regularly update management strategies based on stock assessments and catch trends to ensure long-term sustainability;
- establishing an ad hoc multi annual management plan that integrate management objective and measures in a consistent way;
- agreeing on predetermined management actions according to the state of exploited stock.

By integrating adaptive management tools from the outset, fisheries authorities could prevent the overexploitation of newly targeted species, ensuring the sustainable use of marine resources in the Mediterranean.



[Source: Falsone et al., 2021]

(47) How England is Tackling Discards: Policies to Promote Selective Fishing in England

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An uplift in fishing quotas, in some cases by more than 50%, was applied to account for the implementation of the landing obligation. In the absence of catch monitoring, this may have led to an increase in fishing mortality. Evidence suggests that there was no detectable reduction in discard rates for English vessels following the implementation of the Landing Obligation. Furthermore, a recent series of analyses indicated that when accounting for discards there is a risk that catches may be contributing to fishing mortality above the allowable catch shares. The use of more selective designs is an effective tool to reduce unwanted catches, however the voluntary uptake of selective designs remains low. Here we describe some proposed English policies being developed to incentivise the uptake of more selective gears, including:

- Discard Reduction Schemes
- Quota Allocation Mechanism
- Full Catch Accounting
- Remote Electronic Monitoring

(48) A recent survey of inshore trawl and Danish seine fishing vessels in New Zealand highlights grass-roots innovation and voluntary changes

Emma G Jones*[1], Melanie J. Underwood[2], Tiffany Bock[3], Tamar Wells[3]

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The New Zealand fishing industry has long had concerns about negative public perception of bottom trawling in local waters, despite the fact that 75% of fish landed here comes from trawling. To address this, Seafood New Zealand, the industry's representative organisation, commissioned a survey to collect information from vessel owners and/or skippers on their trawl and Danish seine configurations to improve understanding of what grass-roots innovation has or is occurring within the inshore fleet including efforts to reduce fuel costs, benthic impact and unwanted catch. The survey was carried out via online questionnaire, followed up with one-on-one phone calls to expand participation. We received a total of 44 responses from skippers along with feedback from a local netmaker. The questions covered aspects of the gear including net type, ground gear descriptions, door size, sweep and bridle lengths, mesh sizes and materials used. Additionally, the survey explored the main motivations for any changes made, target and unwanted species, modifications trialed and perceived effectiveness. We will present the results of the survey and explore the efforts being made by NZ fishers to minimize the impacts of trawling.

(49) Keep it shrimp-le: innovative ideas from the brown shrimp fishery

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The North Sea brown shrimp fishery faces the challenge of balancing economic viability with environmental sustainability. A key focus is the continuous adaptation of fishing technology to ecological and economical requirements. Fishers can play an active role in this process, developing innovative solutions to address high fuel consumption, interactions with the marine environment, and selective harvesting. To support these initiatives, the "Innovation Program for Brown Shrimp Fisheries in Schleswig-Holstein" was established based on recommendations from the regional shrimp fishery advisory board. The program enables fishers to test practical modifications to fishing gears, including net design, ground gear and selection devices, to reduce environmental impact. To date, ten pilot projects have been successfully completed, demonstrating promising potential for improving the sustainability of the fishery. These efforts highlight the importance of fisher-driven innovation in achieving a more sustainable and efficient brown shrimp fishery in the North Sea.

[Source: Source: Thünen-Institut/A. Brüger]

(50) New legal gears in the Baltic - a bumpy road

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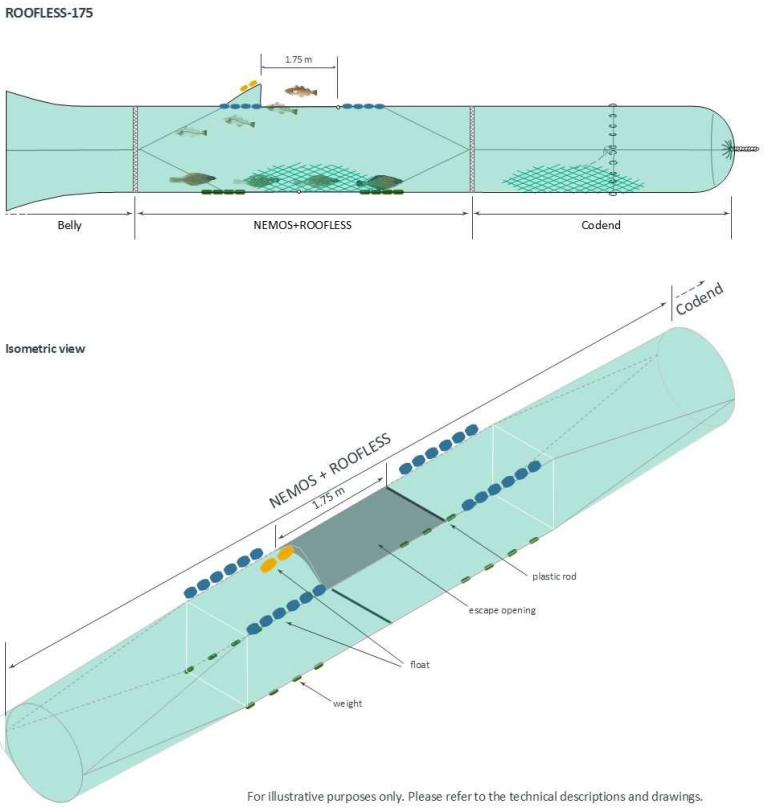
The poor state of cod stocks in the Baltic Sea since at least 2019 requires urgent solutions to reduce cod bycatch in the bottom trawl fishery. Only then can flatfish fisheries continue without hindering the recovery of cod stocks. Baltic gear technologists have developed and offered technical solutions (2 codends and ROOFLESS-device) to achieve this goal in the short term. The presentation will look at the technical aspects and selectivity of the proposed selection devices, but also review the bumpy road from final solutions in 2020 until the mandatory legalisation in April 2025.

Details about gears and corresponding fact sheets can be found at www.thuenen.de/bycatch



[Source: Thünen Institute of Baltic Sea Fisheries (Annemarie Schütz)]

(Poster V) Advantages of commercially testing a proven ultra low opening trawl (ULOT) net across multiple vessel sizes and a wider geographic area

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Despite research trials demonstrating that the Ultra-Low Opening Trawl (ULOT) can reduce Atlantic cod (*Gadus morhua*) bycatch by 46.8%, adoption in the New England groundfish fishery has remained limited. To increase awareness and industry uptake, we launched a targeted social media campaign that reached over 13,000 individuals and generated 29 project applications. We strategically selected participants across different vessel sizes and fishing regions to evaluate ULOT performance under diverse conditions. This approach enabled region-specific net modifications to optimize catch efficiency while maintaining cod bycatch reductions and improving flatfish retention. Additionally, by fostering direct communication between participating fishermen and their peers, we built trust and credibility that traditional research outreach often lacks. Rather than developing an entirely new net, we refined and adapted the ULOT to meet industry needs, facilitating broader acceptance and integration into the fishery.

[Source: Gulf of Maine Research Institute]

[Source: Tim Barrett F/V *Odessa* Marshfield, MA, USA]

[Source: Justin Libby F/V *Capt'n Lee* Portland, ME, USA]