ICES-FAO WORKING GROUP ON FISHING TECHNOLOGY AND FISH BEHAVIOUR (WGFTFB)

VOLUME 5 | ISSUE 83

ICES SCIENTIFIC REPORTS

RAPPORTS SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

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

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371

ICES Scientific Reports

Volume 5 | Issue 83

ICES-FAO WORKING GROUP ON FISHING TECHNOLOGY AND FISH BEHAVIOUR (WGFTFB)

Recommended format for purpose of citation:

ICES. 2023. ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB). ICES Scientific Reports. 5:83. 317 pp. https://doi.org/10.17895/ices.pub.24080889

Editors

Jon Lansley • Antonello Sala • Daniel Stepputtis

Authors

Jure Brčić • Haraldur Einarsson • Jordan Feekings • Gildas Glemarec • Bent Hermann • Lotte Kindt-Larsen
Pandian Krishnan • Jon Lansley • Peter Ljungberg • Valentina Melli • Chryssi Mytilineou • Thomas Noack
Amparo Perez Roda • Kelsey Richardson • Antonello Sala • Daniel Stepputtis • Noëlle Yochum

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

Contents

i Executive summary

The Working Group on Fishing Technology and Fish Behaviour (WGFTFB) discusses and reviews research and practices of fishing technology and fish behaviour in relation to commercial and survey gears. The group provides guidance for management including, *inter alia*, the impacts of fishing on the environment. The working group is jointly supported by the International Council for the Exploration of the Sea (ICES) and the Food and Agriculture Organization of the United Nations (FAO), which have fostered a fruitful working relationship in an international forum. WGFTFB also collaborates with the Working Group on Fisheries, Acoustics, Science and Technology (WGFAST) to facilitate the interdisciplinary exchange of knowledge and to foster cooperation.

Due to the COVID-19 pandemic and the suspension of the Russian Federation from ICES due to the war in Europe, the group did not meet physically in during the period 2020 to 2022.

The 2023 annual meeting was hosted by the Department of Fisheries, Government of India, organized by BOBP-IGO and NFDB in collaboration with ICAR Fisheries Institutes and State Fisheries Universities, and run in parallel to the symposium on "Innovations in Fishing Technologies for Sustainable and Resilient Fisheries. The meeting included several plenum sessions, a series of Topic Group meetings and sessions dedicated to Working Group matters including presentation of National Reports; selection of new chairs; and work plan development. The three Topic Groups examined issues relating to passive gear, performance indicators for fishing gears and abandoned, lost or otherwise discarded fishing gear (ALDFG).

In addition to the work conducted during the meeting, this report contains the national reports describing activities in different countries. National reports are structured to give an overview of current and planned activities in the institutes and organizations of the county that are active in research in fishing gear and fish behaviour and are an important tool to stimulate collaborative research. Current national reports cover a broad field of gear technology research, including research related to bycatch reduction of target and bycatch species, minimizing the effect on the marine environment, pollution, and energy efficiency. In addition to classical gear technology approaches, several projects are presented that focus on techniques, such as computer vision.

ii Expert group information

Expert group name	ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB)
Expert group cycle	Multiannual
Year cycle started	2020
Reporting year in cycle	4/4
Chair(s)	Daniel Stepputtis, Germany (ICES chair)
	Antonello Sala, Italy (ICES chair)
	Jon Lansley, Italy (FAO chair)
Meeting venue(s) and dates	20-24 April 2020, Bergen/Norway (meeting cancelled, by correspondence)
	19-23 April 2021, online (155 participants)
	28 March 2022, online (69 participants)
	13-17 February 2023, Kochi/India (210/115 in-person/online participants)

1 Explanatory Notes on Meeting and Report Structure

ICES and FAO have had a fruitful working relationship on fishing capture technology and related fields for many years. The ICES Working Group on Fishing Technology and Fish Behaviour (WGFTFB) was given a global mandate in 2002 when FAO accepted the invitation of the ICES to form a joint Working Group with the new title ICES-FAO Working Group on Fishing Technology and Fish Behaviour (ICES-FAO WGFTFB). The primary objective of the ICES-FAO WGFTFB is the incorporation of fishing technology issues and expertise into management advice including, inter alia, the impacts of fishing on the environment (e.g. bycatch, unaccounted fishing mortality, habitat impacts, energy use, greenhouse gas emission).

The 2023 meeting was a hybrid meeting to allow working groups members around the world to participate.

The 2023 annual meeting of WGFTFB was hosted by Department of Fisheries, Government of India and organized by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO; https://www.bobpigo.org/). The meeting agenda is shown in Annex (chapter 9).

In parallel to the annual meeting a symposium on "Innovations in Fishing Technologies for Sustainable and Resilient Fisheries" was held with several side events. The agenda and the report of the symposium side events produced by BOBP-IGO can be found on the following link: https://www.bobpigo.org/webroot/img/img-docus/Symposium-on-Innovations-in-Fishing-Technologies-for-Sustainable-and-Resilient-Fisheries.pdf

The report covers the following topics:

- Abstracts of presentations: The abstracts from the oral presentations given during WGFTFB-plenum-meeting are included (chapter 3)
- Topic Group Reports: Three different Topic groups focused on specific topics and reports were developed edited and finalized during the meeting by Topic Group Conveners
    - Passive fishing gears (TG Passive) (chapter 4)
    - The use of indicators to describe and compare the performance of fishing gears (TG Indicator) (chapter 5)
    - Abandoned, lost or otherwise discarded fishing gear (TG ALDFG) (chapter 6)
- National Reports: Description of activities in different countries. National reports are structured to give an overview of current and planned activities in the institutes and organizations that are active in research in fishing gear and fish behaviour.
- Outcomes of the WGFTFB business meeting

The abstracts of presentations and National Reports are included in this report, together with the authors' names and affiliations. Although discussion relating to the individual presentations was encouraged, comments are not included in the text of this report. The contents of the individual abstracts were not discussed fully by the group, and as such, they do not necessarily reflect the views of the WGFTFB.

2 Opening of the meeting

The meeting began with an Inaugural Session organised by meeting hosts, including welcome addresses given by representative of the Government of India who shared plans and perspectives for marine fisheries development and research in India.

The FAO Chair expressed gratitude to the Government of India, and in particular the Bay of Bengal Inter-Governmental Organisation (BOBP-IGO; https://www.bobpigo.org/), for generously hosting this WGFTFB meeting and symposium, acknowledging this to be the first WGFTFB meeting to be held in South Asia.

The FAO Chair provided some background explaining that the Working Group was given a global mandate in 2002 when FAO accepted the invitation of the ICES to form a joint Working Group and that the main objectives of this collaboration is to involve more developing countries in the work of this group;

- to promote exchange of information between experts working around the globe on fishing technology innovations, and
- to facilitate technology transfer and uptake of responsible and sustainable fishing technologies and practices, by fishing fleets worldwide.

A summary of FAO’s global efforts promoting responsible fisheries was provided, a copy of the full statement can be found in chapter 10 of this report.

An overview of ICES and WGFTFB was provided by the ICES Chair.

The opening of the event was concluded with remarks and expectations provided by the Chief Executiv of NFDB, which set the stage for a productive and enlightening event.

The opening of the meeting included the following

- National Anthem / Lighting of lamp
- Welcome and Opening remarks - Dr. A. Gopalakrishnan Director, ICAR-CMFRI
- Program Context & Overview - Dr. P. Krishnan Director, BOBP-IGO
- FAO Welcome and FAO’s global efforts in responsible fishing operations - Mr. Jon Lansley, FAO Fishery Industry Office
- ICES and WGFTFB Overview - Dr. Daniel Stepputtis, Thuenen Institute, Germany
- India’s Plans and Perspectives
- Marine Fisheries Research - Dr. J.K. Jena DDG (FS), ICAR, DARE, India
- Marine Fisheries Development - Dr. J. Balaji, IAS Joint Secretary (Marine), DoF, MoFAHD
- Inaugural Address - Shri. Jatindra Nath Swain Secretary, DoF, MoFAHD
- Concluding Remarks and Expectations for the event - Dr. C. Suvarna, IFS Chief Executive, NFDB

3 Presentations in plenum

In this section, the abstracts will be given in the order as presented during the meeting. The abstracts of presentations given during the Topic Groups are listed thereunder (chapter 4, 5 and 6).

3.1 Session 1: Opening Session

FAO's global efforts in responsible fishing operations (ID 116)

Jon Lansley[1], Amparo Perez Roda[1], Kelsey Richardson[1], Haraldur Einarsson[1], Antonello Sala[1], Pingguo He[1]

[1]Food and Agriculture Organization of the United Nations (FAO); Fisheries Division, Fishing Operations and Technology Branch, Viale delle Terme di Caracalla, 00153, Rome, Italy. Jon.lansley@fao.org

The FAO's Responsible Fishing Operations Team focused on the following areas related to the FTFB during the past two years. Carrying out activities to implement the FAO Voluntary Guidelines for the Marking of Fishing Gear (VGMFG) around the globe, including:

- Development of guidelines for a scheme to operationalise the FAO Voluntary Guidelines on the Marking of Fishing Gear for Indian Ocean Tuna Commission (IOTC) (published 2022).
- Development of a framework for conducting a risk assessment for a system on the marking of fishing gear (VGMFG Suppl. 1, published 2023)
- Development of a manual for the marking of fishing gear (VGMFG Suppl. 2, published 2023)
- Support to IMO sub-committees dealing with the development of an international obligation for the marking of fishing gear under Marpol Annex V

Development of a new project proposal (REBYC-III) addressing bycatch in Caribbean and North Brazilian Shelf (CLME+) trawl and non-trawl fisheries, to commence 2023. Support to projects developing nearshore anchored FAD fisheries in the Pacific (FishFAD) and support to WECAFC Working Group on Development of Sustainable Moored FAD Fishing in the Caribbean. Development of factsheets to promote the "FAO Technical Guidelines to Prevent and Reduce Bycatch of Marine Mammals in Capture Fisheries" (published 2021). Developed and published FAO technical paper "Classification and illustrated definition of fishing gears" (published 2021). Co-sponsoring (with IMO) a GESAMP Working group on sea-based sources of marine litter including fishing gear, especially abandoned, lost or otherwise fishing gear (ALDFG) and other shipping-related litter (1st report published 2021). Support and clearance for fishing gear procurements in FAO emergency and development projects. Activities addressing ALDFG and marine plastic litter through the IMO/FAO GloLitter Partnerships project including:

- Producing knowledge products on "Legal aspects of ALDFG" (published 2022), "Reporting and retrieval of ALDFG" (published 2022), a "Report of good practices to prevent and reduce plastic litter from fishing activities" (published 2022) and a desk study on fishing gear recycling, Extended Producers Responsibility (EPR), and circular economy models around fishing gear (to be published in 2023)
- Support for the development of National Action Plans to address ALDFG.
- Incorporation of the VGMFG in national fisheries frameworks.
- Fishing gear modification trials to reduce potential for ghost fishing.

Implementation of FAO surveys of ALDFG in selected regions and countries to fill data gaps. Desk study on Fuel use and greenhouse gas (GHG) emissions in fisheries (in review).

Information and resources can be found on the following Responsible Fishing Practices for Sustainable Fisheries website https://www.fao.org/responsible-fishing .

3.2 Session 2: Active gears

Turn and Fix – two ways to sharpen size selection (ID 12)

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

[1]*DTU Aqua, Technical University of Denmark, Hirtshals, Denmark, zitba@aqua.dtu.dk*

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

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

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

In demersal trawls the most used codends are made of diamond-mesh netting. However, diamond-mesh codends vary in mesh geometry during fishing which introduces variability in the size selection process. The variability in mesh geometry results in less sharp size selectivity and hence it is more challenging to find the compromise between catching small fish and catch loss using a given mesh size. This phenomenon compromises the rationality of regulating exploitation patterns in trawl fisheries based on mesh size. One technical solution often tried to achieve a sharper size selection is turning the codend netting 45 degrees (square-mesh, T45). However, there is a lack of evidence that square-mesh codends fulfill prior expectations regarding its sharper selectivity. In addition, it is a general assumption that flatfish have better escapement probability in diamond-mesh codends compared to square-mesh codends, while the opposite occurs for roundfish. To test these assumptions, we investigated the size selective properties of five codends: a standard square-mesh, a standard diamond-mesh and three rigid codends, one with mesh geometry fixed in a square shape and two fixed at different diamond opening angles (40 and 60 degrees). We collected selectivity data for cod (*Gadus morhua*) and for three flatfish species, European plaice (*Pleuronectes platessa*), common dab (*Limanda limanda*) and flounder (*Platichthys flesus*). Our results show a significant higher variability in size selection using standard diamond-mesh compared to a fixed diamond-mesh codend for both flatfish and roundfish. Moreover, we found that size selection in square-mesh codend with non-fixed meshes is not as sharp as it could be with fixed meshes, and it has significant effect on the length-dependent retention for flatfish. Thereby size selection could be improved with mesh openness kept constant as this stabilize the selection process and thereby ease achieving the desired exploitation

A brighter future for the Belgian fishing fleet: an overview of 3 years of fishing trials using LED (ID 20)

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

[1]*Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Oostende, Belgium, mattias.vanopstal@ilvo.vlaanderen.be*

Beam trawl fisheries targeting sole are a mixed fishery with high bycatch and discard rates. The instalment of the European Landing Obligation intensified the relevance of minimising discard rates of european plaice (*Pleuronectes platessa*), often thrown back to make space for the more valuable sole. In order to reduce the discards of plaice, research with artificial light illuminating

Square Mesh Panels on board RV Belgica was performed. Without significant loss of valuable commercial fish species, we managed to increase escape rates of the undersized plaice, which gave rise to a new project: Led there be light. It consists of two parts. In the first we tried to further improve escape rates of undersized fish in sole fisheries based on a better understanding of species-specific fish behaviour in relation to environmental conditions and by experimenting with the light itself. We trialled different wavelengths and light sources (SafetyNet Technologies "PISCES" lights, Lindgren Pitman lights and LED ropes) and developed LED separator panels, creating a visual barrier for undersized plaice. The second part of the project aimed at exploring the possibilities for LED innovations in different fishing techniques practiced by the Belgian fleet. Based on what we learned in sole fisheries, we experimented with LED to reduce bycatch of flatfish in beam trawls targeting brown shrimp (*Crangon crangon*). We did preliminary research aiming to increase the catches of squid (*Loligo spp*.) in flyshoot and otter trawl fisheries while recusing gadoid bycatch. Although currently not used in the Belgian fleet, we also looked at the potential of light to attract brown crab (*Cancer pagurus*) with pots. We will shine some light on the preliminary results that we obtained and the lessons learned from the variety of experiments we performed so far in LED there be light.

Trawl goes selective: An insight in to demand induced innovation in trawl fishery of Gujarat (ID 52)

Rajan Kumar[1], Dineshbabu A.P.[1], Shikha Rahangdale[1], Vinayakumar vase[1], Jayasankar J.[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala, rajanfrmcife@gmail.com*

Trawl has often been criticized for being an unselective mode of fish harvest, leading to considerable ecological damage. Trawl were introduced as bottom trawl in India to harvest the lucrative prawn resources available along the continental shelves of the country. Several demonstrations in the 1980s showed that the operation of the high opening bottom trawls can efficiently harvest the demersal teleost resources, especially along the NW coast of India. This has led to the emergence of fish trawls, gradually reducing the effort spent towards bottom trawl operation. Since 2001, there are considerable changes in species preference in response to the export demand. The ribbonfishes and cephalopod emerged as the most sought for species by the fishers of the Gujarat. The changing preference of the species is reflected in the operational changes in the trawl operation, an innovation introduced by fishers of Gujarat. At present, there are basically five types of trawl nets operated by Gujarat fishers, namely perch and shrimp (bottom), ribbonfish (pelagic), cephalopod (squid), and Acetes trawl (only single day operation). Each one designed for harvesting specific resource. The major design difference was in the mesh size of the front panel. It ranges from 6000 mm in ribbonfish trawl to 600 mm (top panel) in Acetes trawl. In all the cases, the foot rope length in longer by 6-9 m. The towing speed varies from 2 to 6 knots. The 2-3 knots were used during shrimp & ribbonfish trawling. During demersal fish and Acetes trawling, the speed is around 4 knots. The towing speed used during squid trawling goes up to 6 knots. Much variation in cod end for perch, ribbonfish and cephalopod trawling is not there. The minimum mesh size for cod end was in Acetes trawl, i.e. 8 mm. A study was conducted along the NW coast during 2018-19 to partition the multi-day trawl effort in to its sub-component, namely bottom trawl, pelagic trawl and cephalopod trawl. The ribbonfish (pelagic) trawling was the most dominant component, accounting for 39.64% (27.0 to 46.97%) of the total hauls. The cephalopod trawling accounted for 20.55 to 32.15% of the total trawl hauls, with a mean of 26.99%. The bottom trawling accounted for only 33.17% (26.1 to 41.58%) of the total hauls. The monthly catch rates of the bottom trawl operation were also worked out. The catch rate of high valued fishes ranged between 22.73 to 98.52 kgs/hr. The discard rate was between 25.62 to 32.67 kgs/hr. The study advocates the shift in data collection procedure to haul based data collection from the existing boat on arrival approach to scientifically account for changing catch and catch rates from the trawl sector.

Does a codend with shortened lastridge ropes provide optimal escape opportunities for different fish species? (ID 32)

Elsa Cuende[1], Manu Sistiaga[2,3], Bent Herrmann[3,4,5], Mikel Basterretxea[1], Luis Arregi[1]

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

[2]*Institute of Marine Research, Postboks 1870 Nordnes, Bergen, 5817, Norway*

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

[4]*SINTEF Ocean, Fishing Gear Technology, Willemoesvej 2, 9850, Hirtshals, Denmark*

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

Diamond meshes in trawl codends have limited openness, which reduces escape chances for roundfish. Shortening the lastridge ropes (LR) attached to codend selvedges can increase the availability of open meshes resulting in higher chances of escape. However, this availability does not imply optimal mesh openness, nor does it guarantee use. We estimate the escape probability of hake, horse mackerel and blue whiting through a 20% shortened LR codend and a standard codend, and quantify the contribution of different mesh opening angles (OAs) to their size selectivity. The results confirm that high OAs increase escape opportunities for all species. However, shortened LR only improved size selectivity significantly for horse mackerel and blue whiting. This difference between species may be related to behavioural differences. The mesh openness achieved with 20% shortened LR was below that necessary to obtain optimal escape opportunities for these species. The study highlights the relevance of considering fish morphology and behaviour to optimally exploit size selectivity when designing shortened LR codends.

Beach seine fishing in India: scope for improvement for sustainability (ID 22)

Manju Lekshmi N.[1], Dhiju Das P.H. [1], and Leela Edwin[1]

[1]*ICAR-Central Institute of Fisheries Technology, Fishing Technology Division, Cochin, India, manjuaem@gmail.com*

The study gives an overview of designs, catch composition, problems, and solutions for beach seine operations in India. The design of beach seines in India varies in structure and size based on region and resources. In India, 2,227 numbers beach seines were reported under different names and operated along the east and west coasts of India (2015). In Kerala and Tamil Nadu, beach seines are locally known as kambavala/karamadi which have a separate bag like cod-end. Rampani/rampan is the seine operated in Maharashtra, Goa, and Karnataka which is without a specific cod-end but only has loosely hung meshes. Natural and biodegradable materials were used for the fabrication of seine nets which are now replaced with synthetic materials (nylon, polyethylene, etc) due to their wide applicability. Normally, beach seines are non-selective fishing gears with small mesh sizes (below 10 mm) and are operated during the post-monsoon season due to the easy availability of coastal pelagics like sardines, mackerel, herrings, ribbon fishes, anchovies, etc. Fishing practices are governed by a well-defined set of traditional rules enforced by the fishing community to share the catch/revenue/wages. The majority of beach seines in India were operated as a community (group of fishers), and few have been owner-operated where each group takes a turn (rotation) for fishing from a specific location. Even though beach seine is one of the traditional fishing gear, management practices followed by the fishers in many of the states

in India are remarkable. Studies conducted by ICAR-Central Institute of Fisheries Technology (CIFT) found that the number of beach seines has been declining in India during the last two decades. Despite its declining contribution to national income, beach seines have an important socio-economic role, especially the management in gear operation, in providing livelihoods, nutrition, and food security. ICAR-CIFT has developed technical guidelines for the operation of beach seines along the Indian coast for the reduction of juvenile incidence by increasing the existing codend mesh size and recommends square mesh at the cod-end. Suggestions are made to avoid ecologically sensitive areas for beach seine operations. This study concludes that technical improvements and the introduction of measures for the reduction of juvenile catches will lead to the sustainability of the beach seine fishery in India which is a source of livelihood for the of aged traditional fisherfolk.

A journey to new regions: Testing and improving the MiniSeine´s performance in waters off the German Baltic Sea coast (ID 19)

Thomas Noack[1], Daniel Stepputtis[1]

[1]*Thünen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, 18069 Rostock, Germany, thomas.noack@thuenen.de*

The MiniSeine is a small demersal seine that might be considered an alternative gear for small passive fisheries suffering from interactions with raiding seals. Such seals can damage or remove fish from for instance gillnets or cause damage to the fishing gear itself. By reducing seine rope length, seine rope diameter as well as seine net size of a conventional demersal seine system, the MiniSeine system can fit and be operated from rather small vessels as gillnetters usually are. As previous studies by Danish and Swedish colleagues have shown, the Danish prototype of the MiniSeine system is able to catch fish, but offers a number of issues, like low hauling speed. Current trials, conducted in summer 2022 off the German Baltic coast, aimed at i) testing the gear with another vessel in another region and ii) improving the gear´s performance (e.g. catch efficiency). The results of these trials will be presented by showing and discussing catch composition as well as other relevant information like gear handling and fuel efficiency. Although several pitfalls of the gear could be identified, the results indicate that the MiniSeine has the potential to become part of the list "efficient fishing gears with reduced seal interactions".

What will it take to get fish out of the trawl? Creating a Low-Flow Zone within and outside the boundaries of a trawl to incentivize fish escape (ID 72)

Valentina Melli[1]*, Finbarr G. O'Neill[1]*, Karsten Breddermann[2], Jens Peter Kofoed[3], Junita D. Karlsen[1]

[1]*DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark, vmel@aqua.dtu.dk ; barone@aqua.dtu.dk*

[2]*University of Rostock, Justus-von-Liebig-Weg 2, D-18059, Rostock, Germany*

[3]*SINTEF Ocean, North Sea Science Park, Hirtshals, Denmark*

A promising, yet under-utilized approach to bycatch reduction in trawl fisheries is one that exploits and manipulate the swimming orientation and flow refuging behaviour of bycatch species to encourage their escape from inside a trawl. We investigated whether a low flow zone area, expanding both within and outside the extension section of a demersal trawl, can be used to increase fish escape. A 360° radial escape opportunity, in the form of a gap in the trawl between the extension and codend, was offered to the fish in the low flow area. The catch was guided into the codend by an impermeable tarpaulin funnel, which generated a low flow area in the wake region behind it, where the gap was located. In principle, only individuals that exploit the low flow area can swim forward and escape through the gap. To prevent fish with strong flow refuging behaviour to hold stationary in the low flow zone, without exiting the gap, a deflector flange also made of an impermeable tarpaulin was mounted outside the entrance of the funnel to expand the low flow area in the open water surrounding the extension piece. This concept was designed using flume tank trials and computational fluid dynamic modelling and tested during experimental trials at sea. Substantial escape rates were found for all three roundfish species considered: cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*). Moreover, based on the fluid dynamic models, we tested two different gap sizes, with the smaller gap (1 m) moving the codend entrance into the recirculation area created by the low flow zone. We found a significant difference in the escape of undersized haddock and whiting, but not cod, which suggest complex and possibly species-dependent interactions between hydrodynamic flow and fish behaviour.

Comparative studies of 30 mm diamond mesh and 30 mm square mesh codends conducted during the demersal fishery resources survey along the Andhra Pradesh Coast (ID 81)

P.Das[1], G.V.A.Prasad[1], A.B.Kar[1], D.B.Reddy[1], K.Silambarasan[2], A.Siva[3], S.R.Panda[1], R. Jeyabaskaran[3]

[1]*Fishery Survey of India, Beach Road, Visakhapatnam, Andhra Pradesh-530 001,* fsi_vizag@yahoo.co.in

[2]*Fishery Survey of India, Royapuram, Chennai, Tamil Nadu- 600013*

[3]*Headquarters, Fishery Survey of India, Sassoon Dock, Colaba, Mumbai 400 005*

Indian Marine Fisheries is a multi-gear and multispecies fishery. However, trawl fishery contributes substantially to the marine fish landings in India. The trawl catch comprises of commercial varieties and also the by-catch. Among the by-catch some are trash fishes which are not economically beneficial hence discarded. The trawl discards have biological and ecological impacts. In Indian waters there are many by-catch reduction mechanism available for the reduction of trash and escapement of juveniles. The most effective one is the square mesh codend as it remains open during the net tow in comparison to the traditional diamond mesh codend. To establish the efficiency of the square mesh codend than the diamond mesh a comparative study was undertaken by Fishery Survey of India, Visakhapatnam along the Andhra Pradesh coast. The study was undertaken onboard the departmental survey vessel MFV Matsya Dashini (OAL: 36.5m, GRT: 268.8T, BHP:1160) during the bottom trawl operations by deploying the 45.6 M expo model bottom trawl with the 30 MM diamond mesh and 30 MM square mesh (2.5mm Φ HDPE) codends. A total of 44hauls (fishing effort of 66 hrs) each using diamond and square mesh codend were made. The collected data was analysed for the average CPUE, spatial variation, species diversity, variation in size etc. The result indicates that in square mesh codend a better CPUE of 55.9 kg/hr was obtained than the diamond mesh codend (CPUE of 50.5 kg/hr). Species composition indicated more trash fishes in the diamond mesh codend. The study also indicated larger size species in the square mesh codend. The square mesh cod end shows better productivity, reduction in by-catch/ trash fishes and escapement of the juveniles in the Andhra Pradesh coast. The same study needs to be carried out in other part of the EEZ also so that effectiveness of the square mesh codend can be established and can be promoted in Indian trawl fisheries.

Key words: Trawl fisheries, by-catch, juveniles, square mesh codend, CPUE, Matsya Darshini

Emergence of specialized trawl net for the fishery of octopus along the southwest coast of India (ID 85)

V. Venkatesan[1], KK. Sajikumar[1], VR Madhu[2], Geetha Sasikumar[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Kochi-682018 Kerala, India, venkatcmfri@yahoo.co.in*

[2]*ICAR-Central Institute of Fisheries Technology, Kochi-682018 Kerala, India*

Cephalopods including octopuses are commercially exploited all along the Indian coast. Octopuses were once thrown overboard as discards but the demand from export trade in the mid-seventies induced the fishers to catch these resources. The cephalopods contribute to about 4% of total marine landings. Among the cephalopods, octopuses formed 10-12 % in total catch. The production of octopuses increased all along the Indian coast However, the increase was more along the west coast than in the east coast. Octopuses are caught as by-catch of trawl nets along the Indian coast except along the certain area where there is a targeted fishery for these resources. Specialized octopus trawl nets are operated from multiday trawlers in the southwest coast. Peak fishing season starts September onwards. Octopus fishing grounds were off Alappuzha or Kollam in the depth ranging from 30- 108 m. it is operated as per the fishing ground either along the bottom or just above the bottom. Peak fishing season are 5 months from August to December. Octopus fishing ground lie between Kanyakumari to Munambam. During the operation of octopus trawl net, the average towing speed of vessel is 2.5 knots.

Improving energy efficiency and seabed impact in deep-sea shrimp trawl fishery (ID 164)

Agustín Mayans Fernández[1], Ignacio J. Martínez Soler[1], A.V. Martínez Sanz[2], Vicente Colomer Romero[2]

[1]*Kongsberg Maritime Spain S.L.U, Polígono Atalayes, 20, 03570 Villajoyosa (Alicante), Spain, agustin.mayans@simrad.com*

[2]*Institute of Design and Manufacturing (IDF) Universitat Politècnica de València. Ciudad Politécnica de la Innovación (CPI), Camino de Vera s/n, Building 8G, 46022 Valencia, Spain, anmarsan@mcm.upv.es*

The objective of this work is to show the benefits of a new eco-systemic fishing gear installed in three bottom trawlers after one year using it. The study has been based on fuel consumption reduction for the three vessels and the catch in two of them.

The new system minimizes the impact of the fishing gear on the seabed, with a reduction on the tow resistance. This generates significant fuel savings that improves the economical result of the fishery, helping the ship owners in the return of investment first, then in the future viability of the operation.

Apart of the evident savings due to the fuel consumption reduction, in the long term, the ship owner will notice also savings on maintenance, both because the winches are towing with less tension (longer life for warps, brakes and hydraulic system) and the engine is running at low rpm's (longer life of the engine and between breakdowns).

The new fishing gear doesn't requires any modification on the way that the fisherman are working, only replacing and/or modify some parts or components of the fishing gear. The implementation is easy and the adjustments required could be done in a couple of days.

Keywords: Mediterranean trawlers, fishing gear, flying bottom trawl doors, energy efficiency, electronics systems

Quick visual observation of pelagic school composition to avoid unwanted catches in commercial pelagic (trawl) fisheries. (ID 95)

Pieke Molenaar[1]

[1]*Wageningen Marine Research, Haringkade 1, 1967 AB IJmuiden, The Netherlands, pieke.molenaar@wur.nl*

Commercial pelagic fisheries locate pelagic schooling fish with sophisticated echo sounding techniques. Those may locate fish school in a range up to 3 kilometer around the vessel. However, when a school is detected in some cases it cannot be determined what species are present. The skipper of a pelagic trawler may decide to perform an experimental short haul to assess species and composition, leading to substantial unwanted catches is case it appeared to be the wrong species. We developed a cost-efficient quick tool that can be deployed and towed through pelagic schools up to 200 meters depth. Within several minutes the skipper knows the species and is able to avoid unwanted catches. The tool has been successfully implemented on trawlers resulting in reduced unwanted catches with some by-catch of interesting underwater recordings.

Demonstration of pingers potential to reduce Common Dolphin bycatch in bottom trawl gears (ID 34)

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

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

Bycatch of common dolphin (*Delphinus delphis*) in commercial bottom trawl fisheries in the Bay of Biscay (NE Atlantic) is of particular concern and its mitigation has become a priority. Active acoustic deterrent devices (pingers) attached to the fishing gears seem to be promising for bycatch mitigation. However, the high number of days at sea needed to monitor common dolphin bycatch due to the low frequency of those events in the fishery challenges demonstrating pingers' effectiveness. The use of remote electronic monitoring (REM) systems in fisheries allows to significantly increase onboard observation and thus, the access to large and robust databases to comprehensively address bycatch mitigation studies. In this study, the effectiveness of pingers to reduce the bycatch of common dolphin was evaluated in a demersal pair trawler in FAO Division 27.8.c. During 195 fishing days, one of the vessels in the pair operated with a set of pingers, while the other one operated without them. In total, 660 fishing hauls were alternatively carried out by the trawls with and without pingers, and the bycatch of common dolphin was monitored through REM system. The results showed that the common dolphin bycatch frequency and the number of individuals bycaught per haul were significantly lower when pingers were deployed. Specifically, the pinger tested reduced the common dolphin bycatch by more than 90%. The results also showed that the bycatch of common dolphin is related to factors such as the type of net used, the fishing zone (north and south of Capbreton Canyon) and the depth, whereas the time of day was not found to significantly affect the bycatch of this species.

3.3 Session 3: Passive gears

Innovations in pot fisheries, a toolbox for a multi-use sea (ID 7)

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

[1] *Flanders Research Institute for Agriculture, Fisheries and Food, Jacobsenstraat 1, 8400 Oostende, Belgium, jasper.vanvlasselaer@ilvo.vlaanderen.be*

Our oceans and seas, though vast as they might seem, are heavily crowded. This is certainly true for the North Sea where many countries lie closely together around a small portion of water. In each of their EEZ's, a plethora of sectors vie for space. Alongside shipping lanes and dredging sites, marine reserves and offshore oil platforms, fishing grounds have a historical claim of presence in our seas. Under the pressure of climate change, an energy crisis and incentives such as the green deal, development of offshore windfarms has taken flight. All along the European coasts, turbines sprout like saplings after a fire, competing for space with other stakeholders, and most importantly fisheries. In their wake, aquaculture at sea or mariculture, follows as there is not only a demand for green (or blue) energy, but also for sustainable food. Besides conflict, the development of these mari- and windfarms offers opportunity. A space for a new type of fishing, that is more like farming.

Due to safety and technical measures implied in offshore development, not any type of fishing is appropriate to take on this role of fisher/farmer, nor does it fall within a sustainable way of food sourcing. Thus, at ILVO, we are developing a toolbox for a pot fisher to take on board, of which the content can vary depending on the location, season, and presence of species. This toolbox consists of innovations that will increase catches in a more sedentary type of fishing. We have tried and tested a variety of innovations related to light, sound and odour focusing on some key species. These were Sepia officinalis, Cancer pagurus, Trisopturus luscus, Solea solea, Pleuronectes platessa, Necora puber and Palaemon serratus. Using fluorescent netting, we increased Sepia catches by tenfold. We used LED's to lure crabs, but the effect was not as effective. For humpback prawns on the other hand we saw significant catch increases. Other tests using underwater speakers for the attraction of roundfish or using the odours of bananas to attract flatfish showed potential and will be further trialled.

Analysis on the catch efficiency of fish traps operated along the coast of Thoothukudi, Southeast coast of India (ID 115)

Mariappan Sangaralingam[1], Neethiselvan Neethirajan[1], Ravikumar Thangaraji[1], Sudan Chandran[2]

[1]*Department of Fishing Technology and Fisheries Engineering, TNJFU-FCRI, Thoothukudi-08, Tamil Nadu, India., mariappan@tnfu.ac.in*

[2]*Department of Fisheries Biology and Resource Management, TNJFU-FCRI, Thoothukudi-08, Tamil Nadu, India.,*

Trap fishing with arrow head shaped traps having the dimension of 90cm L X 76cm B X 40cm H is one of the commercial fishing activities being practiced along the coast of Thoothukudi. The fishermen operate 25 to 30 traps from modified traditional craft of Thoothukudi region namely FRP Vallam of 8.25 m OAL. The traps were soaked for 24 hours per fishing trip. The mean fishing effort per month was estimated as 575 boat days. Shrimp head waste were used as baits (1kg/trap). Twelve species of finfishes were recorded in traps viz *Scarus ghobban*, *Epinephalus coioides*, *Siganus canaliculatus*, *Lethrinus nebulosus*, *Acanthurus nigricauda*, *Lutjanus rivulatus*, *Parupenus indicus*, *Epinephalus areolatus*, *Plectorhincus schotaf*, *Plectorhincus albovittatus*, *Lethrinus microdon*, *Lutjanus indicus*. The mean catch rate of trap was estimated as 0.8 kg hr-1. With regard to species wise catch rate *Scarus ghobban* was recorded the highest catch rate of 0.26 kg hr-1. Regarding month wise catch rate in terms of number the highest and the least rate were recorded during the month of March (S= 12, N=382) and January (S= 12, N=261) respectively. In terms of weight, the catch rate was found to be highest during March (0.17 kg hr-1) and the lowest during April (0.11 kg hr-1). The common fishes recorded in the trap was *Scarus ghobban* (28.17%), *Lethrinus nebulosus* (21.14%) and *Parupenus indicus* (15.77%). The least fishes caught in terms of species composition are *Lethrinus microdon* (0.05%), *Plectorhincus albovittatus* (0.16%) and *Lutjanus indicus* (0.32%).

Comparing entrance designs and testing of fish retention devices for Plaice (Pleuronectes plattesa) and Turbot (Scophthalmus maximus) fish pots (ID 90)

Sara Berzosa[1], Daniel Stepputtis[1], Thomas Noack[1], Uwe Lichtenstein[1], Juan Santos[1], Hannah Schartmann[1]

[1] *Thuenen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, 18069 Rostock, Germany, sara.berzosa@thuenen.de*

Gillnets have many benefits for fishing. Nevertheless, they are also problematic from a nature conservation perspective due to unwanted catches of marine mammals and seabirds. One potential solution to reduce bycatch is to reduce the fishing effort with gillnets by a switch to alternative fishing gear such as fish pots and traps. However, previous studies showed that their catch efficiency is lower compared with gillnets.

To improve the catch efficiency of fish pots, the present study investigates different entrance designs for flatfish and tests the efficiency of a fish retention device. The behaviour and interaction with the fishing gear of two flatfish species, Plaice (*Pleuronectes plattesa*) and Turbot (*Scophthalmus maximus*), were evaluated by observing entry and exit rates. Observations were conducted in an enclose net pen using an infrared (IR) lamp and camera system to avoid influencing the behaviour of the flatfish during the night. The results could help to improve the gear design and development of pots for multiple species.

Simple modification in the trap entrance opening significantly improves catch efficiency of mud crab (Scylla serrata) in a tropical estuarine fishery (ID 56)

Madhu, V.R.[1], Sreelakshmi B. Anand[1], Kristine Cerbule[2,3], Bent Herrmann[2,3,4]

[1]*ICAR-Central Institute of Fisheries Technology, Matsyapuri, W. Island, Cochin – 682029, madhucift@gmail.com*

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

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

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

Traps are widely used fishing gear in Vembanad lake, Kerala, for targeting mud crab (*Scylla serrata*), which has high commercial value. Traps, with dimensions of 820 mm x 400 mm x 400 mm, made of galvanized iron frames are commonly used. The entrance opening of the trap is rectangular in shape (150x150 mm) and made of nylon mesh with a mesh size of 18 mm wrapped around the trap. The catch rates of traps with this design are generally low for the target species. It is speculated that the low catch rates are due to the escape process through the pot entrances. Furthermore, it is observed that a significant quantity of bycatch, mostly fishes, are captured in such traps. Therefore, this study was carried out to find if a simple modification in the entrance opening of the traditional traps, can improve the catch efficiency of mud crab. An extension of the trap entrance (150 mm x 100 mm), with the opening facing towards the bottom of the trap, was the only modification made in the experimental trap, with other parameters remaining the same as in the standard design. A total of 34 simultaneous deployments during June to October 2022 were conducted. Each deployment contained two replications of each trap design, which were separated at a distance of 50 m. The soak time was kept to 24 hours. The results of this experiment showed that the catch efficiency of mud crab was significantly improved for all sizes of mud crab when using modified traps. Specifically, it was estimated that the catch efficiency would be more than six times higher with the modified compared to the traditional design (622% (CI: 344-1867%)). However, the capture of mud crab under length at first sexual maturity (95 mm), would imply that significant quantities of juvenile crabs are caught in modified trap, which although would be welcomed by the fishers, is not acceptable ecologically. The results of the findings, implications, and further directions are discussed.

Design, development, selectivity and underwater observations of pentagonal shape fish traps operated along the Gulf of Mannar (ID 79)

Shunmugavel Chinnadurai[1], V R Madhu[1]

[1]*Fishing Technology Division, IACR-Central Institute of Fisheries Technology, Kochi-29, Kerala, Chinnadurai.S@icar.gov.in*

The Gulf of Mannar (GoM) archipelago is bestowed with 21 uninhabited coral islands that occur between Rameswaram and Tuticorin is known for coral reefs and associated biodiversity. Nearly 100,000 fishermen live in hundreds of fishing villages and hamlets along the coast of GoM, and they mainly depend on the reef-associated fishery for their livelihood. There exists an organized trap fishing along the Gulf of Mannar using traditional traps. Trap fishing is one of the oldest indigenous fishing methods in the Gulf of Mannar. The traditional traps are made out of split branches of Acacia planifrons or out of thin bamboo creepers and midribs of palmyra leaves. These traps are heavy, have short life spans and occupy more space in the traditional fishing craft that are operated with severe space constraints. In recent years, however, the fishermen shifted to traps made of PVC polymesh which is light-weight and easy to handle. But, due to light-weight these traps are prone to lose from the site during rough sea conditions. A recent underwater study in GoM reported that fish traps are the second most dominant marine debris in the studied area. The derelict traps may lead to ghost fishing and adversely affect the coral reefs. To overcome this issue, ICAR-CIFT designed a pentagonal shape fish trap which is made of 10 mm dia. stainless steel for corrosion resistance and covered with HDPE webbing of different mesh sizes. The dimensions of the trap were 0.6 m in length, 1.0 m in width and 0.4 m in height. There is one oval shape entrance at the front side of the trap.

The newly designed pentagonal shape fish traps (PSFT) were field tested along the Gulf of Mannar group of Islands during January to April, 2021 in the depth range of 5-8m. Five PSFTs and five conventional traps were used for experimental fishing with a soaking time of 24 hours. For the selectivity study, we used 5 different mesh sizes for covering the traps starting from 17.5, 20-, 25-, 30- and 40-mm bar mesh. A total of 244 trap deployments were successfully completed during the study, with each experiment involving ~30 replicate deployments of the treatments and the control. An underwater camera was fitted inside the trap to understand the behavioral response of the fish to the trap. Better catch efficiency was recorded in 20, 25 and 30 mm bar mesh traps. On the whole, the 20 mm bar showed better catch efficiency in terms of weight. The major species that formed the catch were Lutjanus fulvus, L. Lutjanus, Lethrinus lentjan, L. nebulosus, L. microdon, Scarus spp., Pristipomoides typus, Parupeneus indicus, Epinephelus bleekeri, E. coioides, and E. malabaricus. The length of the fishes were compared with the minimum legal size (MLS) and nearly 95% of the species caught had lengths above the MLS. The catch efficiency of the PSFTs (20 mm mesh bar) and the control trap was 2.75 kg/trap/day and 1.59 kg/trap/day in terms of weight. Notably, the PSFTs produced very few discards when compared to the conventional traps.

Invivo analysis of attracting ability of bio attractants derived from marine bivalves for evolving gelatin-based artificial fish baits suitable for longline fishing (ID 112)

Arjunan Karthy[1]*, Neethirajan Neethiselvan[1], Thangaraji Ravikumar[1], Robinson Jeya shakila[2], Karunanithi Masilan[3], Chellapa Kalidas[4], Thavasiyandi Umamaheswari[5], Balasubramanian Sivaraman[6]

[1]*Department of Fishing Technology and Fisheries Engineering, FC&RI, Thoothukudi-628 008, Tamil Nadu, India, karthi.fischo@gmail.com , neethiselvan@tnjfu.ac.in , ravikumar@tnjfu.ac.in*

[2]*Dean, Dr.MGR. Fisheries college and Research Institute, Ponneri, jeyashakila@tnjfu.ac.in*

[3]*Department of Fish Processing Technology, Dr.MGR. FC&RI, Ponneri, masilan@tnjfu.ac.in*

[4]*Mariculture Division, Tuticorin Regional Station of CMFRI, Thoothukudi, das@cife.ac.in*

[5]*Dept. of Fisheries Economics, Extension and Statistics, FC&RI, Thoothukudi, umamaheswari@tnjfu.ac.in*

[6]*Department of Fish Processing Technology, FC&RI, Thoothukudi, sivaraman@tnjfu.ac.in*

The commonly used forage fishes as baits in Indian longline fishing industry include squids, sardines, anchovies, mackerels and trigger fishes. These forage fishes also have food value as they have direct human consumption. The present study aimed at deriving potential bait attractants from low-cost and underutilized marine bivalves, incorporation in gelatin-based bait matrix to prepare artificial fish bait suitable for longline fishing. Nine different attractants were prepared from three marine bivalves such as oyster (*Crassostrea madrasensis*), mussel (*Mytella strigata*) and clam (*Gafrarium pectinatum*) at three different levels such as 1% (w/w), 3% (w/w) and 5% (w/w) in laboratory glass tank study. Traditional baits such as Sardines and Squids were taken as control baits. All the attractants tested triggered feeding responses of Lutjanus fulvus, individually indicating that they have potential while incorporating at 3% level attractants for developing artificial baits. The study indicated that both free amino acids and other unidentified compounds are responsible for the baiting responses by the snapper (L. fulvus). However, the attractants from oyster, mussel and clam, showed relatively less bait stimulant in relation to the natural baits such as sardines and squids. Thus, the study emphasized the requirement of additional attractants to improve the performance of the artificial baits of the present study.

Keywords: Invivo analysis, bio attractants, artificial fish baits, feeding response and longline fishing

Evaluating Whalesafe Fishing Gear in Eastern Canada (ID 104)

Genevieve Peck[1], Paul Winger[1]

[1]*Fisheries and Marine Institute, P.O. Box 4920, St. John's, NL, CANADA, Paul.Winger@mi.mun.ca*

Entanglement in fishing gear is one of the main factors inhibiting the recovery of critically endangered North Atlantic Right Whales (NARWs). In Newfoundland and Labrador (NL), whale encounters with fishing gear are expected to increase over the next several years due to warming waters and northward movement of the species. This study focuses on the testing and evaluation of "whalesafe" fishing technology in the snow crab fishery. Whalesafe gear incorporates weak components that allows it to cut or break away in the event of an entanglement. This presentation describes several ongoing experiments monitoring the deployment and hauling of snow crab traps in varying real-life conditions using in-line load cells to measure and log tension exerted on ropes. This research will collect valuable data supporting the implementation and adoption of gear modifications across the industry with the goal of reducing death and injuries in the vulnerable NARW population.

Improving the mean size of harvest in dol net fishery with square mesh cod end design (ID 62)

Karankumar K. Ramteke[1], Zaheer Abass[1], Abuthagir Iburahim[1], B. B. Nayak[1], Asha T. Landge[1]

[1]*ICAR- Central Institute of Fisheries Education, Panch Marg, Off. Yari Road, Versova, Andheri (west), Mumbai 400 061 (India), arankumar@cife.edu.in*

Dol net is an indigenous bag net operated in the mouth of the estauries along the northwest coast of India. Coastal zones also represent nursery sites for numerous fishes. The operation of the dol net depends majorly on the tidal currents, Lunar cycle and the depth of the coastal areas. During Full moon and New moon days, the soaking time of dolnet fishing operation remains 4 to 5 hours. The mesh size of the codend of the traditional dolnets varies and it measures less than 10 mm in most cases for targeting seasonal Acetes fishery. The reduced mesh size indiscriminately catches juvenile bycatch which leads to economic inefficiency and is visible in the reduction in quantity and quality of fishes caught in the net. The choice of the fishing site makes it a destructive passive fishing gear. Fishes cannot withstand strong current get caught irrespective of type of the species. Given the presence of a significant number of juveniles of economically valuable fishes, it appears necessary to control the mean size of dol net catches. These problems call for additional improvements to increase the mean size of the catch and provide opportunity for the fish to grow and breed. In this study, a design was developed and tested to improve mean size selection of fish in the dol net. The modified dol net cod end with 35 mm tested onboard a commercial dol netter and compared to the conventional dol net design. The new design was inclusion of a square mesh panel of 35 mm mesh in the cod end in place of the conventional less than 10 mm existing cod end. This panel reduces the quantity of low value juvenile fishes and increases the quantity of low volume high value fishes.

This codend showed a reduction proportion of fish below the size at first maturity in the catches. The average catch per haul for conventional and modified dol net fishing operations was 20 kg/haul and 12 kg/haul, respectively. A total of 48 species belonging to 25 families were recorded from both conventional and modified experimental gear during experimental fishing. The fishery comprised 31 species of finfishes, 15 Species of Crustaceans, and two species of Molluscan. Major catch composition of dol nets recorded during the study from both the net included Coilia dussumieri, Acetes indicus, Trichiurus lepturus, and Harpadon nehereus. Square mesh codend designs tested in this study could benefit aimed sustainability of fishery resources, albeit at the expense juveniles of some commercially important species.

Designs and operational aspects of dolnets of North West coast of India with particular reference to its sustainability (ID 24)

Ratheesh Kumar R[1]; Ajay Nakhawa[1], Manju Lekshmi N[2], Dinesh Babu

[1]*ICAR - Central Marine Fisheries Research Institute, Kochi, rkcmfri@gmail.com*

[2]*ICAR - Central Institute of Fisheries Technology, Kochi*

Dolnets are traditional fixed bag nets operated in areas of strong tidal currents along the Northwest coast of India, targeting mainly bombay duck and non-penaeid prawns. According to the National Marine Census, Maharashtra has the maximum number of stationary bag nets and the majority are operated in Palghar, Thane, Greater Mumbai, and Raigad districts. The stationary bag net accounts for around 47% of the mechanized vessels owned by fishers and supports the livelihood of a larger fisher population. Mechanization of fishing vessels leads the fishers to operate dolnets up to depths of 40-70 m compared to an operation maximum of 20-25 meters. The study aimed to document the operational aspects, catch composition and design of dolnets of Maharashtra with particular reference to its sustainability. The stationary bag net has technologically evolved in net design and operation to target high-value finfishes. Specially modified dolnets called “Karli dol” which are different from conventional stationary bag nets such as Machardhanis, Ghani dol, Bokshi nets, and Perkawala net in the net design and operational area. The Karli dol is primarily operated in the offshore water, while others are operated near shore or creek areas. The Karli dol net used by fishermen was of two seams; 50-60 m length, 20-25 m in breadth, and 5-6 m in height. The net is tapered from the mouth to the cod end. Usually, 200 to 60 mm mesh size. The other conventional dolnets of two seams with 25-45 m length, 13-25 m breadth, and 5-6 m height. The net is tapered from mouth to codend. Usually, 180 to 10 mm mesh sizes. The bycatch and juveniles of targeted species are comparatively higher in conventional dol nets than in Karli dol due to the large mesh cod end. Based on the catch composition and net specification, the Karli dol proved to comply more with the Code of Conduct for Responsible Fisheries (CCRF) than other conventional dol nets. Although bag net fishing is the most wide-spread among the traditional fisheries in the northwest of India, providing a living for many fishermen, there is no formal policy to manage, develop, and assure the sustainability of bag net fish resources.

Change in the colour of gillnets affects catch efficiency: results of an experimental gillnet trial in a tropical estuary in Kerala, India. (ID 25)

Madhu, V.R.[1*], Kristine Cerbule[2,3], Salini Mohanan[1,4], and Bent Herrmann[2,3,5]

[1]*ICAR-Central Institute of Fisheries Technology, Matsyapuri, W. Island, Cochin – 682029, madhucift@gmail.com*

[2]*SINTEF Ocean, Fishing Gear Technology, Willemoesvej 2, 9850, Hirtshals, Denmark*

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

[4]*Kerala University of Fisheries and Ocean Sciences, Panangad, Cochin- 682506*

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

Gillnets are widely used fishing gears in marine and inland waters and are often made of different coloured webbing. For most fisheries, it is unknown how gillnet colour affects catch efficiency. Therefore, the effect of gillnet colour on the catch efficiency was investigated during trials for Pearlspot (Etroplus suratensis) fishery in Vembanad lake, Kerala, India. Green, blue and transparent gillnets were tested during the trials. Compared to other colours, using green gillnets in this fishery increased catches. On average, green gillnets were 74% (CI: 30.91-126.29%) more effective than transparent gillnets. When comparing the catch efficiency of the green gillnets to that of the blue netting, the catch efficiency increased by 81.25%. (CI: 45.77-127.67). These results demonstrate that in the specific fishery, gillnet colour has a significant impact on the catch efficiency and the results are discussed in the manuscript.

Assessment of gear damage by dolphin in small scale gillnet fishery of Southwest coast of India (ID 36)

Rithin Joseph[1], Dhiju Das P.H[1], Leela Edwin[1]

[1]*ICAR-Central Institute of Fisheries Technology, CIFT Road Matsyapuri, Willingdon Island, Kochi, Kerala, India 682029, josephrithin@gmail.com*

Cetacean interaction with fishing gear has been reported widely around the world. Depredation caused by interaction and damage caused to the gear results in financial loss to the fishers. In India, interaction by Indo-pacific humpback dolphin (Sousa chinensis), spinner dolphin (*Stenella longirostris*), long beaked common dolphin (*Delphinus capensis*) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) has been reported. An experiment was conducted for a period of one year to assess the loss/ damage and effectiveness of acoustic pingers in warding off dolphins. Four commercial gillnets of 700 – 900 m length with the mesh size of 30-50 mm made of nylon monofilament were selected for the study and one of these was equipped with acoustic pingers. The pingers were placed at a distance of 200 – 250 m approximately on the head rope of the selected gillnet. The damage to the gears were assessed on the basis of the number of tears/ holes caused during dolphin attack. When the gear was roughly apportioned to three horizontal

sections, it is observed that 41% of the total tears/ holes were identified on lower portion of the nets followed by 37% in middle portion and 22% in upper portion. The average quantity of net discarded was 50 kg for non-pinger gear and 10 kg for pinger assisted gear respectively. During the initial stages of the experiment pingers showed absolute deterrence of cetaceans, but after three months the same units started reporting attack of dolphins. In the present study it is evidenced that the pingers are effective in reducing dolphin gear interaction but long-term exposure to pingers can possibly result in habituation of dolphins to pinger signals. No dolphin entanglement in gears is observed during the entire period of study.

Artisanal lobster gillnet fisheries along Maharashtra coast: A sustainability perspective (ID 130)

Santosh N Bhendekar[1]*, Anulekshmi C.[1], Ajay D Nakhawa[1], Akhilesh K. V[1], Ratheesh Kumar R[1], Sunil Ail[1], Vaibhav Mhatre1, Thakurdas[1], and P Laxmilatha[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Ernakulam North, P.O., Kochi-682 018, Kerala, India, santucofs@gmail.com*

Lobsters are one of the highly priced and important export commodity in India. India is one among the top five lobster exporting countries of world with destinations to USA, China, Hong Kong, UAE. Lobster fishery of India still remains as a small scale sector where the estimated annual landing in 2021 was 1215 tonnes. Maharashtra coast particularly northern coast is rich in lobster resources and is a major contributor in lobster landing of India (~12%). Artisanal fishing with monofilament polyamide bottom set gillnets (locally named “Shevandi jal”) in rocky area to capture the mud spiny lobster Panulirus polyphagus is a common in coastal region of Maharashtra. It supports artisanal small scale fishers. The study aims to understand the extent of lobster fishing grounds along coastal region, mapping of habitual lobster fishing ground on GIS platform, gill net landing assessment of Panulirus polyphagus and organized market chain in lobster fisheries. The targeted mud spiny lobster fishery is carried out in rocky area near coastal fishing villages. Most of the fishing grounds were located at distance of 8-12 km from fishing villages at depths 6-10 m. The single cylinder boats of OAL 8-12 feet carry 20-25 gill net pieces and soak it for 20 to 24 hours. The mesh size varies from 40-50 mm. The nets last for 10-12 operations as gill net shot in rocky and rough seabed areas. The fishing season for mud spiny lobster start during mid October-November and last up to May. The lobster market and supply chain in coastal villages of Maharashtra is in unique nature. The price is decided on weight of lobster with four weight grade and will not change with glut and lean landing across the season. The bigger individual (>200 g) get higher prices which prevent overexploitation juveniles/small sized individual. The use of larger mesh sized gill nets can help the fishers to stick to the minimum legal size (MLS) of the resources which supports the fishery. The fishers are also reluctant to catch small size lobster as it will not fetch high price in market.

Artisanal lobster fisheries can guarantee a constant seasonal income thus uplifting livelihood of fishing community in coastal villages of Maharashtra. The trends towards the fishing gear diversification, inter-sectoral conflicts, coastal developmental activities, etc. are challenges in near future. The level of sustainability of artisanal lobster fisheries with bottom set gill net is still quite good, but it needs to be regulated by restrictions on fishing efforts during peak breeding season of mud spiny lobster, implementing minimum legal size and market-based incentive scheme to reduce the market demand for juvenile/ small size lobsters.

Keywords: Mud spiny lobster, Gill net, Sustainability, GIS, Livelihood, Maharashtra.

Optimization of 'J' hook number on the catching efficiency of Carangids in the Gulf of Mannar, India. (ID 9)

Vinayagamoorthy Naganandhini[1], Kalaiarasan Muthupandi[2]*, Kathavarayan Vasanth[3], Neethirajan Neethiselvan[4], Pandurangan Padmavathy[5], Kalidoss Radhakrishnan[6]

[1]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, naganandhiniv31@gmail.com*

[2]*Directorate of Incubation and Vocational Training for Fisheries, Ramanathapuram, Tamil Nadu, India, kalaiarasan@tnfu.ac.in*

[3]*Department of Fishing Technology, Kerala University of Fisheries and Ocean Studies, Kochi – 682 506, Kerala, India. kvasanthkvasanth29122@gmail.com*

[4]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, neethiselvan@tnfu.ac.in*

[5]*Department of Aquatic Environment and Management, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, padmavathy@tnfu.ac.in*

[6]*Department of Fisheries Extension, Economics and Statistics, ICAR-Central Institute of Fisheries Education, Mumbai – 400 061, Maharashtra, India, theradhakrishnank@gmail.com*

The efficiency of different 'J' hooks No 7, 8, and 9 in carangid longline fishing gears were studied from January to August 2022. As revealed through the hooking rate, the highest percentage of contribution in terms of number was observed for *Alectis indicus* (35.6%), *Caranx ignobilis* (23.3%), *C. hippos* (17.0%), *Scomberoides commersonnianus* (13.8%) and *Megalaspis cordyla* (10.3%). However, an increased percentage contribution when the catch composition was expressed as basis of weight instead number for *Caranx ignobilis* (35.2%) was dominated followed by *Alectis indicus* (33.7%), *C. hippos* (11.5 %), *Scomberoides commersonnianus* (10.9%) and *Megalaspis cordyla* (8.8%) The result appeared that, using hook 8, the highest percentage compositions of the carangids was 40.9% followed by hook No 9 and hook No 7 were 33.5% and 25.6% in terms of number basis. Further, in terms of weight basis, hook No 8 ranked first (43.5%) among the three hook numbers. Considering catch rates, the overall CPUE (individual/1000 hooks) of hook No 8 was 4.31 higher than that of hooks 7 and 9. Among the three hook number, the overall performance of 'hook No 8' was found to be better than other hook No 7 and hook No 9 in terms of higher catch efficiency and CPUE for carangids.

Monofilament Long line: An effective fishing gear alternative to multifilament long line (ID 96)

Harshavardhan D. Joshi[1], Ashok S. Kadam[1]

[1]*Mumbai base of Fishery Survey of India, Sassoon Dock, Colaba, Mumbai-400005, harshjoshicofsn@gmail.com*

Fishing gear is a special device or structure which is mainly prepared to catch the special type of fish in special habitat. Long line, it is mainly used to catch oceanic fishes mainly high in weight and having migration behaviour. Long line is a special passive gear which is having main line (may be more than 30 Km in commercial fishing) and various branch line (length of branch line depends upon thermocline temperature). Fishery Survey of India having four long line survey and research vessels in which two vessels namely Matsya Vrushti and Matsya Drushti are monofilament longliner and Blue Marline and Yellow Fin are multifilament long liner. In this study, critical issues on long line of the world are re-assessed with specific reference to the long line fishing industry. The adaptability, selectivity and seasonality of both monofilament and

multifilament long line fishing gears to deep sea, fish species and stretch of the year are re-scrutinized. Furthermore, new innovations in Multifilament and Monofilament are required to improve the effectiveness of gears and thus the long line fishery is expressed in the light of speedy socioeconomic variations within the fishery industry.

Oceanic tuna longline survey in Lakshadweep Islands: a hotspot for large pelagics – prerequisite to gear selectivity for mitigating shark bycatch (ID 132)

Raju S Nagpure[1], Nashad M[1], Ramachandran S[1]*, Pradeep H. D[1], Unnikrishnan N[1], Jeyabaskaran R[2]

[1]*Fishery Survey of India, Mormugao Zonal Base, Opp. Microwave station, Bogda road, Mormugao, Goa, India*

[2]*Fishery Survey of India (Headquarters), 2nd Floor, Plot No.2A, Unit No.12, New Fishing Harbour, Sassoon Dock, Colaba, Mumbai, Maharashtra*

**Corresponding author: marineramc1974@gmail.com*

Fishery Survey of India undertook Oceanic Fishery Resources survey in Lakshadweep waters during the period from 2015-2021 using conventional long line gear which were analysed and presented in this paper. Lakshadweep Islands are depending on the skipjack tuna resources for its economy as well as the dwellers lively hood which were exploited by traditional ecofriendly pole and line fishing methods. The annual landings of skipjack resources have been highly fluctuating over the years, which start from 12,516t in 2015 and to 19,444t in 2019; it reached all-time high of 24,923t during 2018. However, the other economically important fishery resources such as large pelagic, mesopelagic fishes and oceanic squids are still exists untapped in the Lakshadweep waters. The survey results of multifilament long line gear operated by the survey vessel MFV Yellow Fin during 2015-2022 revealed that Lakshadweep waters are comparatively higher potential area (1.0-1.7 % hooking rate) in the west coast of India for oceanic fishery resources such as sword fish (*Xiphias gladius*), Yellowfin tuna (*Thunnus albacares*), Indo- pacific sail fin (*Istiophorus platypterus*), Pelagic thresher shark (*Alopias pelagicus),* Bigeye thresher shark (*Alopias supersiliosus*), Silky shark (*Carcharhinus falciformis)*, Oceanic whitetip shark (*Carcharhinus longimanus*), Scalloped hammerhead shark (*Sphyrna lewini*), Common dolphin fish (*Coryphaena hippurus*) and other species of marlins.

The oceanic survey vessel MFV Yellow Fin, a multi filament long liner attached to Mormugao Base of Fishery Survey of India has carried out exploratory fishery survey during the period 2015-2021 along Lat. 08ºN to 13ºN (Lakshadweep waters) above the depth of 1000m to study the Oceanic resources like tunas, swordfishes, sailfishes, marlins, sharks etc. by experimenting diversified fishing method called multifilament tuna long line using "J" hook of 3.6sun in order to back up the livelihood of Island fishermen as an alternative to pole and line fishing. Average aggregate hooking rate during the study varied between 0.15% – 0.56%. Sharks were the major bycatch recorded during the study; they were predominant during the pre-monsoon period like April 2019 (68% of the total large pelagic caught) and March 2019 (66.6%) respectively. Present study revealed that sharks are highly vulnerable to "J" shaped tuna hook used in multifilament long line survey, while comparing with the data on circle hook experimented in sister vessel attached to Fishery survey of India in the same coast. Further studies using various hooks are in essential to understand the mitigation measures to be adopted to reduce the shark bycatch from this niche will be discussed. In addition, FSI has mapped fishing ground for Oceanic purple squid, Stenotheuthis oualaniensis in and around Lakshadweep group of Islands which are also an alternative to tuna fishery. Mapping and dissemination of these new fishery resources will encourage the fishers of Lakshadweep to diversify their fishing practices, which minimize fishing pressure on skipjack tuna and leads to sustainable fishery in Islands.

Keywords: Lakshadweep Islands, Tuna longline, MFV Yellow Fin, Mapping, J hook, Oceanic purple squid, bycatch

Effect of hook size and baits on the catch efficiency of demersal longlines of Thoothukudi coast, Southeast coast of India (ID 137)

Thangaraji Ravikumar[1], Neethirajan Neethiselvan[1], Sangaralingam Mariappan[1], Arjunan Karthy[1]

[1]*Tamil Nadu Dr.J.Jayalalithaa Fisheries University, FC&RI, Thoothukudi, ravikumar@tnfu.ac.in*

A survey was undertaken to analyze the effect of two different hook sizes of 'J' hook such as Hook No 13 and Hook No 14 with two different bait viz., Sardines and Squids in the commercial longline fishery of Thoothukudi. The group wise percentage composition revealed that Lethrinids contributed highest to the catch irrespective of the hook sizes. Regarding species wise contribution, the fishery was found constituted by 37 species under 10 fish groups. Further, the study revealed significant difference in catch per unit effort (CPUE) both with respect to hook sizes and baits($p<0.05$). The CPUE found to be higher for longlining with squid bait than that with sardines as baits. Out of the two baits studied, squid bait (12.02%) showed better performance over sardine bait (10.02%) in terms of hooking rate. The estimated hooking rate of longline lines baited with squids and sardines in hook No 14 were 12.62% and 10.65% respectively and in the case of hook No 13, the respective hooking rates were 11.41% and 9.39%. A overall hooking rate of 11.64% was observed for hook No 14 while it was 10.40% for hook No.13 indicating higher hooking rate for smaller hook. However, a reverse phenomenon was observed with respect to CPUE. The overall CPUE in terms of weight for hook No.14 was 3.68kg/100 hooks/soaking whereas for hook No.13 was 4.18 kg/100 hooks/soaking. It could be observed that as the hook size increased the CPUE increased indicating the fact that larger hook (Hook No.13) captured fishes of higher weight than smaller hook (Hook No.14).

Design and operational characteristics influence the catch rate in longline: Evidence from Pulicat Region, India (ID 100)

R. Velmurugan[1], M.Kalaiarasan[2], D.Arun Jenish[1], V. Durai Varatharajan[3]

[1]*Dr. MGR Fisheries College and Research Institute, Ponneri, Tamil Nadu 601204, rvelmurugan@tnfu.ac.in*

[2]*Directorate of Incubation and Vocational Training in Fisheries, Ramanathapuram, 623 519*

[3]*Dr.M.G.R. Fisheries College and Research Institute, Thalainayar, Tamil Nadu 614712*

Pulicat Coast is in Tamil Nadu, which is a species-rich aquatic habitat and provides livelihood to fishers. Fast-moving high-value fish have been reaped in particular longlines. Therefore, the present study aimed to document the design and operational details with respective catch data in Pulicat Coast, from January to December 2020. The results of the study manifested that there were three types of longlines namely seer fish, snapper, and tuna operated that were classified based on the depth of operation. We also noticed that there were considerable differences in the mainline, branch line, depth of operation, and number of branches. The catch rate was greater in yellowfin tuna than in the other two species. Interestingly, snapper longline catch was 10-fold higher (100 kg operation-1) compared to seer fish longline (10 kg operation-1). The weight, number of fish caught, and market price did not differ statistically ($P>0.05$) among the studied areas of longline whereas a significant ($P<0.05$) difference was observed for the monthly catch rate. No significant differences were observed in weight, the number of fish caught, and market price

between the gillnet and longline. Data from the present study suggest that longline design and operational details are significantly influenced the catch rate in the Pulicat Coast.

Initiatives to scale up the sustainable pole and line tuna fishing in Lakshadweep (ID 142)

Mini Sekharan.N[1]

[1]*School of Industrial Fisheries, Cochin University of Science and Technology, Kochi, Kerala, India, minisekharan@cusat.ac.in*

In India, sustainable pole and line fishing for the capture of skipjack tuna (Katsuwonus pelamis) is practised only in Lakshadweep Island (FAO 51) in alignment with SDG. This selective tuna harvesting method target skipjack tuna specifically and has no by catch and low impact on environment. Pole and line harvested tuna is of high quality and safety and have a good demand in global markets and fetch a premium price. Customers demand information on transparency of seafood from ocean to plate for ensuring standard safety and quality. Therefore, traceability has to be set right from the primary link in tuna supply chain i.e. the pole and line fishing to the end consumer. The paper tries to analyse the initiatives needed to scale up the pole and line fishing sector in Lakshadweep through an exploratory survey of tuna fishers and focus group interviews with the stakeholders in Lakshadweep. Tuna fishing in Lakshadweep is characterized by the small vessels <15 m operating live bait-pole and line with limited facilities for fish storage and multiday fishing. Well equipped mechanized live bait pole-and-line vessels are needed to capture tuna in good quality. Vessels must be equipped with on- board chilling facilities using RSW (Refrigerated seawater) or CSW (Chilled Sea Water) and other onboard preservation equipment. Possibility to commission larger vessels for multiday fish collection motherships/factory vessels or freezer vessels with on board pre-processing and storage and preservation facilities need to be analysed. The sector needs enhancing of infrastructure facilities and organising of the fragmented value chain to cater highest grade tuna to the national and international markets. Sustainability certifications are gaining importance in international marketing and aim at sustainability of a fishery and therefore Lakshadweep pole and line skipjack tuna fishery completed the pre-assessment for sustainability and FIP (Fishery improvement projects) for obtaining sustainability certification of Marine Stewardship Council Certification (MSC). Full certification of MSC has to be taken forward at the earliest to kick start the exports of pole and live tuna from India. Some implications for fisheries management and sustainability certifications in Lakshadweep are ecological issues behind the removal of lower trophic level baitfish species, Fish Aggregation Devices (FAD) and implementation of harvest control strategies for the tuna stock. A Strategic management plan has to be designed for responsible management of Lakshadweep pole and line tuna fisheries system which integrate technologies for tuna harvest, post harvest, utilisation and processing, supply chain coordination, livelihood empowerment, capacity building of fishers and value chain players on best management practises for sustainable fisheries management and marketing, communication and digitalisation.

3.4 Session 4: Indicator

A holistic approach in trawl selectivity that account for the full species community in the catches - a Mediterranean case study (ID 107)

Andrea Petetta[1,2*]; Bent Herrmann[3,4,5]; Daniel Li Veli[2]; Massimo Virgili[2]; Rocco De Marco[2], Alessandro Lucchetti[2]

[1]*Department of Biological, Geological and Environmental Sciences (BIGEA), University of Bologna (UNIBO), Piazza di Porta San Donato 1, 40126, Bologna, Italy, andrea.petetta@irbim.cnr.it*

[2]*Institute for Biological Resources and Marine Biotechnologies (IRBIM), National Research Council (CNR), Largo Fiera della Pesca 1, 60125, Ancona, Italy, andrea.petetta@irbim.cnr.it*

[3]*The Arctic University of Norway UIT, Hansine Hansens veg 18, 9019, Tromsø, Norway*

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

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

Bottom trawl fisheries target species that often inhabit areas occupied by a wide range of other species (multi-species fisheries). However, most studies addressing selectivity and catch performance of a specific trawl usually focus on a few commercially important or most vulnerable species requiring management measures. This traditional approach leads to neglecting large fractions of the catch when evaluating the ecological impact of the specific fishing gear. By contrast, the present study considers the multispecies nature of Mediterranean bottom trawl fisheries by accounting, through a holistic approach, for the full species community in the catches. In particular, we evaluated and compared the catch performance of the two legal codends for this fishery, made of 40 mm square (SM40) and 50 mm diamond (DM50) meshes. We included in the analysis all the animals being caught intentionally or unintentionally and being both landed or discarded, and determined if there were changes in the catch profiles, in terms of species composition and dominance, when shifting from one codend to another. Regardless of the codend used, results showed that 50 and 80% of the catch in weight and in count numbers, respectively, consisted of species without commercial value, highlighting the high impact exerted by this fishing gear on the benthic community and demonstrating that large proportions of the catch are not considered when using the existing approaches to evaluate its ecological impact. Significant differences in catch profiles between the two codends were observed, especially for two commercial flatfish species, Arnoglossus laterna and Citharus linguatula, which had a larger dominance in the SM40 catches. Further, the SM40 codend had a significantly higher retention, compared to DM50 codend, for specific sizes of Merluccius merluccius and Mullus barbatus. Both legal codends were insufficiently size selective for M. merluccius. The methodology here described can contribute to assess the viability of a technical solution or modification, by evaluating more in-depth its overall impact and comparing the catches obtained with it to those obtained with traditional gears from a species community perspective.

Back to the future: revisiting fishing technologies to address current by-catch problems in the North Sea shrimp fishery. (ID 156)

Juan Santos[1], Daniel Stepputtis[1*], Uwe Lichtenstein[1], Frederik Furkert[1], Mathis Mahler[1], Thomas Noack[1]

[1]*Thünen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, Rostock, 18069; Germany, juan.santos@thuenen.de, daniel.stepputtis@thuenen.de*

The brown shrimp (*Crangon crangon*) beam-trawl fishery is one of the most important North-Sea coastal fisheries, supporting an international fleet of more than 500 vessels. One recurrent issue in the fishery is the bycatch of unwanted fish species, as consequence of the small-mesh codends that are used to efficiently capture the targeted shrimp. This bycatch issue has been extensively addressed in the past by the development of bycatch reduction devices (BRD) aiming at providing escape possibilities to fish species before entering the codend. As a result of those efforts, fishers are obliged to mount either sieve-nets or sorting grids in their nets. However, while sieve nets and sorting grids can effectively reduce the bycatch of medium and large fish, none of them deliver an optimal species separation. Moreover, the performance of these devices can be largely affected by spatio-temporal variations of fishing grounds conditions, e.g. benthos material entering the trawl and clogging their selection surface. The latter is an issue of increasing concern

in the German fishery, especially during the summer season, when the presence of high densities of suspended sea-grass in estuarine fishing grounds are encountered by the trawls. Therefore, there is a need to develop effective Bycatch-reduction technologies to address today's fisheries challenges. This study tested the catch efficiency of the mandatory sieve-net and housed-elliptic sorting grid devices, and two device concepts as alternatives i) a simplified, rectangular grid design developed in the English fishery, and the letterbox device developed in the Dutch fishery. Results obtained from a paired-gear experiment conducted in German fishing grounds revealed that ~95% of the marketable shrimps (total length ≥ 50 mm) available for the trawl ended in the codend when the sieve net was used. Fishing with the traditional housed-elliptic sorting grid was impractical due to clogging problems, leading to a catch efficiency for the target shrimp of less than ~50%. In contrast, the simplified rectangular grid and the letterbox did not suffer clogging-related issues, delivering a catch efficiency for marketable shrimp of ~75%. Altogether, the rectangular grid delivered the best bycatch-reduction performance with catch efficiency below 50% for the quoted species plaice and whiting. The study reveals the potential of alternative BRD to address today's bycatch and practical issues in the fishery and paths for further development of the tested devices.

Optimizing the prediction of discard survival of bottom-trawled plaice based on vitality indicators (ID 141)

Sven Sebastian Uhlmann[1,2,3,4], Bart Ampe[1], Junita Karlsen[4], Esther Savina[4]

[1]*Fisheries and Aquatic Production, Animal Sciences Unit, Institute of Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium,* bart.ampe@ilvo.vlaanderen.be

[2]*Marine Institute, Rinville, Co., Galway H91 R673, Ireland*

[3]*Vrije Universiteit Brussel (VUB), Brussels, Belgium,* sven.sebastian.uhlmann@vub.be

[4]*Technical University of Denmark, National Institute of Aquatic Resources, North Sea Science Park, PO Box 101, DK-9850 Hirtshals, Denmark,* juka@aqua.dtu.dk , esav@aqua.dtu.dk

Routine, at-sea observations of an organism's vitality (responsiveness, vigor, and visible condition) are needed to address management policies related to post-release fate (i.e., discard survival), as well as growing welfare concerns. An animal's involuntary motor responses to external stimuli (i.e., reflexes), external physical condition (i.e., injury) and vigor of movements (i.e., activity) upon capture can be rapidly collected after immediate capture impact. This has been a common approach to integrate the effects of multiple stressors a fish experiences during fishing. Using vitality scores or aggregated indices (e.g., a simple proportion: mean score of impaired reflexes and present injury or sum of impaired reflex and present injury scores divided by the total number of tested reflexes and injury types, R&I index) does not always allow for accurate predictions of post-release survival. One reason could be that due to collapsing individual reflex and injury scores into a single index, any differential contributions (or loadings) of individual reflexes/injuries to observed mortality events are not accounted for. To test whether some reflexes and injuries may be more relevant over others in contributing to survival, in this study, the performance of suitable optimization functions was evaluated to optimize the loadings of individual reflex and injury attributes (either at individual or aggregated at trip level), and compared with conventional vitality proxy indicators (i.e., the original R&I index; number of absent reflexes; number of present injuries; number of absent reflexes and present injuries; categorical vitality index; reflexes and injuries as individual covariates ; and only the environmental variables). The proposed method was tested by using two datasets of bottom-trawl-caught plaice collected following a harmonized protocol in Belgium and Denmark. From 14 and 3 commercial fishing trips, and 51 and 18 gear deployments of Belgian beam- and Danish otter trawlers, respectively, in total, 736 and 386 undersized plaice (~ 23 cm TL) were assessed for vitality and delayed survival from the monitored trips in Belgium and Denmark, respectively. Alive individuals were sampled and monitored for their post-capture fate by being held in captivity until fishing-capture related mortality events were not observed for at least three days. It was difficult to predict either the average (per trip) survival probability of a group of fish (i.e., those discarded per trip) or that of individual fish without ancillary information about capture (environmental) conditions. Knowing what kind of gear was used and the temperature at the fishing depth was needed to improve predictions based on vitality information, and much more so than optimizing the loadings of individual reflex/injury attributes. Hemorrhages around the head region constituted the single most relevant predictor, whereas point bleeding injury assessments were redundant to score. A categorical vitality index provided a viable alternative to the more labour-intensive, scoring method of reflex responsiveness.

Keywords: Catch welfare; Landing Obligation; Reflex Action Mortality Predictor (RAMP); Indicator optimization.

3.5 Session 5: ALDFG

Introduction of the Global ALDFG Survey (ID 117)

Haraldur A. Einarsson[1], Eric Gilman[1], Kelsey Richardson[1], and Amparo Perez Roda[1]

[1]*Food and Agriculture Organization of the United Nations (FAO); Fisheries Division, Fishing technology and operations team (NFIFO), http://www.fao.org/responsible-fishing/ , Viale delle Terme di Caracalla, 00153, Rome, Italy. haraldur.einarsson@fao.org*

Abandoned, lost or otherwise discarded fishing gear (ALDFG) is of increasing concern due to its numerous adverse environmental and economic impacts, including navigational hazards and associated safety issues. Some approaches to estimating total marine debris from world fisheries are published but often focus on a few regions or limited data collection without synchronisation between studies. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) Working Group 43 report on Sea-based sources of marine plastic litter advises updating global ALDFG estimates and identifying data gaps. The FAO Fishing Technology and Operations team (NFIFO) have organised a global survey to collect data from fishers' knowledge and experiences within their fisheries around ALDFG amounts, sources, causes and prevention measures. The ALDFG global survey comprises nine almost identical questionnaires adapted to unique characteristics of different gear types; surrounding nets, seine nets, trawls, dredges, lift nets, falling gear, gillnets, traps, and hooks and lines. While the target group for these surveys are the world's fishers, the surveys focus on oceanic fisheries (i.e., aquaculture or inland fisheries are currently excluded). Survey sample sizes are adapted to achieve the lowest possible uncertainty levels, with confidence levels at or near 90%. These sample sizes are typically achieved by surveying around 120 fishers per gear type for fisheries with more than 500 vessels operating using the given gear type. After the surveyor has entered all respondents' answers for a provided questionnaire into the FAO global ALDFG database, the FAO team generates a summary report from the survey responses to validate the data, followed by a country report with the main results and possible recommendations. These reports are only available for the cooperating parties, and FAO will not publish single-country outcomes. This presentation will summarise the ALDFG Global survey structure and identify how collaborators will benefit from joining these project efforts and collecting this data within their fisheries. The presentation also presents some questions to the audience and provides a summary of approaches to interpreting the outcomes of these questions.

Understanding fishing gear marking systems (ID 129)

Amparo Perez Roda[1], Jon Lansley[1]

[1] *Food and Agriculture Organization of the United Nations (FAO); Fisheries Division, Fishing Operations and Technology Branch, Viale delle Terme di Caracalla, 00153, Rome, Italy. amparo.perezroda@fao.org*

The Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) are a tool to contribute to sustainable fisheries, to improve the state of the marine environment, and to enhance safety at sea by combatting, minimizing and eliminating abandoned, lost or otherwise discarded fishing gear (ALDFG) and facilitating the identification and recovery of such gear. The Guidelines assist fisheries management and can be used as a tool in the identification of illegal, unreported and unregulated (IUU) fishing activities. The Guidelines address the implementation of a gear marking system and its associated components, including reporting, recovery and disposal of ALDFG or unwanted fishing gear and commercial traceability of fishing gear. The VGMFG were designed to assist States in meeting their obligations under international law, including relevant international agreements and related governance frameworks and the specific requirements for gear marking contained in FAO's Code of Conduct for Responsible Fisheries.

The proposed presentation will provide the audience with an overview of the elements needed to develop and implement effective fishing gear marking system as the main mechanism to prevent, reduce and eliminate ALDFG. The presentation will also inform of the knowledge products and tools produced by FAO to support its implementation: guide on how to legislate fishing gear marking systems, the gear marking manual, a risk assessment framework, a guideline document on "Operationalization of FAO Voluntary Guidelines for the Marking of Fishing Gear in the IOTC Area of Competence",etc.

Knowledge Base on ALDFG and Ghost Fishing in India (ID 80)

Saly N Thomas[1]

[1] *ICAR-Central Institute of Fisheries Technology, Cochin, India, salynthomas@gmail.com*

Abandoned, lost or otherwise discarded fishing gear (ALDFG) constitute a key component of the marine plastic pollution today. While quantity wise, it contributes around 10% of marine plastic debris, the negative impacts are wider. There is wide knowledge gap on ALDFG related aspects from different geographic areas especially from Africa, Asia, South America and Antarctica.

The intensity of the problem is greater for India, having a long coastline of 7516 kms, harbours/fish landing sites numbering around1500, and a total of 251969 fishing vessels in operation as of 2022. The key contributors to ALDFG, the wide spread use of nylon monofilament netting and lines of a short life, apart from the intensity of the gear deployed and the multiplicity of gears operated across jurisdictional boundaries. Lack of regulatory measures across the country is a matter of concern, besides lack of in-depth studies and inadequate knowledge base. Under beach litter surveys conducted by different organizations since 2007, fisheries have been identified as a primary source of litter on the Indian coast. The first quantitative assessment on contribution of fishing related debris (FRD) was made during 2017-18, by systematically analysing the beach litter across 25 beaches of Kerala over a year. This study indicated FRD contribution to the total debris at 36% while that to the plastic debris at 48%.

The first systematic study on ALDFG undertaken in 2017 by ICAR-CIFT confining to gillnet and trammel net sectors covering four States, exposed the severity of the problem. This study based on fishers' perception estimated ALDFG contributing to 29% of the total gear used per vessel annually in selected gillnet sectors. The magnitude of the problem gets exacerbated against the intensity of vessels and gears in the country. Operational pressures and spatial pressures along with lack of proper collection facilities at the harbours/landing sites magnify the problem. Underwater investigations by CIFT during 2018-2020, through scuba diving, retrieved about 33 kg lost gears settled on trap fishing ground at Enayam, Tamil Nadu by scanning 700 m2 of sea bottom.

The pioneering study by ICAR-CIFT in 2018, assessed the ghost fishing capacity of lost gears. Ghost fishing efficiency of purposefully lost shrimp gillnets in the backwaters indicated that in calm weather, the ghost nets continue to have the fishing capacity upto 53 days while in turbulent weather, it was upto 14 days only and the catch rate reduced to 3.6 - 4.2% of the initial catch rate. Trials (obstructed by COVID 19 pandemic) on mitigation of ghost fishing by derelict fish traps through timed release mechanism (TRM) incorporated with natural fibres and metal wires showed that TRM based on jute fibre became effective after 45 days exposure in sea while that based on aluminium wire after 53 days.

Retrieval and removal of lost nets, is a method to address ALDFG and ghost fishing. NGOs and Coastal community voluntary organisations such as Friends of the Sea, Temple Adventures etc have been conducting ghost net removal/ Marine Debris Clean-up programmes with support from different Organizations and Volunteers. Under Suchitva Sagaram ("clean ocean") project in Kerala, trawl operators collect plastic during trawling operations and is recycled. Govt of India conducted a 75-day long cleanliness campaign named Swachch Sagar, Surakshit Sagar ("Clean coast safe sea") in July 2022, through which 75 beaches all across the country's coastline were cleaned.

ALDFG related research is yet to take off in India. The areas with research potential are, finding out the hotspot areas and fishing sectors of origin. Management of fishing operations and gear-based interventions including gear marking are researchable problems. Regulatory policies also need close examination and analysis.

Assessment of ALDFG from selected marine gillnet and trap fishing sectors of India (ID 37)

Saly N Thomas[1], Sandhya K M[1]

[1] *ICAR-Central Institute of Fisheries Technology, Cochin, India, sandhyafrm@gmail.com*

Abandoned, lost or otherwise discarded fishing gears (ALDFG) is a growing issue of global concern due to its deleterious impacts on target and non-target species in marine systems. ALDFG causes "ghost fishing", as lost fishing gears continue to function even after they are left in water leading to death of marine mammals, seabirds, turtles and fishes through entanglement, ingestion etc. Knowledge concerning ALDFG is scanty from Indian waters. Few scattered reports on lost nets washed on seashores and retrieved are available from India. Over the years, Indian marine fisheries sector has shown significant growth with regard to size of the gear. For example, the gillnet sector during the last one decade has switched over from small- scale to large-scale, by increasing the length of net from 2500 m to more than 15000 meter and height from 7 to 18 meters. Deployment of very long nets and widespread use of polyamide (nylon) monofilament which lasts for less than a year create greater chances of gear loss and consequent ghost fishing in Indian waters. Hence, a study has been undertaken to estimate the fishing gear loss rate in the small-scale gillnet sector in Chellanam, Puthuvypu and Arthunkal areas in Kerala and in the trap fishing sites in Enayam coast of Tamil Nadu. The evidences for occurrence of ALDFG also were assessed. Average gillnet loss varied from 4-10 kg/year/vessel and trap loss was 10- 12 traps/year/vessel. The main reasons identified from fishers for gillnet loss were operational pressure (bottom obstacles, bad weather/season, loss of gear components, strong currents) followed by spatial pressure (gear conflicts, collision with ships/ vessel). The reasons identified for trap loss were operational pressure mainly bad weather/season, current/ tides and spatial pressure mainly vandalism/ theft and gear conflicts. About six types of lost fishing gears/gear parts were retrieved from the trap fishing ground at Enayam by scanning an area of 700m2 of seabottom by scuba diving. The retrieved gears included nylon monofilament netting panels, traps, pieces of trawl codends, pieces of monofilament lines, ropes and squid jigs. Nylon monofilament gillnet panels (47.3%) were the predominant gear types. This baseline information generated from the present study, the first kind of it in India, is a pointer to the scale and distribution of ALDFG in Indian seas and to the need for identification of the hotspot areas of gear losses.

Gear modifications to reduce ghostfishing in small-scale Brazilian lobster trap, Indonesian crab pot and Kenyan gillnet fisheries (ID 153)

Kelsey Richardson[1], Amparo Perez Roda[1], Eric Okuku[2], Mochammad Riyanto[3], Vanildo Souza de Oliveira[4]

[1]Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00153, Rome, Italy. Kelsey.Richardson@fao.org

[2]Kenya Marine and Fisheries Research Institute

[3]Bogor Agricultural University

[4]Universidade Federal Rural de Pernambuco

The GloLitter Partnerships project aims to prevent, reduce and mitigate impacts from sea-based sources of marine plastic litter (SBMPL) from the shipping and fisheries sectors in developing countries around the world. As part of this project, the Food and Agriculture Organization of the United Nations (FAO) is supporting pilot studies in Brazilian lobster trap, Indonesian crab pot and Kenyan gillnet fisheries that modify small-scale artisanal gears to reduce ghostfishing impacts when these gears are lost, discarded or abandoned to the marine environment. Each pilot study is led by researchers at local and national Universities and research institutions who collaborate directly with artisanal fishers and relevant fisheries authorities to trial the gears and communicate results. This presentation will highlight key findings from these gear modification trials including a comparison of costs and benefits of employing the modified gears and trade-offs with the traditional gears. The presentation will also discuss how community uptake of the modified gears is achieved both from the fishers themselves as well as support engaged from local and national fishery managers.

Background study on fishing gear recycling (ID 159)

Antonello Sala[1], Kelsey Richardson[1]

[1] Food and Agriculture Organization of the United Nations (FAO); Fisheries Division, Fishing technology and operations team (NFIFO), http://www.fao.org/responsible-fishing/ , Viale delle Terme di Caracalla, 00153, Rome, Italy. antonello.sala@fao.org

The Food and Agriculture Organization of the United Nations (FAO) through its collaborative GloLitter Partnerships project supported the development of a Background study on fishing gear recycling to examine recycling options as possible effective interventions to prevent and reduce marine plastic litter from the fishing sector. This study provides an overview of the technical feasibility of current fishing gear recycling practices and mechanisms, with a special emphasis on end-of-life fishing gear (EOLFG) and retrieved abandoned, lost or otherwise discarded fishing gear (ALDFG). Technologies summarized include primary (reuse), secondary (mechanical), tertiary (thermochemical), and quaternary (energy recovery) recycling processes. The background study highlights the need for a combination of circular economy and Extended Producer Responsibility (EPR) principles to be applied to the full suite of primary to quaternary recycling processes to responsibly manage EOLFG and recovered ALDFG. These interventions should be aimed at all levels of the fisheries sector and tailored to the requirements and capacities of each country. Although recycling is essential, it is not a viable stand-alone solution to the global marine litter crisis. Product circularity must be considered while designing more effective fishing gear management systems, materials, and products. Additionally, socioeconomic incentives are required to promote the selection of renewable alternative materials (i.e., more recyclable or non-plastic materials) in the design, manufacture and assembly of fishing gears, as well as to promote fishing gear reuse and repair options. The report's collected information of best practices and case studies of fishing gear recycling provide illustrative practical examples to be more widely applied. In some cases, the good practices highlighted by the report are enforceable by legislation, in other situations, the case studies presented may be adopted by the public or private sector to improve waste management and reduce the flow of marine plastic litter to the marine environment.

Smart acoustic solution for tagging fishing gears and objects underwater (PingMe) (ID 166)

Ulf Lundvall[1]

[1] *Ocean Space Acoustics, Trondheim, Norway, ulflundvall@gmail.com , ulf@osac.no*

Three hundred kilometres of ghost-fishing gillnets were retrieved by the authorities from the Barents Sea last year. With PingMe, a lot more of the gear would have been located and identified by the fisherman himself, and removed much earlier. PingMe is patented and consists of three units:

1) PingMe transponder: A smart, small device attached to gear / objects you want identified and located underwater.

2) PingMe Software: A software module integrated in the boat's existing sonar system or as a stand-alone system. The software allows communication with the transponder to determine location and ID.

3) PingMe Service in the cloud: A management tool for the authorities. Information of lost, detected and retrieved gear is reported to the cloud, some of it automatically. This enables the authorities to keep better control of litter in the ocean, which might come in conflicts with other boats or fisheries.

The transponder is passive and reflects the sound waves originating from the sonar. The reflected signal is encoded with a unique identity so that the sonar with PingMe software integrated can identify the transponder and calculate its position. This information might be encrypted if the information is to be transferred to the cloud. With PingMe's scheduled online service, you can:

- Register your own lost gear with associated ID, or
- Report findings of other lost tools

In the long term, such a service can be integrated into the Authorities Public Service (in Norway: The Directorate of Fisheries). PingMe can also be used for better control during active fishing, by attaching transponders at regular intervals to the gear (long-line). Better control of where the gear is located can make fishing more efficient and profitable.

3.6 Session 6: Survival / Behaviour / Physiology

RAMP scores correspond well with biochemical test indicators: results of in-situ studies (ID 74)

Vishnupriya, M.S.[1]*, Madhu, V.R.[2], Manojkumar, B.[1], Tejpal C.S.[2], Amrutha R. Krishnan[1]

[1] *Kerala University of Fisheries and Ocean Studies, Kochi -06, sasivp2898@gmail.com*

[2] *ICAR-Central Institute of Fisheries Technology, Willington Island, Kochi - 29*

Reflex Action Mortality Predictor (RAMP) is now used for the prediction of escape and delay mortality during fishing. Since assessment of immediate and delay mortality was difficult to access in the field, simulated experiments were conducted using Tilapia (Oreochromis mossambicus) by trawl simulation experiment in a towing tank, with three towing times viz. 15 min., 30 min. and 45 min., followed by air exposure for 10 min. Different reflex action were selected to score the vitality impairment on a five-point categorical scale. After scoring for each reflex action, RAMP was calculated as the sum of vitality impairment divided by the total possible reflex action. In addition to scoring, the same fish were used for conducting different biochemical tests like LDH, MDH, AST and ALT to measure changes in body tissues. The overall findings demonstrated a strong correlation between the reflex scores and mortality, demonstrating lower mortality when reflex activity was higher and vice versa. Overall, it was observed that organ damage and biochemical testing associated well with mortality, which was in turn connected to the length of stress events during simulated trawling. The biochemical indicators and mortality estimations also showed good correlations. Based on the findings a preliminary model was developed and the results will be discussed.

Optomotor response in Atlantic cod (Gadus morhua) – can it be elicited and manipulated by trawl netting? (ID 140)

Junita D. Karlsen[1]*, Niels G. Andersen[2]

[1] *DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark, jka@aqua.dtu.dk*

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

The optomotor response is when animals move with a moving visual pattern. It is well documented in a wide range of animal groups including fish and is believed to be a major behavioral mechanism of fish in the process of being captured by trawl. Thus, the response has the potential of being utilized to increase trawl selectivity. It is the steady swimming of fishes at the same speed of the moving trawl gear often observed in the front of the trawl mouth on structures inside thee trawl that has been interpreted as the optomotor response. The optomotor response is suggested elicited by the moving trawl netting. However, other confounding stimuli during trawling may be responsible for the observed steady swimming, for example the groundgear in the trawl mouth area, leading to other interpretations of the holding behavior, such as herding.

Movement with moving visual pattern is considered an innate behavior and compulsory to normally performing individuals. Thus, the optomotor response is commonly used in the laboratory to study a range of topics, such as various aspects of the visual systems of fishes, schooling behavior and effect of pollutants. However, the optomotor response has shown to vary between species, and too little is known about the optomotor response in trawls. This study investigated for the first time the optomotor response of wild Atlantic cod (*Gadus morhua*), an important commercial species in demersal fisheries, using a standard laboratory set-up consisting of a rotating drum with black and white vertical stripes placed outside circular transparent fish tank. Furthermore, in the same set-up, the black and white stripes were replaced by five sets of standard polyethylene trawl netting with different visual appearances, which were tested for their ability to elicit, enhance, or break-up the optomotor response of cod in two ambient light levels. Cod behavior was observed using infrared light (940 nm). The results from the video analysis are presented and discussed in relation to trawl fishery and with focus on inter-individual variability.

3.7 Session 7: Energy

Greening Trawl Fishing Operation: Optimized Energy Saving, Minimized Seabottom Contact, and Improved Safety at Sea (ID 33)

Thaweesak Thimkrap[1]

Marine Engineering Section , SEAFDEC/TD Suksawasdi Road, Tambon Laem Fa Pha, Phra Samut Chedi District, Samut Prakan 10290 Thailand, thaweesakt@seafdec.org

General

Fishing is one of the most important employers and sources of protein for coastal communities. Bottom trawls are fishing method is that is indiscriminate in what it catches, and kinds of unselective fishing gear are taken an account one of the most destructive ways to catch cause harm to other fisheries and the marine environment by catching juvenile fish, and often juveniles of valuable species damaging the seafloor, and leading to overfishing because the gear is not selective and discards a lot of dead fish. For this reason, bottom trawling has a large bycatch impact, with many non-target species being fished in the process. Overfishing by bottom trawls is a direct threat to local fishing communities. This activity has an impact on biodiversity and means many species are being fished to the brink simply as a consequence of commercial activities, not as the target species. In addition to the turtles, juvenile fish, and invertebrates that get swept up in trawling nets, corals/seafloor are victims of trawling.

Objective

Promoting the appropriate fishing vessel under the concept of Low Impact and Fuel Efficiency "LIFE" will be applied. To reduce the impact of fishing vessels operating in an environment at a low level. The special devices/tools and techniques have been implemented on M.V. Plalung a 29.98 GT-wooden, the multipurpose fishery training vessels that use lesser fuel consumption/less manpower and improve safety while operating at sea to serve as a training model/material for fishers and fishery resources persons in SEA. The upgrading of the new vessel training vessel and model is, therefore.

- Improve/promote responsible fishing and selective fishing gear to reduce the environmental impact of fishing activities, e.g., discards, carbon emission, seabed, and especially the concerned species.
- Implement the concept of an appropriate fishing vessel design on improving energy efficiency, safety at sea for better living conditions, and safety working onboard based on the conventional standard (C-188) including implementation of hygiene of the fishing vessel.
- Improve appropriate fishery machinery, tools, and fishing operation techniques to support the manpower of the fishing vessel in capture fisheries.

Materials and Methods

a) Improve responsible fishing to reduce the negative impacts of trawling vessels by examining the efficiency of energy-saving ability, and performance of fishing gear design. The goal is to conduct good practices to reduce the negative impacts of trawling fishing activities on the seabed, especially noting the negative physical and biological impacts on the marine ecosystem in the study area, e.g. The Gulf of Thailand to reduce carbon emissions to mitigate climate change.

Otter board is the main equipment of a single trawl fishing vessel, and its hydrodynamic performance is an important factor affecting the catch and fishing efficiency. The function of the otter board is to accelerate the settlement of the trawl net by increasing the horizontal expansion of the trawl net.

The V-type horizontal cambered otter board is implemented in the coastal area single trawl training vessel. The hydrodynamic force on the otter boards decomposed into the expansion force. The expansion force is perpendicular to the flow velocity, which effect is increasing the lifting force of the otter boards where the trawl doors do not contact the seabed and minimizing damage to bottom fauna, expansion of the trawl net sweeping area, and directly cutting fuel consumption.

To improve good practice, the hydraulic Net drum, and wrap line rope are wide-powered spool for the hauling and shooting process that is used to facilitate wound when hauling up and releasing the trawl nets and wrap line. Type of sources by implementing the power-takeoff from the propulsion engine to haul a trawl net with its catch onboard. Net drum constitutes the hydraulic components placed on the stern portion, and gallows the inverted "U" shape is the most common one for trawl gallows are used to facilitate hitching up of heavy otter boards as well as for shooting and hauling of towing warps. The adjustable gallows are a new design by SEAFDEC/TD with the specific design it being a function as an outrigger or beam trawl when it adjusts to the waterline angle. Use to facilitate the extending on each side of the trawl wrap. The positioning of gallows is important as they must be forward of the rudder axis to allow the vessel adequate maneuverability.

Concerning global warming, several techniques including responsible user are applied to this issue, e.g., the recondition of a propulsion engine, the appropriate engine to the vessel type, and engine size to the generator, monitoring, and awareness building by the installation of fuel flow meter, including engine and vessel maintenances program and accepted the efficient application on board, i.e., led lighting bulbs, the new refrigerant with non-CFC and life fish handling is implemented

b) Concerning promoting the concept of an appropriate fishing vessel design. Referenced to the conventional standard of living of the crew onboard. The appropriate arrangement based on C-188 will be applied e.g., living space, sanitary, food, drinking water, canteen, cabinet, entertainment, etc.

c) Improve appropriate fishery machinery, tools, and fishing operation techniques. (Power take-off for winch drives) The power take-off is the unit to take the power from the main engine for the winch drive. From the power take-off point, the belt drive is preferable to the chain drive as it has more flexibility. The hydraulic drive may prove cheaper than a mechanical drive in the long run, provided that expertise and spare parts are locally available. On a small fishing vessel, the most usual power take-off is for a wrap line winch or Hydraulic oil pump for net drum in the trawl fishery.

Hybrid refrigeration system. In a fishing vessel, the propulsion engine or diesel generator has greater power delivering and a relatively steady amount of torque at both high and low running speeds. Consequently, the propulsion engine drives the compressor for refrigeration by providing enough power take-off as a mechanism to bring its power from at operating speed, therefore just properly matched with the requirement for the refrigeration unit as utilized as the power source.

SEAFDEC/TD designed and constructed the split shaft power take-offs with many advantages, which can make it an excellent option to capitalize on the full potential of fishing vessels. The Split shaft power take-offs are equipment such as a gearbox or power take-off application to allow single or multiple pumps to be driven from a single prime mover. This Multiple/split-type power take-off is a combination of different propulsion technologies

Innovation in Dutch beam trawl fisheries: rubberticklers-twister gear (ID 10)

Allard van Mens[1]; Lennert van de Pol[1]

[1]*Wageningen Marine Research, Haringkade 1, 1976 CP IJmuiden, Netherlands, allard.vanmens@wur.nl*

When the ban on pulse trawling in EU waters was introduced, some fishermen decided to not return to classic beam trawl gear which, according to them, was not a sustainable economic and ecological alternative to pulse fishing. One of the lessons pulse trawling taught these fishermen was the use of lighter gear and subsequent lower fishing speeds resulting in lower fuel consumption. With these lessons in mind, in 2019 an innovation undertaken by the Dutch vessel UK95 'Aart Maaskant', led to the design of a 'rubberticklers' gear, which comprises a set of rubber discs parallel to the fishing direction to startle flatfish from the seafloor. This design uses the square formed nets used for pulse fishing and drastically decreases the weight compared to chain-beam trawl gear. The design was later improved by the addition of 'twisters'. These are dome shaped metal devices placed face down perpendicular to the fishing direction and were originally designed for dethatching shells in Canadian shellfish fishing.

Since July 2021 the UK95 has, together with WMR, been working to improve the gear and create an economically viable alternative to chain-beamtrawl gear for sole fisheries in the North Sea. This resulted in 34 weeks of self-sampling and 1 week of comparative fishing, where a chain-beamtrawl was used to compare catches, survival rates, discard composition and fuel consumption to the innovative gear. Tow tank trials were also undertaken to improve the understanding of 'twisters' on waterflow.

The self-sampling weeks resulted in a dataset following the evolution and various improvements through the 34 weeks of development. In these weeks the innovative gear averaged a return of 1,83 euro per liter of fuel. The rubberticklers-twister gear caught an average of 59.4%, 33.6%, 64.4% of the catches of sole, plaice and turbot respectively, compared to chain-beam trawl during the week of comparative fishing. These results were significant. Although the innovative gear did less well in terms of marketable catch, it also caught 60.8% of the discards per fished area and consumed 60.5% of the fuel compared to the chain-beamtrawl. On some hauls the caught undersized plaice was scored on reflexes and overall quality. The rubberticklers-twister gear had yielded higher quality undersized plaice, with only 23.3% of the scored fish being dead on recording while beam trawl recorded 58% dead when scoring, indicating higher survivability.

To conclude, the innovative gear will need to improve the marketable catch efficiency or further reduce fuel consumption to be a potential alternative to chain-beamtrawl gear for commercial fisheries. The potential reduction in benthic disturbance and improvements to selectivity and survivability of the technique are important factors when considering innovative techniques.

Development of VFDS Otter Boards for Energy Conservation (ID 29)

Remesan, M.P.[1], Paras Nath Jha[1], Madhu, V.R.[1], Baiju, M.V.[1], Prajith, K.K[1], Chinnadurai, S[1], Renjith, R.K[1], Dhiju Das, P.H[1], Dilipkumar, V.N[1], Vipin, V[1]

[1]*ICAR-Central Institute of Fisheries Technology, Kochi- 682 029, India, mpremesan@gmail.com*

In India about 165.2 million liters of diesel is consumed annually by the different category of trawlers. Several attempts were made world over to reduce the fuel consumption in trawl systems. ICAR-CIFT has optimized trawl designs for different category of trawlers for reducing fuel consumption and resource conservation.

Trawl accessories also significantly contribute to the total trawl drag and about 20% of the trawl drag is contributed by the otter boards alone. Studies were also made to reduce the drag of otter boards and to optimize the trawl openings. Slotted otter boards are known for less drag and fuel consumption as it permits water to flow through the openings.

Wooden rectangular boards and V-form steel boards are the two types of sheer devices commonly used in India. V-form otter boards are popular mostly in the west coast of India starting from Kerala to Maharashtra. ICAR-CIFT has recently introduced an innovative V-form double slotted otter board (VFDS otter board) for reducing the drag, fuel consumption and GHG emission of trawlers.

Experiments onboard CIFT research vessel and commercial vessels revealed that depending on the sea conditions 2-3 liters of diesel can be saved per hour of trawling, compared to the existing boards of same dimensions. Trawl telemetry analysis revealed that expansion performance of the new otter boards is better. The technology has been accepted by the trawl owners, especially in Kerala, Tamil Nadu and Karnataka in the southern coast of India. In Indian several million liters of diesel can be saved annually and emission of greenhouse gases can be reduced by adopting VFDS otter boards by the trawlers of all the maritime states.

Using pair trawling to reduce fuel in a demersal fishery (ID 97)

Matthew McHugh[1], Martin Oliver[1], Daragh Browne[1], Rory Campbell[1], Ronan Cosgrove[1]

[1] *Ireland's Seafood Development agency (BIM), New Docks, Galway, Ireland.* matthew.mchugh@bim.ie

Irish bottom trawlers typically operate individually or 'solo' vessel with one net. BIM recently assessed bottom trawling as a means of improving efficiency. A 150% increase in fuel prices between 2021 and 2022 prompted this investigation. Two identical vessels were chartered to tow a single net without trawl doors using 724 m long sweeps. This pair trawling method is more like seining than trawling with 440 m of heavy 38 mm combination wire rope near the net, eliminating the need for a clump weight. For a solo vessel comparison, data on catches from a vessel operating nearby as well as follow up operational information from the vessels involved were used. Operationally the wing end spread was similar for the trawls used by the pair team and solo trawlers but the sweep divergence (i.e., where they join to the towing warps) was 3.1 times greater when pair trawling giving a greater (3.2×) swept area—7.92 versus 2.84 km2. Catches were 29% greater likely due to this increase in swept area. Fuel consumption and engine load was estimated to be 40% and 38% lower while profitability was 32% greater for each of the pair trawlers. Results suggest that pair trawling is a viable option for Irish bottom trawlers and could also be of benefit to Ireland's commercially important seine-net fleet.

Fuel use and greenhouse gas (GHG) emissions in fisheries (ID 149)

Antonello Sala[1], Jon Lansley[1], Xuechan Ma[1], Tarub Bahri[1]

FAO-NFIFO, antonello.sala@fao.org

The FAO background study provides an overview of the current state of research into energy use and greenhouse gas (GHG) emissions in fisheries with a focus on industrial fleets. Fuel use intensity, or litres of fuel consumed per tonne of landings, resulted typically much higher in low volume fisheries than for many other fishing techniques. There are two widely acknowledged main approaches to estimate the contribution of marine capture fisheries to global fuel use and GHG emissions. One approach uses catch-based fuel use intensity for well-studied fisheries, the second uses fishing effort data to estimate fuel use based on vessel size and fishing times. In our opinion, the two approaches are found to be complementary to one another, not contradictory, and global estimates of fuel use and GHG emissions from marine fishing should be based on their combination, depending on the data available. However, both approaches have several limitations and rely in many cases on strong assumptions when it comes to "catch or effort reconstruction". The advantages and disadvantages of each method regarding the limits of the nominal effort available for both coastal and industrial fisheries but also of the current algorithms have been largely discussed. The collected information and the identified approaches offer viable opportunities both for the quantification of global fuel use and GHG emissions in fisheries and also an insight on whether there are possibilities to address the reduction of emissions.

Studies on alternate fuel for out board motor (OBM) driven fishing boats in India (ID 121)

Ravichandran A.[1], M G Makhwana[2], K S Vinod[3]

[1]*Central Institute of Fisheries Nautical and Engineering Training, Royapuram, Chennai, aravichandran1965@gmail.com*

[2]*Central Institute of Fisheries Nautical and Engineering Training, Royapuram, Kochi, manjimakwana@gmail.com*

[3]*Central Institute of Fisheries Nautical and Engineering Training, Kochi, ksvinod72@gmail.com*

As per the recent Fisheries statistics 2022, India has more than 130000 Motorized non Mechanical fishing crafts fitted with OBM which are mostly operated with Kerosene/petrol as fuel. The exhaust emissions from the petrol/kerosene fuel based OBMs is creating health hazards to the fishermen as well as contributing to the global warming and also affecting the marine ecosystem.

During 2006, Central Institute of Fisheries Nautical and Engineering Training (CIFNET) had conducted a pilot study on the 'Efficacy of LPG kit on OBMs' with vapor off-take technology (VOT) LPG kit. In this technology, fuel is supplied in the form of vapor to the kit from normal LPG cylinder. The load bearing capacity and fuel efficiency are comparatively lesser in this technology in comparison with Kerosene/petrol fuel OBMs.

Presently, a new LPG kit has been developed with liquid off-take technology (LOT) in which LPG is supplied to the kit in liquid form and converted into vapour form mixed with air to supply to the engine. The kit manufacturer also has made LPG cylinder with customized valve in collaboration with petroleum companies so as to use the LOT LPG kit.

This technology was tested for the usage in the OBM during the period from 20.04.2022 to 14.05.2022. The results indicate that the usage of LPG with LOT Kit on OBM proved to be more efficient & eco-friendly in comparison to Petrol start Kerosene run OBM based on the critical analysis of the data collected. The methodology, economics of operation, cost analysis and overall efficacy are discussed in this paper for disseminating the information to the Fishermen and Fishing Industry.

Experiments with LNG as fuel for fishing vessel propulsion: Indian experience (ID 16)

M.V. Baiju[1], V.R. Madhu[1], Vipin Kumar V. [1], Dhijudas, P.H. [1]

[1]*ICAR CIFT*

There are 42,985 mechanised commercial fishing vessels in India consisting of Trawlers, Gillnetters, Dol netters, Bag netters, Liners, Ring seiners and Purse seiners. The length of these vessels varies from 13 to 24 metres, and their engine power ranges from 40 to 550 horsepower. The bulk of these vessels have length ranging from 13 to 24 metres. The engine power of these vessels ranges from 40 to 550 horsepower. Trawlers make up more than 75% of the vessels in the mechanised sector and depending on the class of trawler, the projected yearly fuel consumption ranges from 12,000 to 54, 000 litres.

LNG was tested as a fuel for trawling operations as part of the worldwide experiments with alternative energy sources to save operational costs and reduce pollution. R.V. Matsyakumari-II, a 17.7 m LOA diesel-powered research vessel, was adapted to run on LNG+ Diesel dual fuel for trawling operations. The vessel was modified to accommodate the dual fuel injection system (targeted substitution of 30–40%), and a cryogenic tank with a capacity of 450 litres was fitted.

A 27.0% substitution of diesel with LNG could be achieved during the experiments. The average consumption of HSD per hour was calculated as 20.8 litres and the quantity of LNG used per hour of operation was concurrently estimated as 8.4 liters. Trials using LNG, showed encouraging results. There were no safety concerns, and the switching processes and power output went without interruption. The findings show that LNG could replace HSD by at least 30% without causing any power loss during steaming or trawling activities.

Semi-pelagic self-adjusting otter boards: effects on the catching performance of a demersal trawl (ID 6)

Morteza Eighani[1], Tiago Veiga-Malta[1], Valentina Melli[1], Finbarr G. O'Neill[1]

[1]*National Institute of Aquatic Resources (DTU AQUA), Technical University of Denmark, North Sea Science Park, 9850 Hirtshals, Denmark, moei@aqua.dtu.dk*

Using semi-pelagic otter boards that operate off the seabed can make demersal trawling activities more sustainable and energy efficient. In this study, we investigated if and how replacing conventional seabed-contacting doors with semi-pelagic self-adjusting otter boards (SAO) affects catch efficiency of a demersal trawl. These doors are unique because they have onboard altimeters and adjustable flaps, which gives them the ability to control their position into the water column both vertically and horizontally from the vessel during the fishing operation. Full-scale experimental trials were conducted in a Kattegat fishery targeting demersal fishes with three doors configurations: conventional seabed-contacting otter boards, and the SAO set to maintain a target height over the seabed of 1 and 5 m, respectively. These target heights were chosen to keep the visual herding stimulus of the door while ensuring that there is no interaction between the doors and seabed. The data for this study were collected using the alternate haul method and analyzed using a catch comparison analysis for unpaired data. Replacing conventional doors with the SAO – 1m resulted in loss of catch efficiency for haddock and plaice, while there was no significant difference for cod. On the other hand, increasing the target height of the doors to 5 m over the seabed (SAO – 5m) decreased the catch efficiency for all species with respect to conventional doors. Fuel consumption of the trawler significantly decreased by about 14% at 3.3 knots when replacing conventional doors with the SAO. These results highlight a significant loss of herding effect, even for species where herding is considered neglectable in literature. Our study show that having the doors in proximity of the seabed is not sufficient to effectively herd species towards the trawl, and additional stimuli may be required to replace the visual and mechanical stimuli produced by a seabed-contacting doors.

3.8 Session 8: General Topics

A review of initiatives in India to lower bycatch and discard rates in trawling (ID 26)

Madhu V R[1]

[1]*ICAR-Central Institute of Fisheries Technology, Matsyapuri, W. Island, Cochin – 29, madhucift@gmail.com*

There has been considerable increase in the understanding of the negative aspects of trawling, in terms of impacts to the bottom integrity and generation of large quantities of non-targeted biota. Trawling contributes more than 55% of the total marine landings in India. Though the total number of trawlers has stagnated over the years, there is an increasing trend in the installed capacity of the trawlers in India. It is estimated that about 30-35% of the catch in the trawlers are constituted by low value bycatch, which predominantly consists of juveniles of commercially important species. The mechanism to reduce bycatch in the Indian trawl fisheries, had been regarding input restrictions, which includes seasonal closures during breeding season and regulations in codend mesh size. The output control is the minimum landing size (MLS) for species. However, in a mixed fishery, this is wrought with problems, due to multitude of species with different life strategies and determining a suitable mesh size in the fishery. To understand and to have more insight into this problem, a total of 29 publications were analyzed, which included works related to selection parameters for species and others that dealt with studies to reduce bycatch in trawls. The results show that the most widely researched and implemented input control is the square mesh codend, which has been adopted legally by five maritime states. The analysis revealed that use of square mesh codend alone, cannot be used as an input restriction, since even with the use of stipulated mesh size, the percentage of juveniles in the codend ranges from 20 to 40 percentage, which means that, a comparatively large mesh size would be required in codend, with significant revenue loss. Among the other technical measures, TED are mandatory, along with seasonal closure for trawling along the east coast of India, to reduce the interaction with breeding migration of olive ridleys. Other technologies, such as off-bottom trawling, that were evaluated to lessen bottom impacts are not widely adopted. It is also noticed that there has been a shift in the resources targeted by trawlers, from shrimp to fish, where vessels operate large sized fish trawls, mostly as pair trawls. The implications related to uncontrolled size of the trawlnets and shift in resources targeted, including areas for future research is discussed.

Fishing Gear Modification: A Solution To Achieve Ecosystem Objectives (ID 31)

Neha Kothari[1], Archana Mishra[1]

[1]*Govind Ballabh Pant University Of Agriculture And Technology Pantnagar 263145, Uttarakhand, India, nehakothari972003@gmail.com*

Fishing gear are devices used for fishing. There have been significant efforts in recent years to alter fishing techniques and equipment to more effectively target specific fish sizes and species as well as other marine animals while also minimizing the impact on habitat on the bottom. There are many different types of fishing gear devices that are made with various technologies and are operated in different ways. The methodology of the use of these gears, their effects on the water body and environment should be discussed. Concerns regarding the impact of non-sustainable fishing practices causing massive fish death have grown over the past few decades. Appropriate knowledge of development of gears instruments and practices that can reduce the impacts of Ghost fishing, otherwise they will reduce biodiversity. Discussion on future development of modern gear to achieve ecosystem objectives might plays a crucial role in achieving sustainability. Modification in gear technology will eliminate all adverse effect completely.

Keywords: Gear, Habitat, Methodology, Ghost fishing, Sustainability.

Technological inputs for fisheries conservation and management in Kerala, India (ID 50)

Leela Edwin[1]

[1]*ICAR-Central Institute of Fisheries Technology, CIFT Road Matsyapuri, Willingdon Island, Kochi, Kerala, India 682029, leelaedwin@gmail.com*

Among the maritime states of India, Kerala was the first to enact the Kerala Marine Fisheries Regulation Act in 1980 to conserve and manage the marine fish resources sustainably to improve the livelihood of the fishers of the state. Currently, as per the constitution of India, fisheries within 12 nautical miles are under the administrative control of the states and area beyond 12 to

200 nautical miles under the control of the union government. Over the decades and through various notifications and a major amendment regulations have been brought out for effective management. The ICAR-Central Institute of Fisheries Technology has provided technologies/ advisories for sustainable exploitation of fishery resources in the territorial waters. This includes measures for reduction of bycatch/ juveniles by stipulatory measures like, use of CIFT-TED, square mesh for trawls, optimum mesh size for all types of fishing gears used, gear marking and registration, use of safety and navigational devices onboard, ensuring vessel and crew facilities as per international regulations, restricting of engine horsepower etc. ICAR-CIFT has also assessed the environmental impact of various fishing systems currently in use in the state. Co-management was first time introduced in the country by the Department of Fisheries, Kerala state through the establishment of Fisheries Management Councils (FMCs) at the village, district and state levels. The monitoring control and surveillance system envisaged by the state and steps to create awareness regarding all management measures is however weakly implemented due to various technical reasons. The department also lays emphasis on improvement fishermen education, studying impact of climate change and its mitigation strategies. This communication presents the major technological inputs for design and operation of fishing gear and vessels, use of appropriate materials for construction/ fabrication of fishing systems and their potential environmental impacts. These can be effectively implemented only through co-management measures where all stakeholders voluntarily participate.

Preserving the tradition: Fishing crafts of artisanal fisherfolks in Bay of Bengal (ID 125)

Swaminathan Jayaraj[1], Pandian Krishnan[1], Murugesan SriHari[1]

[1]*Bay of Bengal Programme Inter-Governmental Organisation, Chennai, India – 600 018, s.jayaraj@bobpigo.org*

Construction of traditional boats in the Bay of Bengal region dates back to Third millennium BC. In the region, traditional boats are constructed in many places with region-specific types of boats Kattamaran (Boat kattamarans and Raft kattamarans) is one of the major craft that dominate along the east coast of India, from Puri in Odisha and Kanyakumari in Tamil Nadu. These boats are used for near-shore fishery. Since the Kattamaran can easily penetrate breakers and avoid capsizing, it is best suited for the harsh conditions along the east coast of India. Fishermen consider that the nava, a traditional boat of Odisha, is suitable for the deep-sea fishery. The other popular traditional fishing crafts along the Indian coast are masula boats, dingies and dhonies. The traditional boats of Bangladesh are either plank-built or dug out. Chandi, plank-built boat is one of the most widely used traditional fishing boats in Bangladesh and gill net is operated from these boats. Traditional fishing boats in Thailand do not vary much in shape and structure, and they are mostly used for fishing in the shallow waters and the surrounding mangrove forest. Sri Lanka's traditional crafts consist of dugouts with or without outriggers, log rafts and planked craft. They are mainly utilized for coastal and lagoon fishing. The teppams are widely used in the lagoons and backwaters for catching small fishes and juveniles. While, in Maldives masudhoni, vadhudhoni and bokkura are traditional crafts which are used for fishing. Several million small-scale fishermen in the Bay of Bengal fish with crafts that have seen little change from generation to generation. In recent days, due to modernization, most of the traditional crafts are motorized and the original traditional boats are getting replaced. Though fishing with traditional crafts is considered to be primitive and dangerous, it is necessary to preserve the crafts along with the traditional knowledge of the fishers.

The Fisheries of Uganda. Current and future perspectives from an African Inland Fishery (ID 2)

Drake Ssempijja[1]

School for Marine Science and Technology, University of Massachusetts Dartmouth, 836 South Rodney French Boulevard, New Bedford MA 02744 USA, dssempijja@umassd.edu

Global inland fisheries resources are important for food security, nutrition, economic development and sustainable livelihoods development especially in the least developed and developing nations of Asia and Africa. FAO estimated the global catches in inland waters in 2020 at 11.5 million tonnes and remain at a historically high level. This has been attributed to improved reporting and assessment by the producing countries. Africa accounts for over 25 percent of this production, which represents an important source of income and food security, particularly in the case of landlocked and low-income countries like Uganda. However, a lot of the inland fisheries resources currently face existential threats from over exploitation, climate change, pollution and environmental degradation as well as poor management mainly because of limited human and financial resources to monitor and manage them. FAO's global threat map for inland fisheries indicates that 55 percent of inland fisheries are under moderate pressure and 17 percent under high pressure. Uganda is ranked the biggest producer from inland fisheries on the African continent producing an estimated 570,000 metric tonnes of fish accounting for 5percent of global inland capture production. This presentation provides background, challenges, emerging threats (ALDFG) and current and future perspectives from an African inland fishery with a case study of the Lake Victoria fishery of Uganda.

The beach seine ban / phase out in Mozambique - tasks, opportunity and challenges (ID 161)

Júlio Zitha[1]

[1]Senior Navegation and Fisheries Technologist, SCDPA – MIMAIP/MZ, Mozambique, jzithamoz@gmail.com

Mozambique has a territory of 799.380 km^2, on which 786.380 km^2 are land (+ 13 000 km^2 of territorial sea). It has a coastline of almost 2 700 km, the fourth largest in Africa and the exclusive economic zone (EEZ), which extends from the coast to 200 nautical miles (370 km) off the coast is large 572 000 km^2.

The total of fish Production is around 448.000 tons (2021) and the per capita of fish consumption is around 16kg / year. More than 90% of the fish production comes from artisanal fisheries. The main group of species are shallow water shrimp, demersal rock fish, deep water crustaceans (shrimp, lobster, crayfish), big and small pelagic, molluscs and other invertebrates. The industrial fleet is dominated by trawlers (vessels more than 24 m length) targeting shallow water shrimp and deep water crustaceans. There is also an emerging longline fleet targeting tuna and tuna-like species. Semi-industrial fleet (vessels between 13m<LoA<24m) composed by trawlers and line fleet targeting bottom fish.

The artisanal fisheries are a multi-specie fishery using a variety of fishing gears and methods (beach seines, gillnets, purse seine, traps, line fish, harpoons and hand collectors targeting invertebrates). Beach seine is one of the most important fishing gear, considering the quantity of catches and number of labour employed. However, due to its impact on seabed, seaweeds and juveniles (most of the beach seines uses mesh sizes less than 1 inches) the Government adopted a Decree, in October 2020, to phase-out the beach seine in 3 years and apply a total ban in 2023/2024. The decree states that a phase-out plan needs to be designed and implemented.

The plan includes the socio-economic impact of the beach seine ban, a technological proposed alternative of using other fishing gears and methods, and the challenges and opportunities arising from this measure. For the ICES-FAO WGFTFB annual, this presentation is an opportunity for Mozambique to exchange ideas and experiences on similar initiatives worldwide.

Dissension on modern fishing technology: the bizarre saga of Blue Revolution in Sri Lanka (ID 111)

K.H.K.L.Piyasiri[1], Oscar Amarasinghe[2]

[1]*Sri Lanka Forum for Small Scale Fisheries, kaumi.khklpiyasiri@gmail.com*

[2]*Ocean University of Sri Lanka*

Introduction of outboard motors to motorize the traditional crafts, introduction of new mechanised crafts along with new fishing catching technology using nylon nets and hooked lines, in early 1960's, mark the onset of the Blue Revolution in Sri Lanka. The revolution led to a movement of fishing loci away from the coast and fishers started exploiting the offshore waters. Fish Production increased at a very fast pace, reaching 530,000 tons by 2017 from 25,000 MT in 1950, while fishing incomes were on the rise unremittingly. However, this growth was also accompanied by heavy fishing pressure on coastal waters, pervasive use of destructive gear, declining catch per boat for small scale fishers, and more recently the fuel crisis preventing many crafts from fishing. This study aimed at examining the process of blue revolution in Sri Lanka, to find reasons for the above situation and to propose a road map for securing a sustainable fisheries sector, based on secondary information which consisted of both published articles, statistical reports and grey literature. Evidently, the blue revolution has led to significant increases in fish production and fishing incomes, by means of year-round fishing, exploiting previously unexploited resources, using modern fishing methods, etc. The process was facilitated by state sponsored credit and subsidy schemes which were channeled through fisheries cooperatives allowing the asset poor to have access to the new technology. Nevertheless, due to governance and management failures, the process also led to increased fishing pressure on resources and the use of environmentally unfriendly gear which were considered destructive. Moreover, some studies have shown that the tendency towards constructing longer multiday crafts would lead to declining net returns making the technology non-viable. Recent energy crisis has made things worse for all. Small scale fishers suffer from lack of kerosene for their outboard motors, increased cost of production and declining incomes, while the offshore sector suffered from rising fuel prices and falling supplies. In conclusion, we propose a road map which aims at redressing the current situation and moving towards securing a sustainable fisheries sector. The major propositions include, establishment of a regulatory authority for regulating technological change, further research on profitability of craft operations, strictly enforcing law against destructive fishing, shifting fishing effort towards less exploited resources and alterative livelihoods, and establishing an expert panel to probe into the issue of improving fuel use efficiency in fishing crafts and to seek alternative sources of energy for propulsion.

An update on the gear characteristics of trawls operated off the Karnataka Coast, eastern Arabian Sea (ID 131)

Geetha Sasikumar[1], Prathibha Rohit[1], V. R. Madhu[2], Divya Viswambharan[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Mangalore Regional Centre, P.B. 244, Hoige Bazar Mangalore-575 001, geetha.sasikumar@icar.gov.in*

[2]*ICAR-Central Institute of Fisheries Technology, Matsyapuri, Kochi- 682 029*

Trawling accounts for nearly 70% (2021) of marine fish landings along the Karnataka Coast. Trawls have evolved in response to technological advancements in the fishing industry and over the years, there has been a noticeable change in the size as well as the designs of trawls used by the trawl fleet. In Karnataka, records of basic vessel attributes and gear types are accessible through the state machinery, but accurate information regarding gear characteristics is lacking. This study outlines the trawl gear characteristics in the mechanized fishing sector of Karnataka.

The gear information has been collected by interviews during field visits to the fishing harbours; interviews with the fishermen onboard vessels and from net fabricators. Information on the trawl characteristics, target species, vessel horsepower, trawling technique, and depth were all recorded. The mechanized trawling fleet in the state of Karnataka includes boats ranging from small vessels undertaking daily fishing in the nearshore waters (<9.75 m LOA) to medium-sized vessels that range in size from 9.75 to 15.0m LOA. There has been a progression toward larger and better-equipped trawlers over time, but with the increase in the LOA limit, the trend towards larger vessels (up to 23.78m) has been accelerated. These trawlers have a steel body and are powered by engines with more than 350 hp. The earlier smaller trawl nets, typical of the industry since the commencement of trawl fishing in the region, have evolved into larger gears as the vertical height and length of the net have increased. In contrast to the bottom trawling, the mesh size of the fore part of the presently operated trawls has increased several folds, to reduce drag for semi-pelagic operations. The fishing capacity of the vessels has increased due to the introduction of powerful engines, more robust winches, and improved fishing gear designs.

Innovative technological interventions in harvesting methods for minimizing the impact of fishing on fish quality and post-harvest losses (ID 126)

Sarasan Sabu[1]

[1]*School of Industrial Fisheries, Cochin University of Science and Technology (CUSAT), Cochin, Kerala, India, PIN-682016 Email: sabuif@cusat.ac.in*

The freshness of fish and nutritional quality has to be at their finest right from the first stage of the value chain, as the quality lessened in this phase cannot be enhanced at a later stage. Fishing gears have multiple impacts on the quality and freshness of fish. The fish-catching method should be as gentle as possible, and the mortality must not be high during capture. Studies pointed out that soaking times for various fishing gears vary, and fishes suffer stress when crowded in the fishing net. The longer the soaking time, the lower the quality of the fish. The fish caught using trawl nets are more exhausted and have little or no reserve energy than those caught from purse seining. Gill net is one of the most popular environmentally safe fishing gears, resulting in poor quality catch due to the prolonged struggle of fish under the water and extended soaking time. Hand line, jigging, traps, and pole and line fishing are comparatively better fishing methods for the quality of fish harvested. Gaffing injuries in long lines; bruises, scale loss, and discoloration in trawl-caught fish; skin loss, and piercing of net into the body of fish in gill nets are some of the significant quality concerns that need to be addressed. Fishers must be imparted the technical skills to handle the fish according to the fishing method and apt on-board fish preservation techniques to extend the freshness and storage life of fish and minimize fish spoilage and post-harvest loss. Technological interventions to address these concerns include developing and popularizing: (i) innovative fish harvesting technologies with minimum fish struggle; (ii) fishing gear materials and implements generating the least damage to the fish body; (iii) bycatch reduction and catch sorting devices; and (iv) species-specific on-board fish handling techniques. Minimizing the adverse effects of fishing through the proposed technological interventions shall ensure superior catch quality, better returns for the fishers, and a reduction in post-harvest fish losses, thus leading to food safety and food security.

Understanding the research needs of pelagic fisheries using a research prioritisation exercise (ID 160)

Hannah Fennell[1], Michel Kaiser[1], Eric Gilman[2]

[1]*Lyell Centre, Heriot Watt University, Riccarton, Edinburgh, Scotland, UK hf4@hw.ac.uk*

[2]*Hawai'i Pacifc University, Honolulu, Hawaii, USA*

On the 23rd April 2020, a sub-group of WGFTFB met virtually and discussed the need to identify priority research questions related to the mitigation and by-catch of endangered, threatened and protected species in pelagic fisheries that could be addressed through meta-synthesis approaches. The goal of the work was to ensure the research conducted by the subgroup met the needs of industry, decision-makers, and conservationists and identified shared research priorities between these stakeholder groups. An online questionnaire was circulated to members of the working group, who were asked to circulate it among their professional networks. Participants were asked to provide up to ten knowledge-needs that they feel should be a research priority and would be answerable within a three- to five-year period. An expert working group then met to discuss the submissions and identify whether they were suitable for a meta-analytical approach. The remaining knowledge needs were then grouped thematically, before a final prioritisation occurred using input from a wider stakeholder group. Priorities that were identified across stakeholder groups included knowledge needs about bycatch, bycatch avoidance, and fisheries monitoring.

3.9 Session 9: Gear Design

Simulation of fluid flow across fishing nets for studying the impact of trawling near the seabed (ID 15)

Sarath-Krishnan Karumathil[1] and Finbarr G O'Neill[2]

[1]*Universidade da Coruña, Campus Industrial de Ferrol, Laboratory of Me-chanical Engineering, Ferrol, 15403, A Coruña, Spain, sarath.karumathil@udc.es*

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

Bottom trawling is a globally used fishing technique where fishing gears are trawled close to or on the seabed to capture species which are located there. This fishing technique often results in large amounts of by-catch, poor fuel efficiency and negative impact on the seabed. Improving the selectivity of bottom trawling and reducing its effect on biodiversity is an area of research that needs more attention. This study presents a computational simulation of the flow through and around netting panels using a porous media model in order to understand some of the basic processes associated with bottom trawling.

Computational simulation of fishing nets is extremely useful in research and development in the fishing industry. Sea trials are costly and time-consuming and computational simulations can give a better idea of where to focus research before doing sea trials. The movement of a fishing net in water is a fluid-structure interaction problem and the fluid part of the problem, in general, is very computationally expensive and almost unachievable even with supercomputers when simulated in the real scale. In this study, to efficiently simulate the problem a porous media model is used, where fishing nets are modelled as surfaces and the cells close to them were selected to apply the hydrodynamic resistance offered by the fishing net.

This approach is used to understand the effect of netting being towed close to the seabed. Multiple simulations of a rigid netting panel are carried out where parameters like the distance from the seabed, the angle the panel makes with the seabed, and the length and porosity of the netting panel were varied. The wall shear stress on the seabed and the hydrodynamic forces on the netting panel are calculated, and in particular, the shear stresses are compared to the critical values for mobilizing sediments of different grain size. The results demonstrate that across a range of normal operating conditions, that the turbulence around netting panels will mobilize sediments from fine silt to coarse sands.

SimuNet - Numerical modelling of fishing gear (ID 35)

Karsten Breddermann[1], Uwe Lichtenstein[2], Daniel Stepputtis[2], Daniel Priour[3]

[1]*University of Rostock, Ocean Engineering, Albert-Einstein-Str. 2, Rostock, 18059, Germany,* *karsten.breddermann@uni-rostock.de*

[2]*Thuenen Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, 18069 Rostock, Germany, uwe.lichten-stein@thuenen.de, daniel.stepputtis@thuenen.de*

[3]*Ifremer, LCSM, BP70, Plouzane, 29280, France, Daniel.Priour@ifremer.fr*

Fish behaviour in fishing gear is poorly understood. One reason is that the stimuli the fish is exposed to are hardly known. Next to visual light and acoustic sources, especially fluid flow velocities, pressure changes and turbulence fields are believed to play a major role in the fish's reaction to its surrounding. Measurements of the triggering stimuli is a task nearly impossible to achieve in field tests and requiring a lot of time on a laboratory scale.

A simulation tool that enables viscous flow dynamics simulations and is coupled with another that predicts the shape of the fishing gear can enable the gathering of information on flow, pressure, and turbulence fields. This information could be used to link the fish behaviour to its triggering stimuli. The overall goal of the ongoing SimuNet research project is to create such a simulation tool. The current status, applications and weak points will be presented and discussed here.

Introducing RightFish – a BlueBio CoFund project to reduce environmental impact and greenhouse gas emissions in commercial fisheries. (ID 46)

Finbarr G. O'Neill[1], Tiago Veiga-Malta[1], Jens Peter Kofoed[2], Ingunn Marie Holmen[2], Eduardo Grimaldo[2], Sepideh Jafarzadeh[2], Hanne Hjelle Hatlebrekke[2], Emilio Notti[3], Massimiliano Pinat[3], Antonello Sala[3], Einar Skaftason[4]

[1]*DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark, barone@aqua.dtu.dk*

[2]*SINTEF Ocean, Norway*

[3]*IRBIM-CNR, Largo Fiera della Pesca, 2, 60125 Ancona AN, Italy*

[4]*Hampiðjan, Skarfagörðum 4, 104 Reykjavík, Iceland*

Here we present an overview of RightFish: a new project that is funded under the EU BlueBio Cofund. The BlueBio Cofund supports projects that promote the Blue Bioeconomy, and RightFish contributes to this by developing methodologies to design demersal fishing gears of reduced environmental impact and reduced carbon emissions.

In particular, RightFish will establish criteria for small scale modelling in the Flume Tank that incorporate the contact forces associated with fishing gears being towed over the seabed. Then it will apply these approaches in two case studies, which characterize European demersal trawl fisheries: a single trawl whitefish fishery and a twin trawl Nephrops fishery. and demonstrate the environmental and economic benefits that can be achieved. These gears will be more fuel-efficient, disturb fewer carbon-rich sediments and penetrate less into the seabed. Accordingly, they will ensure that marine resources are managed and harvested in a sustainable way that maintains ecosystem integrity and resilience and reduces greenhouse gas emissions.

Experimental and numerical investigation of hydrodynamics around towed fishing gear to develop selective fishing methods in a sea star fishery (ID 113)

Karen B. Burgaard[1], Stefan Carstensen[2], David R. Fuhrman[2], Finbarr G. O'Neill[1]

[1]DTU Aqua, Technical University of Denmark, barone@aqua.dtu.dk

[2]Department of Civil and Mechanical Engineering, Technical University of Denmark

Towed fishing gears are responsible for a large proportion of global landed catch. However, little is known about the hydrodynamics around these gears, even though it is likely to have a large impact on both catch efficiency, selectivity and impact on the seabed.

An experimental investigation has been carried out in a current flume within the DTU Department of Civil and Mechanical Engineering Hydraulics Laboratory, measuring flow velocities with LDV around a model of the groundgear of a standard fishing gear. The experimental data is used to validate a Reynolds Averaged Navier-Stokes computational fluid dynamics (CFD) model in OpenFOAM using the Wilcox 2006 k-ω turbulence model.

The CFD model is used to improve the sea star fisheries in Limfjorden, Denmark, where they are fished to remove them from mussel beds and for processing into protein powder. The density and settling velocity of starfish have been measured and the results from the CFD model are combined with a particle path model to provide an initial estimate of how the hydrodynamics around the beam affects the sea star dynamics and their catchability in the trawl. Sea trials have been conducted and the results are compared with the simulations of the particle path model.

Nano silicon dioxide incorporated epoxy polymers: Effective solution against lead pollution from fishing gear sinkers. (ID 5)

Shifa Jalal[1], Vrinda KR[1], P Muhamed Ashraf[1], Remesan MP[1]

[1]ICAR Central Institute of Fisheries Technology, ashrafp2008@gmail.com

Lead based sinkers were extensively employed in fishing operations like trawling, gill netting, purse seining, etc due to its easy availability, cheaper, ease of production, casting, chemical inertness (resistance to corrosion), and density. Its use banned in developed countries but lead sinkers were natural choice among fishers. Fishermen confronted with an issue of leaching and degradation of lead sinkers, thereby losing the efficiency of sinkers. Lead contamination in aquatic environments due to commercial and recreational fishing activities mainly by loss of sinkers, abrasion during fishing gear operations. Present study aimed to provide a nano silicon dioxide reinforced epoxy coating over the lead, and to evaluate its impact on corrosion and physicochemical characteristics. Lead underwent corrosion in seawater and 3.5% NaCl was 0.009 and 0.006 mpy respectively. Reinforcement of SiO_2 was confirmed by UV-Vis spectroscopy and FTIR, and the SiO_2 was interacted with benzene moiety of the bisphenol A epoxy resin. The SiO_2 – epoxy resin exhibited smoother surface with less pore compared to control. Electrochemical evaluation (linear sweep voltammetry and electrochemical impedance spectroscopy) showed 0.5% SiO_2 reinforcement in epoxy resin is optimum for enhanced corrosion inhibition. Abrasion test and sinking characteristics of the SiO_2 reinforced epoxy coated lead sinkers showed about 50% more efficient in abrasion and comparable sinking speed.

Durability studies of ring seine (mini purse seine) gear used along the Kerala coast, India (ID 48)

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

[1]Fishing Technology Division, ICAR-Central Institute of Fisheries Technology, Cochin – 682 029, Kerala, India, dhijudas@gmail.com

Among the various fishing gears employed for pelagic schooling fishes along the Kerala coast, ring seines are the most efficient. Polyamide webbing is generally used for ring seine gear construction. One of the main problems encountered by ring seine fishers is the huge expenses incurred for the periodic replacement and repair of polyamide webbings. To figure out the webbing durability related problems faced by the ring seine fishers, an 18-month durability study of ring seine polyamide webbing of 210Dx2x3 with 20mm mesh size was conducted in natural weather conditions and in simulated lab conditions with accelerated weathering equipment. Apart from this, webbing strength studies were conducted in webbing samples collected from five different locations of the gear. The locations most subjected to wear and tear were revealed that the strength reduction in ring seine is not uniform and it varied from part to part and the parameters causing deterioration are also different in different gear locations. To attain better service life of gear there is an urgent need of area specific improvisations and use of alternative materials with high strength, high abrasion resistance and high resistance to UV radiation. A model design is suggested using high strength materials like Ultra-High Molecular Weight Polyethylene (UHMWPE), sapphire, bite resistant polyethylene, etc. this would also reduce the damage due to bite by cetaceans.

Side-scan sonar development of sweep modifications to facilitate early release of unwanted catches (ID 101)

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

[1]*Irish Sea Fisheries Board (BIM), New Docks, Galway, Ireland, daragh.browne@bim.ie*

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

Post release survival of unwanted catches is key if gear based technical measures are to achieve management objectives such as fish stock recovery. The Irish Sea whiting stock is below a critical level (Blim) and the majority of catches occur in the Nephrops trawl fishery. Gear based technical measures have been implemented and include codend mesh size, escape windows and sorting grids. Testing suggests these measures are not effective for small whiting (< 20 cm). Our aim was to develop a gear modification that prioritises early release of small whiting to optimise survival outcomes.

Using side-scan sonar to visualise candidate gear modifications we selected one that had potential to herd fish through an escape route between twin Nephrops trawls. We tested the gear modification against the standard gear and found that it was not successful in reducing catches of small whiting, likely due to their reduced swimming ability and herding response. Trial results also suggest that the gear modification may retain more Nephrops while reducing catches of larger unwanted species such as skates and rays and lesser spotted dogfish. Further testing is needed to confirm these results.

Kiwi cod-end trials in the Dutch mixed demersal beam trawl fishery to improve fish quality and post capture survival of discarded unwanted bycatch. (ID 103)

Pieke Molenaar[1]

[1]*Wageningen Marine Research, Haringkade 1, 1967 AB IJmuiden, The Netherlands, pieke.molenaar@wur.nl*

The Dutch demersal tickler chain beam trawl fishery targeting sole (Solea Solea) in the North Sea is known to catch substantial amounts of undersized plaice (Pleuronectus platessa). Post capture survival studies show that 14% of the discarded undersized plaice survive being caught and discarded. To improve discard survival and fish quality the Modular Harvest System (MHS) concept was customized for the beam trawl fishery, this modified MHS is further referred as the Kiwi cod-end. The concept replaces the traditional mesh tunnel and cod-end of the trawl net with membrane-based modules, comprised of a cone module, escape module and a lift bag. The cone module assures the shape of the other modules. The opening slits in the escape module were tailor made for sole selectivity. The lift bag is a completely closed off module collecting the fish. This module allows the captured fish to keep swimming in~2000 liters of water while hauled on board.

During two 4-day trials in July 2022 the performance of the kiwi cod-end with 62mm 'mesh' openings was compared with a regular 80mm mesh cod-end on a 24m commercial vessel equipped with two chain matrices beam trawls. The first tows were done to optimize the kiwi cod-end performance, with additional underwater video observations on several positions in the kiwi cod-end modules. Marketable catch composition and selectivity for sole and undersized plaice were compared between the regular mesh and kiwi cod-end. Additionally, a subsample of undersized place was assessed for post capture condition, this included external damage and reflex action mortality predictor (RAMP) scores that are an indicator for discards survival.

Although the kiwi cod-end did have slightly lower marketable sole catches, length distribution both sole and undersized place did not differ significantly. Direct mortality of undersized plaice after capture reduced from 25% in a conventional cod-end to 5% in the kiwi cod-end. RAMP scores and external damage scores significantly improved with undersized plaice caught in a kiwi cod-end, indicating a better survival after discarding. The fixated openings in the kiwi cod-end unexpectedly allowed for the escape of colonies of Bryozoa. This feature is of particular interest for commercial fisherman who are contemplating to take up the kiwi cod-end. Additional experiments in the first quarter of 2023 will focus on the application of the kiwi cod-end on larger beam trawlers.

Design and operational details of deep sea pelagic longlines by fishermen of Thoothoor, South-West coast of India (ID 136)

Dinesh Kumar Esakkimuthu[1], Neethiselvan Neethirajan[1], Thangaraji Ravikumar[1], Durairaja Ramulu[1]

[1]*Tamilnadu Dr. J. Jayalalithaa Fisheries University, FCRI, Thoothukudi, edineshramukedk@gmail.com*

The present study was carried out to analyse the design and operational status of deep sea long-lines operated by the fishermen of Thoothoor fishing village complex from the Thengapattinam fishing harbour (Lat 770 15' E and Long 80 23' N) of Kanyakumari district. Among 800 registered deep-sea fishing vessels of Thoothoor fishing village complex of Kanyakumari district which operated from Thengapattinam fishing harbour as base, 100 were found to be Exclusive Long-liners (EL) and the remaining 700 vessels were Gill Netter Cum Longliners (GNCL). Four types of longline gears viz., Longline A targeting Sharks, Longline B targeting Yellowfin tuna, Longline C and Longline D targeting Groupers and Snappers respectively were recorded. The gear composition of GNCL and EL also differed notably with the combination of different types of long-line gears. The Longline A and B were mainly used by EL while Longline C and Longline D were mainly used by GNCL and only few by EL. There was notable difference in the design features of different types of longline gears. All the longlines were found devoid of swivel in their design. Further, the branch lines of Long line A and Longline C had snood wire while Long-line B and Longline D did not have snood wire in their design Hook sizes i.e. hook No. 1, 0 and 00 were found used In Longline A and B, while in Longline C and D, hook No. 4, 5, 6, 7 and 8 were found used. Live flying fishes were found used as baits in Longline A and B and Lesser sardines were used as baits in Longline C and D. Usage of separate longline with Hook No. 14

and 15 was found used to catch bait fishes in Longline A and B. Average duration of fishing voyage ranged from 24 to 30 days. The fishing grounds of Longline A and B were between 7° to 20° N and 60° to 72° E whereas, fishing ground of Longline C and D were between 7° to 20° N and 65° to 74° E and the peak fishing season was found to be from March to May. The study suggested to incorporate a line hauler in the operation system of longline both from GNCL and EL and discuss about various design improvements required for the upgradation of the longline gears to improve the hooking rate.

Bottom set, yet floating pontoon traps for multispecies fishery (ID 165)

Peter Ljungberg[1], Mikael Lundin[1], Stefan Eiler[1], Lars Hillström[1]

[1]*Swedish University of Agricultural Sciences, Institute of Coastal Research, 75007 Uppsala, peter.ljungberg@slu.se*

Swedish coastal fisheries are severely affected by the steady increasing seal populations. In addition, the EU’s landing obligation makes coastal fisheries even more complex due to their simultaneous targeting of multiple species. A stronger focus on the advancement of both selective and seal-safe gear is therefore of great importance to sustain coastal fisheries. In Sweden, more than 300 pontoon traps are used in the salmon (*Salmo salar*) and whitefish (*Coregonus lavaretus*) fisheries.

The advantage of the pontoon trap is undisputed however struggles include its ability to catch also other target species. Here we show the development of bottom set, yet floating pontoon traps targeting perch (*Percha fluventalis*) and vendace (*Coregonus albula*). We include the evaluation of selection panel size and type on catch efficiency for the different species and put it in the perspective on potential implementation of the gear in Swedish coastal fisheries.

The FishScanner (ID 110)

Haraldur A. Einarsson[1]

[1]*Marine and Freshwater Research Institute, Fornubúðum 5, 202 Hafnarfjörður, Iceland, haraldur@hafogvatn.is*

Today, fishers have limited information about catch composition from the trawl in real-time when towing. Catching sensors give a rough indication of relative catch levels by detecting the expansion of the codend. A funded project in Iceland is developing a device providing the fishers with real-time information about the catch composition. It cooperates between the Marine and Freshwater Research Institute, StarOddi, and Hampiðjan. The device is called FishScanner. Using the FishScanner will give real-time information on the species composition with length distribution and the total volume of each species entering the codend. That is a significant improvement for science work and a commercial fishery with towed fishing gear. Information obtained from this device will change the intelligence from pelagic and bottom surveys. The obtained data will give a higher resolution on when and where the fish enter any sample trawl and allow sampling species and sizes composition without using a codend by simply having the trawl open behind the FishScanner to leave all sampled animals escaping at the sampling site. This technology can significantly affect commercial fishery. Fishers can use the information to optimise the towing time by knowing the catch composition in the trawl in real-time instead of after the trawl has been taken on board. A version of the FishScanner suiting better for the commercial fishery has been developed. In this presentation, the main parts of the device will be explained and briefly how it works.

Real-time detections of bycatch species in demersal trawl fisheries (ID 157)

Mette Svantemann Lyngby[1], Esther Savina[1], Fletcher Thompson[2], Ludvig Ahm Krag[1]

[1]*DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark, msvly@aqua.dtu.dk*

[2]*DTU Aqua, Section for Oceans and Arctic, Kgs. Lyngby, Denmark*

Catches of unwanted species and sizes still challenge numerous demersal trawl fisheries despite extensive research devoted to developing more species and size selective fishing gears over the past decades. The balance between a fishing gear's selective performance for non-target species and the catch efficiency of target species is difficult to achieve in demersal mixed species trawl fisheries. This study aims to provide an information-based solution to efficiently inform and alert fishers of bycatch via automatic image processing and machine learning. We have developed automatic detection of bycatch species by training supervised machine learning models on underwater images from a real-time trawl camera. In detail, we use deep learning-based object detection methods that localize and classify the bycatch species in the video frames. To be able to estimate the bycatch item counts, we used object tracking methods to couple detections in consecutive video frames. We have thereby developed a bycatch notification tool that, in near real-time, informs the fisher how much, when, and where bycatch is being caught during the single trawl tow.

We have acquired in-trawl video data from the Nephrops (*Nephrops norvegicus*) directed demersal trawl fishery in Kattegat, where cod (*Gadus morhua*) numbers are critically low, to demonstrate a bycatch detector that can detect the presence of cod. The model's performance and perspectives of such real-time decision tools for fishers and managers are discussed.

3.10 Poster Session

In this section, the abstracts will be listed in the order of their submission (sorted by ID).

Influence of Hook number on Species Composition, Catch Rate and Size of Needlefishes in the Gulf of Mannar, India (ID 8)

Vinayagamoorthy Naganandhini[1], Kalaiarasan Muthupandi[2], Kathavarayan Vasanth[3], Neethirajan Neethiselvan[4], Pandurangan Padmavathy[5], Kalidoss Radhakrishnan[6]

[1]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, naganandhiniv31@gmail.com*

[2]*Directorate of Incubation and Vocational Training for Fisheries, Ramanathapuram, Tamil Nadu, India, kalaiarasan@tnfu.ac.in*

[3]*Department of Fishing Technology, Kerala University of Fisheries and Ocean Studies, Kochi – 682 506, Kerala, India. kvasanthkvasanth29122@gmail.com*

[4]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, neethiselvan@tnfu.ac.in*

[5]*Department of Aquatic Environment and Management, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, padmavathy@tnfu.ac.in*

[6]*Department of Fisheries Extension, Economics and Statistics, ICAR-Central Institute of Fisheries Education, Mumbai – 400 061, Maharashtra, India, theradhakrishnank@gmail.com*

The contribution of needlefishes from the Gulf of Mannar coast has been remarkable and is presently exploited by pelagic longlines. The J hook is extensively used in longlines in the Indian region to capture carnivore fishes, including needlefish. The catch rate significantly differed between the hook numbers. In this context, three hook numbers of 10 “J”, 11 “J”, and 12 “J” were studied from January to May 2022. Results showed that the Ablennes hians was the dominant fish caught (47.9 %) followed by Tylosurus crocodiles (22.2 %), T. choram (16.6 %) and Strongylura strongylura (13.3 %) in terms of number basis whereas, weight basis T. crocodiles (39.7 %) was higher dominant followed by A. hians (35.9 %), T. choram (13.8 %) and S. strongylura (10.6 %). The two-way ANOVA results revealed that there was a significant ($P < 0.05$) difference between the hook size and the number of species caught. The highest number of fish caught in hook size 12 (3,769) followed by hook size 11 (2,745) and hook size 10 (1,445). However, the highest weight of 2749.74 kg was recorded in hook size 11 and the lowest of 1602.65 kg in hook size 10 ($P < 0.05$) and is related to a lesser number of fish caught in hook size 10 and, heavy fishing pressure on sub-adult (<50 cm) due to the use of hook No12. Considering the maximum total length and weight, the optimum hook number for the commercial exploitation of needlefishes was arrived as hook No 11. The CPUE was disproportionately increased with increasing the hook number; which the significantly higher contribution of 48.25 individuals/1,000 hooks was from hook No 12 whilst hook No 11 and hook No 10 were 35.13 individuals/1,000 hooks and 18.51 individuals/1,000 hooks respectively.

Fishing around the open aquaculture cages using passive fishing gears, a novel concept for effective utilization of resource and energy: preliminary observations from a tropical estuary of South west coast of India. (ID 11)

Prajith K K[1], Risvana B.[2], Sandhya M.[1], Remesan M P[1], Manoj Kumar B[2]

[1]*ICAR-Central Institute of Fisheries Technology, Kochi, India.* prajithkk@gmail.com

[2]*Kerala University of Fisheries and Ocean Studies, Kochi, India.*

Cage aquaculture is one of the efficient and effective means of fish production systems which ensure low impact farming with high returns and least carbon emission. The cages comprise of various components like floating frame, netting materials and mooring systems etc. these structures may act as an aggregation site for wild fishes. To study the extend of assemblage and possibility of harvesting the assembled fishes using suitable fishing gears, an experiment was conducted in the inland fish farms of Vembanad estuary of South west coast of India. Two passive fishing gears, traditional drift gill net and Hemi-Spherical Fish Traps were fabricated and operated near and away from the cage site. Catch composition was analyzed and compared. A total of 1015 fishes belonging to 14 species were recorded from the experimental site. 62% fishes were harvested from the gears operated near cage site. Labeo dussumieri an endemic species to the rivers originating from the Western Ghats of India was the major catch during the study period. Better diversity, richness and evenness index are reported from the gar operated near cage site. Paired sample test for gill nets shows a significant variation ($T=3.717$, $p< 0.05$) in fish abundance among the near cage and control site. Similar observations were recorded for the traps. Analysis of major water quality parameters around the experimental sites shows that there is no significant difference in water quality parameters and its influence on catch composition. Study reveals use of appropriate fishing gear facilitate effective harvesting of assembled, untapped fishery resources which can be an additional income for the fishermen. besides this, harvested live fishes can be used for further fostering in dedicated cages.

Key words: energy efficient fishing, fish assemblage, species composition, fishing environment

Environmental performance of deep-sea gillnet fishing systems (ID 17)

Paras Nath Jha[1], Leela Edwin[1]

[1]*ICAR-Central Institute of Fisheries Technology, Cochin-682029, India,* parasincof@gmail.com

Mechanization brought major developments in deep-sea gillnet fishing systems in India. The gillnet fishing sector has undergone many changes during the last few decades in terms of size of vessel and gear, area of operation and trip duration. In addition to increased catch and exploitation of untapped resources, these developments have also brought several negative environmental consequences, viz. emission of greenhouse gases. In this study comparison has been made on Global Warming Potential (GWP) associated with construction and operation of different length class of gillnet fishing systems. The deep-sea gillnets of length 8-12 km, made of polyamide and mesh size range of 100-150 mm are compared. Catch per unit effort (CPUE) was assessed based on area of gear employed, number of crew, fuel consumed per trip etc. Results shown GWP for construction of gillnets are directly proportional to dimensions of the fishing gear. Gillnetters of different LOA (Length Over All: 14, 16, 17, 18, 19 and 20 m) made of different boat building materials were also compared for GWP. The gillnetters of LOA 18 m emitted the maximum quantity of eq. CO2 and minimum quantity of eq. CO2 emission was from LOA of 14 m gillnetters. Boat building material for construction of fishing vessels and fuel are the key components contributing the GWP and it is higher in larger vessel (18-20 m) compared to medium vessels (14-17 m). For medium gillnetter operation, the GWP was 2.22 kg CO2 eq/ kg of fish landed and for large vessels GWP was 2.31 kg CO2 eq/ kg of fish landed. Fuel contributes maximum to GWP by large gillnetter compared to medium category. Therefore, it is the need of hour to adopt more environment friendly implements for harvest of sea food in order to reduce carbon foot print rather than competitive and unsustainable practices.

Technology and solutions to tackle illegal fishing across the Central and Western Indian Ocean regions - Poster presentation (ID 18)

Dr Claire Collins[1,2], Professor Divya Karnad[3], Sneha Satheesh K[3], Abhishek Dudi[3], Lasuni Chathurima[4], Dr. Mohamed Shainee[5]

[1]*Institute of Zoology, Zoological Society of London, UK and Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY, UK, Claire.Collins@ioz.ac.uk*

[2]*Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn, Cornwall, TR10 9FE, UK*

[3]*Ashoka University, India*

[4]*Oceanswell, Sri Lanka*

[5]*Virginia Tech, Blacksburg, VA 24061*

Illegal fishing is a key threat to socioecological sustainability of fisheries globally. Accordingly, there is an increasing number of proposed solutions to tackle it including enhancing vessel tracking technology, enhancing traceability and labelling of seafood, and bilateral and regional collaboration to tackle key social drivers. The suitability of solutions is highly context-dependent, and uptake will be constrained by factors such as political and economic barriers and specific social drivers of illegal fishing.

This poster will highlight the work of our interdisciplinary and multilateral project that is researching progress, challenges and opportunities to tackle illegal fishing at the local, regional and national level across the Central and Western Indian Ocean (IO) area. It will identify research being done at local and national level in Sri Lanka and India by early career researchers. It will also outline research findings from an expert elicitation process that has engaged with individuals across ten IO countries to identify key proposed solutions to tackle illegal fishing including mean weights and ranking scores for impact of solutions as well as a diagram of top solutions with associated justification.

Overall, we will present an overview of the regional suitability of technology and solutions to tackle illegal fishing and encourage engagement with a related conference session. This abstract submission is for a poster presentation. It aligns with the 'new ideas and projects' topic by highlighting the novel research that is ongoing around the Indian Ocean (IO) area to tackle illegal fishing, a key fisheries management issue. It will also identify salient issues around fisheries technology, such as vessel satellite monitoring systems, that we are researching as a project cohort. This poster is also intended to encourage engagement with the planned conference session on, "how best to tackle illegal fishing in the NW Indian Ocean region".

Abandonment of end-of-life FRP fishing boats along the beaches: a growing hazard on Kerala coast (ID 21)

Sreejith S. Kumar[1], Manju Lekshmi N. [1], Leela Edwin[1]

[1]*ICAR-Central Institute of Fisheries Technology, P. O. Matsyapuri, Willingdon Island, Cochin – 682029, manjuaem@gmail.com*

Fibreglass or glass-reinforced plastics (FRP or GRP) are thermosetting plastic polymer matrices reinforced with glass fibres that are preferred for marine boat construction because of their production capabilities, corrosion resistance, long shelf life, low operating costs, water resistance, maintenance, and good strength to weight ratio when compared to conventional materials. In the initial phases of the replacement of boat building materials, wood/plywood was sheathed with FRP and the latter hull was completely transformed to FRP. As the number of fishing boats is increasing, the abandonment of FRP/sheathed fishing boats is a common practice and the coastal zones are impacted by an escalating intensity of disposal. Impacts relating to aesthetics, loss of public access, reduction in space for fishing, etc are the generally associated issues with boat disposal. Hence, FRP is developed from polymers and monomers, it cannot be separated or recycled. However, limited knowledge is available about the contamination of the marine environment by microplastics, weathered minerals, heavy metals, and, the generation of highly toxic PCDD/Fs that are both airborne and components of the residual ash through open burning. A survey was conducted by ICAR-CIFT to assess the extent of disposal of abandoned FRP fishing boats. The marine districts of Kerala were grouped into the South region (Thiruvananthapuram, Kollam, Alappuzha), Central region (Ernakulam, Trissur, Malappuram) & North region (Kozhikkode, Kannur, Kasaragod) with the selection of nine fish landing centers for the study. The major types of abandonments observed are discarded in the high tide line, disposal sites (huge numbers of abandoned boats), disposed of in water, backyard burning, and landfilling of end-of-life boats. Based on the intensity of boat disposal in each location, GIS mapping was carried out with the help of QGIS software. A total of 292 abandoned boats were observed across nine landing centers, with abandonment ranging from 13 to 48 nos/km (average = 29 km-1) and the ecological effects were also assessed. The results will be baseline data for further studies and formulating guidelines for FRP fishing boat abandonments in the marine environment.

Assessment of stocks to understand trends of data-poor marine capture fisheries of Bangladesh (ID 23)

Mohammed Shahidul Alam[1], Qun Liu[2]

[1]*Department of Fisheries, University of Chittagong, Chattogram-4331, Bangladesh, alamms@cu.ac.bd*

[2]*College of Fisheries, Ocean University of China, Qingdao-266003, China, qunliu@ouc.edu.cn*

According to the Yearbook of Fisheries Statistic of Bangladesh, the marine capture fisheries of Bangladesh are expanding in terms of total landings. This, however, is not the complete picture. While total landings are increasing, the proportion of high-value fish and shrimp species in this landing is declining alarmingly, with low-value fish and shrimp species taking their place.

Therefore, immediate management measures are necessary to prevent further deterioration and rebuild the stock's biomass of those high-value species. Scientific information based on reliable stock assessments is urgently required to formulate effective management measures. However, given the data-poor condition, scientific information is lacking, and management frequently fails to take necessary steps. As a result, these fisheries exploit resources without an adequate management plan. Again, assessing all fish's stock is impractical given the limited resources. Therefore, this study selected twelve common and high-value fish and shrimp species as indicators for evaluating their stock status to understand the fisheries' current trends and provide policymakers with scientific information. The stock health of eight fish species (Tenualosa ilisha, Harpadon nehereus, Bregmaceros mcclellandi, Escualosa thoracata, Ilisha filigera, Johnius belangerii, and Coilia dussumieri) was assessed using length-based methods. The stock status of four high-value fish and shrimp species (Pampus argenteus, Pampus chinensis, Penaeus monodon, and Metapenaeus monoceros) were assessed using catch-based methods. Results revealed the depleted stock biomass of eleven of the twelve species. Existing management measures are also found to be ineffective in preventing the biomass depletion of the species. Based on the findings and lessons learned from previous studies, this study concluded with viable recommendations on lower length limits, total allowable catch limit (TAC) for all species of interest, and a focus on reforming current rules and regulations for sustainable marine capture fisheries in Bangladesh.

Analyzing carbon emission level of motorized fishing sector of Pulicat region (ID 38)

Arun Jenish[1], Velmurugan[2], Neethiselvan[3], Kalaiarasan[4]

[1,2]*Department of Fishing Technology and Fisheries Engineering, Dr.MGR Fisheries College and Research Institute, Ponneri, arunjenish@tnfu.ac.in*

[3]*Fisheries College and Research Institute, Thoothukudi*

[4]*Assistant Professor, Directorate of Incubation and Vocational Training in Fisheries*

Pulicat region is a motorized fishing sector and has two parts such as Pulicat Lake and Pulicat coastal. Adappu valai, Sutthu valai, Baadi valai, Kallu valai, Siru valai, Nandu valai, Konda valai, and Nandu katcha are some of the traditional fishing techniques used in Pulicat Lake. The Pulicat coast also has got different major fishing gears namely Pannu valai, surukku valai, Yeppo valai, Kola valai, Thoondil, Navarai valai, Set valai and Vanjaram valai. As they use powered fishing boats, it uses a significant amount of fuel and releases CO2 into the environment. For the study period of June 2021 to May 2022, the total fuel consumption level by all traditional fishing gears in Pulicat Lake and Pulicat coast was 148515 litres and 1650429 litres, respectively. For the study period, the total carbon emissions from the Pulicat Lake and coast fishing methods were 390594.55 kg and 4340628.27 kg, respectively. According to estimates, fishing in Pulicat Lake and along the coast resulted in emissions of 0.31 tonnes of CO2 and 1.37 tonnes of CO2 for every tonne of fish caught, respectively. When compared to fishing techniques on the Pulicat coast, the traditional fishing methods in the Pulicat Lake emit a very little quantity of CO2. This might be as a result of the little energy required for fishing in Pulicat Lake's tranquil environment and simple capture techniques. Additionally, it was discovered that throughout the study period, the entire motorised fishing sector of the Pulicat region used 0.401 litres and produced 1 kg of fish while emitting 1.06 kg of CO2.

Deep-sea Ichthyofaunal Assemblages in South-Eastern Arabian Sea (SEAS) Through a Combination of Conventional Taxonomy and eDNA Meta-barcoding (ID 39)

Mujeeb Rahiman. K.M[1], M. Harikrishnan[1]

[1]*School of Industrial Fisheries, Cochin University of Science and Technology, Cochin- 682016, Kerala, India, rkmmujeeb@gmail.com*

In India, exploration of deep-sea resources is important for increased fish production as the catches from pelagic and demersal fisheries becoming unsustainable. Continuous and comprehensive studies are to be conducted for a proper understanding of deep-sea resources and their status in the Indian EEZ and beyond. The data regarding the deep sea fishes beyond 1000m depth are scarce and the information generated from the previous studies is not sufficient to understand the diversity and the identity of the deep-sea resources beyond 1000m depth. Considering the importance of Ocean sciences for sustainable development of the country, the Ministry of Earth Science, Govt. of India has recently launched Deep Ocean Mission which aimed at developing technologies to explore deep ocean for resources and their sustainable use, growing the country's marine and maritime economy. One of the focusing areas of this deep ocean mission is the screening of Deep- Sea metagenomic libraries by constructing deep- sea metagenome clone libraries and development of process to screen large scale metagenome libraries. The project idea discuss the ichthyofaunal diversity inhabiting the South Eastern Arabian Sea (SEAS) beyond 1000m depth by undertaking morphological and molecular taxonomy of deep sea fishes of fishery exploitation potential. The project will throw light on the conservation and ecological consideration of the deep-sea ichthyofauna and the result will be used as a basic data for future plans related to deep ocean mission and deep ocean fishing.

Exploitation status of Ochrebanded goatfish Upeneussundaicus (Bleeker, 1855) fishery from Tamil Nadu, India waters using surplus production models. (ID 40)

Sajeevan M. K[1], Abinaya. R.[1]

[1]*Department of Fisheries Resource Management, Kerala University of Fisheries and Ocean Studies, Kochi, 682506, Kerala, India, sajeevanfsi@gmail.com*

In light of the dramatic increase in marine fish production of Tamil Nadu, it is important to analyze the fishery status of major economically important fish species in order to determine their long-term sustainability. The purpose of this study is to assess the sustainability of the Ochrebanded goatfish Upeneussundaicus (Bleeker, 1855) fishery and estimate its current status in Tamil Nadu maritime waters when data is limited. Historical catch and effort of the Ochrebanded goatfish in Tamil Nadu marine water from 2001 to 2020 were reconstructed and analysed using fishery specific stock assessment tools Catch and Effort Data Analysis (CEDA), Catch-Maximum Sustainable Yield (C-MSY), and the Bayesian Schaefer production model (BSM). The best-fitting model was chosen from the CEDA results to investigate the biological reference points (BRPs) of maximum sustainable yield (MSY), biomass yield MSY (BMSY), and fishing mortality yield MSY (FMSY). By correlating the BRP results from both cases and taking B/BMSY and F/FMSY into account, it is clear that the Ochrebanded goatfish fishery resource has reached an optimally exploited stage and that an additional fishing fleet is not recommended for this fishery. As a result, it is suggested that the fishing effort for this fishery be maintained at its current level, without any additional development, and that timely action, such as proper forecasting and legislative implementation, be taken to ensure their long-term exploitation.

Exploitation status of marine fishery resources of Tamil Nadu, India waters using a surplus production modelling approach. (ID 41)

Abinaya R[1], Sajeevan MK[1]

[1]*Department of Fisheries Resource Management, Kerala University of Fisheries and Ocean Studies, Kochi, 682506, Kerala, India, abinayabfsc@gmail.com , sajeevanfsi@gmail.com*

Surplus production models can be performed in any stock assessment framework that incorporates catch and effort data. To determine the marine fishery status of Tamil Nadu, annual catch and effort data from 2001 to 2020 were reconstructed and analysed using the catch effort data analysis (CEDA) software. The average annual landings of Tamil Nadu marine stocks were 5.44 lakh tonnes, with the highest and lowest being 7.74 lakh tonnes in 2019 and 2.87 lakh tonnes in 2005, correspondingly. The estimated biological reference points such as maximum sustainable yield (MSY), biomass producing maximum sustainable yield (BMSY) and fishing mortality producing maximum sustainable yield (FMSY) with the best fit Schaefer- Log Normal using the initial proportion (IP) value of 0.5 were 5.32 lakh tonnes, 35. 3 lakh tonnes and 0.151, respectively. The result of the reference points indicated that the stocks are in a safe condition, and it is recommended that the current level of fishing be sustained to retain the stock at near optimal fishing pressure. Future stock biomass was forecasted by varying total allowable catch (TAC) and future effort levels and it was discovered that a TAC of 2.87 lakh tonnes and effort of 167 million horse power days will yield to stock biomass exceeding total biomass during the next decades.

Does shrimp trawling contribute to the decline of Sciaenid stocks? (ID 43)

N.M.S. Jayasekara[1], D.C.T. Dissanayake[1]

[1]*Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka; chamari@sjp.ac.lk*

Although trawling is widely used to exploit shrimp resources worldwide, it is considered a highly destructive fishing method due to its high by-catch and discards. By-catch levels in shrimp trawling are reported to be in the range of 5–10 times the target catch and consist mostly of fishes belonging to the families Carangidae, Mullidae, Gerridae, Nemipteridae, Leiognathidae, Sciaenidae, Dasayatidae, Siluridae, Lutjanidae, Cynoglossidae, and Sphyrenidae, especially in the subtropics and tropics. Thus, this study aims to assess the status of sciaenids landed by mechanized shrimp trawls, off Handala, Sri Lanka.

Shrimp and by-catch data and samples were collected at the Handala fish landing site (6°59'25.5"N 79°52'27.9"E) by making biweekly field visits from January 2021 to February 2022. On each sampling day, 50–60% of trawlers operating in the shrimp fishery were randomly sampled, and by-catch samples (n = 3) of ~2 kg each were collected to identify the taxonomic status of sciaenids and their composition in the by-catch.

The size at first sexual maturity (L50) and population parameters of highly dominant species, Otolithes ruber, Johnius belangerii, Johnius macropterus, Kathala axillaris were also assessed. Of the estimated total annual by-catch of 25.55 Mt, 26% were from the family Scianidae. Fourteen Sciaenid species belonging to 8 genera including Johnius (Johnieops) dussumieri, which is a new record for Sri Lanka, were reported in this study. Otolithes ruber (27%) made the highest contribution followed by K. axillaris (21%), J. belangerii (15%), J. macropterus (15%), J. borneensis (10%), J. dussumieri (6%) and N. maculata (1%). The size at first sexual maturity of 4 dominant species was assessed and it was estimated that 18% of O. ruber, 1% of J. macropterus and J. belangerii and 2% of K. axillaris were caught before reaching first sexual maturity. Fishing mortality (F, yr-1) and exploitation rate (E) of these species were reported as 1.41, 1.30, 0.33, 1.84 and 0.74, 0.28, 0.51, 0.72, respectively. The high level of exploitation of this non-target sciaenid species by shrimp trawling appears to have some impact on this valuable fish resource, and further studies and immediate management measures are recommended.

Selectivity characteristics of Rainbow Sardine Dussumieria acuta Valenciennes, 1847 with respect to diamond and square mesh cod ends in Indian Trawl Fishery from Bay of Bengal (ID 47)

Raghu Prakash Reghu[1], Kamai,Gaihiamngam[1], Utravalli Sreedhar[1]

[1]Research Centre of Central Institute of Fisheries Technology, Ocean View Layout, Pandurangapuram, Visakhapatnam- 530 003, Andhra Pradesh, India, drraghuprakash@gmail.com

Selectivity studies help gear technologists to isolate the elements of gear or the harvesting procedures that permit the escapement of unwanted bycatch. Huge quantities of bycatch are generated from trawl nets due to their low selectivity and high efficiency. Large quantities of undersized fishes and invertebrates are discarded in the trawl fishery along the Indian Coast. The size and shape of meshes in the codend of trawls play a very vital role in the exclusion of juveniles. In contrast to diamond mesh, square mesh is more selective, for several species. The present study was undertaken to study the size selectivity of diamond and square mesh cod ends with respect to Dussumieria acuta in Bay of Bengal. The L25, L50 and L75 for D.acuta in respect for 40 mm diamond mesh cod end were 12.7, 14.7 and 16.7 mm, respectively. The selection range, selection factor and selection ratio were 3.9, 4.9 and 1.3, respectively. The L25, L50 and L75 values for D. acuta were 14.6, 15.9 and 17.2 mm, respectively for 40 mm square mesh. The SR, SF and SRA were 2.5, 3.2 and 0.5 respectively

Assessing the barriers to uptake of Vessel Monitoring and Automatic Identification Systems for improved fisheries management (ID 49)

Lasuni Chathurima Gule Godage[1]

[1]Ocean University, Mahawela, Tangalle, Sri Lanka, lasunichathuri@gmail.com

Technology plays a substantial role in improving fisheries management. Vessel Monitoring Systems (VMS) and Automatic Identification Systems (AIS) are technologies used to provide continuous and accurate vessel location information in near-real time to monitoring authorities. Potential benefits of VMS tracking include efficient monitoring of fleet dynamics and vessel behaviour, combatting illegal fishing in foreign Exclusive Economic Zones (EEZ) and reduced costs of violence-related investigations, while AIS enables safe navigation and avoidance of vessel collisions.

Through this work I seek to identify the barriers and opportunities for the uptake of VMS and AIS which are tools used for monitoring, controlling and surveillance of fishing vessels at the national as well as international levels. I intend to discuss the conference topics “implementation and implications for fisheries management” and “technical solutions to help investigations” by submitting this abstract. Further, the preliminary findings from this study will be presented during the conference.

Initial results from pilot studies across the Western and Eastern provinces of Sri Lanka revealed that fishers have sufficient technical knowledge of VMS and AIS. Based on the findings, lack of trust in governing bodies and lack of trust in whether battery power will last the journey are two attributes that act as barriers to the uptake and utilisation of VMS and AIS. Overall, these preliminary findings will help inform the overarching research that can potentially ensure more successful implementation of fisheries management policies in Sri Lanka. Further, this study is being done as part of a wider project "Human dimensions of the blue horizon: behavioural insights for compliance and deterrence" that aims to draw specific management and policy recommendations for improving fisher compliance and deterrence in the region.

Impact of derelict fishing gears on vulnerable coastal ecosystems along west coast of India (ID 51)

DivyaViswambharan[1], Sreenath K R[2], Prathibha Rohit[1], Shobhana K S[2], Geetha Sasikumar[1]

[1]*Mangalore RC of ICAR-CMFRI, Hoige bazar, Mangaluru 575 001, divyaarinu.dv@gmail.com*

[2]*Marine Biodiversity and Environment Management Division, ICAR-CMFRI, Kochi*

Derelict fishing gears are widely distributed around the world and they are found to cause serious threat to marine life as they can trap and kill marine organisms indiscriminately, including those belonging to endangered or of economic importance. Majority of the lost fishing gear is made of nondegradable materials and they sink to the sea floor or drift around in currents. Mostly these derelict gears remain unnoticed until they show up on coral reefs, rocky reefs and in other vulnerable coastal habitats. The studies on the generation of ALDFG by various fisheries and their impact on vulnerable coastal ecosystems are limited in the Indian context. Therefore, an assessment of the abundance of ALDFGs and their impact on the floral and faunal assemblages of vulnerable ecosystems was undertaken in the rocky outcrops, which are frequent in the west coast of India. These areas act as the natural shelter, breeding and nursery sites for marine organisms especially reef fishes and sessile organisms. The underwater visual census using rapid visual transect was done at two vulnerable ecosystems, having different levels of fishing intensities from May 2018 to December 2022. The biodiversity in the area surveyed is facing harmful effects due to derelict fishing gears. The derelict gears found in these vulnerable ecosystems are mainly influenced by the local fishing activities. The study highlights the effort taken by research organization and NGOs in mitigating the impacts of ALDFGs on vulnerable ecosystems with a social survey- based on fishers' and other stakeholders' perspective and suggestions to mitigate/ reduce ALDFG.

Developments in the major fishing methods along the Northwest coast of India: dynamics in fishing attributes and species composition (ID 53)

Vinaya Kumar Vase[1], Jayasankar Jayaraman[1], Rajan Kumar[1], Shikha R[1]., Ajay Nakhawa[1], Mohammed Koya[1], Sreenath K. R[1]., Gyanaranjan Dash[1], and Prathibha Rohit[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Ernakulam North, P.O., Kochi-682 018, Kerala, India, v.vinaykumarvs@gmail.com*

No historic spatial fishing information is available to understand the expansion of fishing, depth of operation, catch rates, etc. along the northwest coast of India. Real-time spatial fishery data is limited due to high cost, a vast area to cover, poor infrastructure, and scarce research vessels. The fishing data at the temporospatial scale is crucial in fishery management plans, shifts in fishing grounds, habitat modeling, and marine spatial planning. The Haversine functions are used for arriving at the GPS location of fishing grounds based on the input data like geocoordinates of the landing center, distance travelled (in kilometers), and bearing (in degrees from North) (van Brummelen and Glen Robert, 2013). We investigated the developments in major fishing methods like mechanized Dolnetter (MDOL), multi-day trawlers (MDTN), mechanized gillnetter (MGN), mechanized trawler (MTN), outboard dolnetter (OBDOL), and outboard gillnetter (OBGN). The significant expansion in fishing grounds was observed in terms of distance recently by major fishing crafts like MDOL (28.4±17.5 km), MDTN (104.6±68.2 km), MGN (96.6±67.2 km), MTN (16.8±8.4 km), OBDOL (11.3±7.5 km), and OBGN (15.1±9.1 km). A prominent increase of non-penaeid prawns, penaeid prawns, ribbonfish, and croakers was observed in dolnets. Resources like cephalopods, lizardfishes, threadfin breams, rock cods, and other perches significantly increased in trawl catches in recent times. The depth of fishing was highest for MGN (101.4±58.0 m), followed by MDTN (81.5±33.3 m), MDOL (33.4±13.7 m), OBGN (25.4±10.5 m), MTN (24.6±9.5

m), and OBDOL (19.4±8.6 m). The mechanized fleet in the region indicated an increase in the distance and depth of fishing with modifications in mesh size, engine power, realm-wise operation, craft remodeling, etc. The key factors like poor catch rates in the coastal waters, conflicts with the motorized sector, and demand for resources like ribbonfish, cephalopods, perches, and large pelagic are directing fishers to deeper and farther grounds. Fishing by the major fleet concerning spatial expansion is key for resource monitoring, spatial planning & management, and habitat modeling.

Keywords: fishing attributes; northwest coast of India; georeferenced fishing grounds; market-driven

Indian Marine Capture Fisheries- Gear and effort-oriented stock assessment approaches (ID 54)

Eldho Varghese[1], Jayasankar Jayaraman[1], Mini K.G.[1], Sindhu K. Augustine[1], Sijo Paul[1]

[1]*Indian Council of Agricultural Research- Central Marine Fisheries Research Institute, jjsankar@gmail.com*

The gears and their extent of utilization is the most unassuming commentary about any marine fishing paradigm. Indian marine capture fisheries scenario is replete with situations where the effort both in quality and quantity had decided the quantum of landings and thereby directly or indirectly moderated the whole set of dashboard components from sustainable fishing to optimal market efficiency. The overall dynamics of mechanized and motorized fishing efforts expended in the fifteen years period- 2007-2021 has in it all that could make an analyst undergo an involuntary SWOT mode.

This paper focuses on the recent shots in arm received on the stock assessment front at more than one plane. One such plane is the gear and effort centred modeling of stock abundance. Though most of the famed biological reference points are built around the stock- subpopulation-population- species workflow, the situation in a multi-gear multi-resource fishery, where there is a very thin line between what is primarily targeted and what's next needs an approach that views the scenario through the gear advancement prism. Three candidate models which have the gear details both at generic as well as specific levels are being tried with the twenty years data so a to see their role in guiding the tracking of travails of the most common marine resources of India. A couple of indices that are based on the gear-combinations are also suggested to the intelligentsia for critical review. In a way this work aims at laying down a framework for practical Ecosystems Approach to Fishery Management for the fisheries that are in action in the subcontinent.

Review on marine fisheries management measures in South Asian countries (ID 55)

Murugesan SriHari[1], Pandian Krishnan[1], Rajdeep Mukherjee[1], Elayaperumal Vivekanandan[1]

[1]*Bay of Bengal Programme Inter-Governmental Organisation, Chennai, India – 600 018, sriharimurugesan94@gmail.com*

Marine fisheries in South Asian countries are small-scale in nature, but deploy a large number of boats and use low technology. Like other tropical fisheries, the countries have multi-species and multi-gear fisheries, with heavy dependence on natural fish resources for livelihood by a large fisher population. The major problems facing the fisheries in these countries are unsustainable fishing including overcapacity, depleting fish stocks, and conflicts within the sector and with other sectors. This review summarizes the management measures and regulatory enforcement practiced in four South Asian countries Bangladesh, India, Maldives and Sri Lanka with the objective of assessing the fisheries management performance towards sustainable fisheries. For the purpose of this review, legal documents such as Acts and Policies were retrieved from

FAOLEX and websites of country-specific sources. Legal framework that plays an important role in regulating and managing the fisheries in the four countries focus primarily on input control measures such as fishing effort regulation/limitation, restrictions on gear including mesh size, zoning systems, Marine Protected Areas, and restrictions on seasons and time of fishing. The review shows that a few regulations in the region are not adequately designed and implemented, so they are less effective. Data collection on fish catch, fishing areas and distribution pattern on fish assemblages needs improvement. Issues related to regulation of overcapacity needs to be addressed in order to ensure long-term sustainability of fisheries. In addition, output control measures need to be introduced to complement input controls. As problems in managing marine fisheries are interconnected with other issues such as habitat degradation, pollution and climate change, the laws on management should have an expanded scope with ecosystem considerations and co-management as the fulcrum. As the four countries have close national boundaries and the fish resources are shared between the countries, sustainable conservation and management of shared fish stocks and other living marine resources needs to be ensured through regional cooperation. In conclusion, there is a strong need for policy reforms to meet Sustainable Development Goal (SDG) 14 of the 2030 Agenda for Sustainable Development.

Indian Marine Fisheries- inherently robust or intuitively buoyant? (ID 57)

E. M. Abdussamad[1], Jayasankar Jayaraman[1], Eldho Varghese[1], Somy Kuriakose[1], Ramachandran C.[1], Reshma Gills[1]

[1]*Indian Council of Agricultural Research- Central Marine Fisheries Research Institute, jjsankar@gmail.com*

In states (countries) where fishing is propelled by a workforce that is driven by traditional passion and urge of subsistence in major parts, the study of resource health would be quite dicey. The fishermen, whose creative genius is at its best in face of adversity, occupies the centre stage much before the pundits take a call. Thus, the EAFM and other fisher- ecosystem- resource kinds of approach do form the silent majority of the fishing nations as is evidenced by the reports of various RFMOs. Thus, any transparent and well-founded approach to categorize, analyse and predict a fishery would be heavily dependent on the dynamics of what the fisheries is made of from the fishermen point of view.

This work attempts to analyse the marine fish landing data pertaining to Indian mainland from 2012 to 2021 with a view to arrive at the easiest yet sturdy indicator of the health of common resources that are regularly exploited. With the sensitivity of fish stock status (FSS) approaches mooted by Froese et al(2019) and the Kobe Plot based Overfished- Tending to overfish kind of quadrant based advisories going for a toss in face of certain sudden shifts in fishing patterns that could flummox the seasoned observer, wherein what is targeted turned into a bycatch overnight while that was incidental swaps roles, the kind of fisheries that are in exhibition in India and neighborhood needs to have an out of box way of looking at these falls or spikes in catch rates alongside the evolution of fishing methods. This study focusses on four such measures that help one arrive at the status of fishery health, especially its sustainability, while yielding additional sneak peeks onto the resource resilience and adaptability in short and medium terms. These measures used in tandem or individually are capable of explaining certain unique phenomenon as expressed in Indian marine fishing scenario, wherein stock depletion, rebuilding etc. are quite a complex narrative to set to fore. Thus, these indicators would well establish the undercurrent that marks up the quintessential inner robustness of the ecosystem coupled with the fleeting ingenuity of the fishermen who make the most of their liberty to adopt modes of fishing as much much as their intellectual choice-band. The work comes out with a couple of factors that are pivotal to scale, compare and rank fisheries that fall in this unique range of diverse resources and much more diversified fishing initiatives.

Ref: 10.1093/icesjms/fsz230

Structural Breaks in Fishing Efforts in the Indian EEZ (ID 61)

Eldho Varghese[1], Jayasankar Jayaraman[1]

[1]*Central Marine Fisheries Research Institute, eldhoiasri@gmail.com*

Assessing the status of fish stock is of utmost importance in developing management strategies for the sustainable harvest of marine fishery resources. To make a reasonable assessment of the stocks, information on the fishing effort expended by various gears over the years is very pivotal. This information enables individual catch rates to be evaluated concerning fishing mortality and is commonly used as a basic input in fish stock assessment models. India is one among few countries where a system based on sampling theory is used to collect data pertaining to marine fish landings and fishing efforts and through stratified multistage random sampling design (SMRSD), the Central Marine Fisheries Research Institute (ICAR-CMFRI) estimates landings and fishing efforts each month for smaller non-overlapping geographical regions referred to as fishing zones, covering the entire coast. In this presentation, an attempt has been made to explore the changes in the fishing efforts expended by major fishing gear over the last few decades in the Indian EEZ.

Study on hook and line fishing in Agatti island, Lakshadweep with special reference to the impact of cyclone Ockhi in fishery production (ID 63)

Mohammed Jabir K.K.[1], Salim G[1]

[1]*ICAR-CIFT, Kochi, mohammedjabz44@gmail.com*

Natural disasters can cause significant changes in fish community structure. Cyclone Ockhi reached closer to the Lakshadweep islands on 1st December 2017, as strong winds struck the southernmost islands of Minicoy and Kalpeni. The fish catches from the hook and line fishery during pre-Ockhi and post-Ockhi cyclone period was assessed to understand the impact of the cyclone and a database on hook and line fishing gears and crafts used in the Agatti island, Lakshadweep was developed to understand the impact of the cyclone, which could help later on in fisheries management. The traditional fishing and land rights of the people of Agatti extend as far as Perumal Par reef and includes the small island of kalpitti in the south of Agatti Island. The five-month survey was undertaken regarding the landings of hook and line fishing gears from Agatti island during November 2017 to March 2018. Average monthly production from hand line during the month of November 2017 (Pre- Ockhi period) was 22,416 kg, which reduced to 6,448 kg during the post Ockhi period. During the month of January 2018, the average production was 12,520 kg and in February it was 18,372 kg. The average monthly production of March 2018 was 23,350 kg, which showed that the catches increased to the pre Ockhi period. The outcome of the study and the impact of natural disasters in the island groups is discussed

Need for an action plan for stock validation, fishery management and efficient utilization of myctophid resources in India EEZ (ID 64)

P.M. Vipin[1], M.P. Remesan[2], V. R. Madhu[2], K. Pradeep[1], M.R. Boopendranath[2]

[1]Central Institute of Fisheries Nautical and Engineering Training, Kochi - 682 016, India, cifnethq@yahoo.com

[2]ICAR-Central Institute of Fisheries Technology (CIFT), Cochin-29, India, aris.cift@gmail.com

Mesopelagics are among the most abundant group of fishes which offers excellent scope for development of fisheries in Indian Ocean. Stock sizes of mesopelagic fishes, of which myctophids are predominant, has been estimated as 263 million t and 102 million t, in the Western Indian Ocean and Eastern Indian Ocean respectively. It is mainly used for the production of fish meal and oil and a small percentage is used directly for human consumption. Many of the mesopelagic fishes are known to have high content of wax esters. However, myctophids have the potential to become a major source of fish protein, when efficient harvesting and appropriate processing and value addition technologies are evolved. Currently, commercial exploitation of world mesopelagic resources is minimal due to the unavailability of optimized resource specific harvesting technology and inexpensive processing technologies.

Though there has been no targeted fishery for myctophids in the eastern Arabian sea, they constituted a significant proportion of bycatch generated. This present paper is based on the work carried out under the project "Assessment of Myctophid Resources in the Arabian Sea and Development of Harvest and Post-harvest Technologies" as part of MoES, Govt. of India/CMLRE funded project. During the period of 2009-10 a total by-catch of deep-sea shrimp trawlers was estimated at 11,488 t, of which myctophid constituted about 32% (3676 t). Available estimates on abundance and the new information indicate that about 16 species of myctophids occur in Arabian Sea as per the present study, and if sustainably harvested with economically viable midwater trawling and judiciously utilized, can form a significant source of fish protein and contribute to the nutritional security. While the present catch levels are sustainable, the stocks can become unsustainable when the fishery expands and intensifies in the future, particularly due to increasing demand from the fish meal industry unless a proper fishery management plan is adopted. Since this resource plays such a crucial role in the ecosystem, there is a need for better resource management and governance. Techniques for unlocking nutritional quality are also needed, as is the development of harvest technology that is biologically sustainable and socioeconomically viable for commercial use.

Mortality of sharks and other large pelagics in Indian tuna fisheries (ID 68)

Sijo P Varghese[1], Ayoob AE[1], Jacob Thomas[1], Sujit Kumar Pattnayak[1], Solly Solomon[1], R Jeyabaskaran[1]

[1]Fishery Survey of India, fsikochi@yahoo.co.in

The at-haul mortality of sharks and other large pelagics caught during the longline; gillnet; hook and line and pole and line fishery targeting tunas were studied for drawing inferences on the ecological risk of these fisheries and to estimate the survival of sharks, rays, bill fishes, tunas and tuna like fishes caught as bycatch in the tuna fishery of Indian seas. The data gathered during survey voyages of tuna longline vessels of Fishery Survey of India, the observations recorded onboard the pole and line fishing vessels during the tuna tagging exercise during the period 2005 - 2008 and the in-person interview of the fishermen involved in gillnet and hook and line fisheries were used for the present analysis. The study revealed that the thresher sharks (Alopias spp, 91 ± 5.2%), pelagic stingray (Pteroplatytrygonviolacea, 96.2 ± 3.2%) and common dolphin fish (Coryphaena hippurus, 75.7 ± 12.5%) recorded minimum at - haul mortality while the sword fish (Xiphias gladius), skipjack tuna (Katsuwonus pelamis) and the long snouted lancet fish (Alepisaurus ferox) had maximum mortality in long line fishery. Maximum survival rate was observed in pole and line fishery (100%) followed by hook and line whereas in gillnet fishery the at-haul mortality rate was high irrespective of the species being caught. The study indicates that the type of hooks used (circle vs J hooks; barbed vs barbless), immersion time, the extent of time since the fish being hooked and the site of hooking had a significant role in the survival rate. Based on the observations and the factors influencing the mortality the study helps to get an idea on the post release survival rates as well.

Prospects and potential of artificial reefs in replenishing coastal and neritic fishery resources in India (ID 69)

Solly Solomon[1], Sijo P Varghese[1], Ayoob AE[1], Jacob Thomas[1], Sujit Kumar Pattnayak[1], R Jeyabaskaran[1]

[1]*Fishery Survey of India, fsikochi@yahoo.co.in*

The rich and diverse coastal and neritic waters are often put under immense anthropogenic pressure by fishing, navigation, tourism and wide extend of pollution by marine as well as terrigenous inputs. Though the fishing potential of India is estimated to be 5.31 million metric tonnes, the lion's share of fishing operations at present are concentrated just within the coastal waters. Reefs and rocky grounds act as natural shelter and breeding ground for various commercially important species. The global rise in temperature coupled along with ocean acidification alters the pace of calcareous deposition in the marine ecosystem and cause wide spread damage to the reefs and the reef associated/depended fishery resources. The increasing fishing pressure coupled with habitat degradation heighten the pace of fishery resource depletion. To tackle this decline in fishery resources and increasing unemployment, replenishing the nearshore waters with artificial reefs that restores the natural fishery resources is found to be an effective, eco-friendly and sustainable management program. In a country like India with multi-gear and multispecies fisheries along with widespread and active regional and international maritime activities the introduction of artificial reefs should be carried out after proper scientific studies so as to specifically identify the most suitable site which can be explored. This mini review will bring to limelight the various parameters that has to be the prime checkpoints in site selection for successful deployment of artificial reefs to augment fishery resources.

Addressing issues of fisheries bycatch in the Indian Seas on a conservation angle (ID 70)

Rekha J Nair[1], E. M. Abdussamad[1], A Gopalakrishnan[1]

[1]*ICAR -Central Marine Fisheries Research Institute, Kochi 682018, Kerala, rekhacmfri@gmail.com*

Bycatch is defined as the incidental take of undesirable size or age classes of the target species, or to the incidental take of other non-target species or protected, endangered, or threatened species (FAO, 2010). Bycatch can be sold, or it may be unusable or unwanted for a number of regulatory and economic reasons and therefore thrown back to sea (i.e., discarded), either alive with injuries or dead (Harrington et al. 2006, FAO, 2010). Bycatch and discards in trawl fishing is a serious issue that requires prompt interventions. Different management measures are being followed to mitigate this issue among the catch in the form of juveniles is harmful as it reduces future yield. As juvenile fish catching became rampant and started affecting the total catch, the government has brought out a list of minimum legal size for various species which was based on the recommendations of Central Marine Fisheries Research Institute.

Studies on Spiny cheek grouper, the main commercial grouper resource showed that in 2009-2010, individuals of this species landed in trawls ranged from 10-32 cm, and immature individuals constituted 74% of the catch and a further 26% were nearly mature (predominantly 1+ year class fish). In 2011-2012, immature individuals also dominated trawl landings (CMFRI 2011-2012). In the

Bycatch poses a significant threat to marine megafauna such as elasmobranchs comprising sharks, rays, skates and sawfish. Recent research suggests that with fishing effort increasing worldwide, there is a need to evaluate strategies intended to reduce marine megafauna bycatch. A concerted effort by the Government to ear mark fishing grounds from the areas of juvenile occurrence/spawning and breeding grounds of fishes may be a small step in the bycatch reduction process. The paper will evaluate recent trends and possible solutions

Studies on the distribution and abundance of yellowfin tuna, Thunnus albacares in the east coast of India using GIS (ID 71)

Babu Chelliah[1], Anntonet Daffodil Agilus[2], Anrose Antony Pillai[3], Jeyabaskaran R[4], Tiburtius Antony Pillai[5]

[1]*Central Institute of Fisheries Nautical and Engineering Training, Royapuram, Chennai, babufsi@gmail.com*

[2]*Anna University, Chennai , daffodilbabu@gmail.com*

[3]*Fishery Survey of India, Chennai , anrosefsi@gmail.com*

[4]*Fishery Survey of India, Mumbai,jbcmfri@gmail.com*

[5]*Fishery Survey of India, Chennai tibufsi@yahoo.co.in*

In this paper, an attempt has been made to map the Yellowfin Tuna Thunnus albacares using Quantum Geographical Information System (QGIS) based on the data collected from the survey cruises of the vessel Matsya Drushti during the period 2015-2019. The abundance of the species in the east coast of India is evident from the fact that the average catch rate obtained has been 71.54Kg/1000 hooks constituting 68.75% of the total monofilament long line catches. The area wise hooking rate in 1oNx 1oE indicates that highest hooking rate of 4.92% recorded in the area 14oN/84oE. The studies revealed that during October-December Yellowfin Tuna are abundant in east coast of India. The monthly variation in the catch shows that the December recorded the highest hooking rate of 0.83%. The potential Tuna fishing areas and seasonal abundance of Yellowfin Tuna in east coast of India are mapped using QGIS.

Keywords: GIS, Yellowfin Tuna, Longlining, Abundance.

Application of geostatistics in the mapping of bycatch distribution from mid-water trawlers in the north-eastern Arabian Sea: A step towards the Marine Spatial Planning (ID 73)

P. Abdul Azeez[1,2], Prathibha Rohit[1], K. Mohammed Koya[1], Latha Shenoy[2], Ashok Kumar Jaiswar[2], Mini Raman[3], Shikha Rahangdale[1], Divu Damodaran[1]

[1]*ICAR- Central Marine Fisheries Research Institute, Cochin- 682018, Kerala, India, azeez.cr7@gmail.com*

[2]*ICAR-Central Institute of Fisheries Education, Fishery Resources, Mumbai- 400061, Maharashtra, India.*

[3]*Space Applications Centre, Indian Space Research Organisation, Ahmedabad- 380015, Gujarat, India.*

nformation on the distribution of bycatch in fishing grounds is essential for developing spatial conservation planning to reduce fisheries' adverse impacts on ecosystems. The lack of such information limits the spatially explicit management measure for managers and policymakers in Indian waters. Therefore, a preliminary spatio-temporal distribution study of nine key species of mid-water trawlers targeting largehead hairtail (Trichiurus lepturus) was analyzed on the northwest coast of India to identify the most persistent areas of key bycatch species. Spatio-temporal distribution patterns of fish were analyzed using semi-variogram models, and maps obtained by kriging interpolation revealed significant differences in bycatch abundance by species

and associated habitat or depth preferences. Furthermore, a significant positive correlation between species observed in bycatch abundance indicated that few share the same habitat in the region. Key bycatch species were concentrated in the inshore area (<70 m depth) during the post-monsoon and summer seasons, but their density decreased significantly in winter. The new knowledge of the spatial pattern and temporal distribution of key bycatch species in the fishery will support the future application of spatial management measures, such as the designation of no-fishing zones and their integration into a conservation network. Furthermore, this framework can be applied more broadly to inform ecosystem management and priority areas for conservation or fisheries regulation.

Implication of shifting spawning seasons on marine fisheries management: A case study from Gujarat (ID 75)

Shikha Rahangdale[1], Rajan Kumar[1], Abdul Azeez P.[1], Vinayakumar vase[1]

[1]*Central Marine Fisheries Research Institute, Kochi, Kerala-682018, India, shikharahangdalecife@gmail.com*

Temporal closure is one of the effective means of regulating and managing fisheries, especially in the tropical marine ecosystem. The Marine Fisheries Regulation Acts (MFRAs) enacted by maritime states of India empowers the state to declare temporal closure as a part of the marine fisheries management plan. At present, India has a uniform monsoon ban of two months along east and west coast of India. The ban is intended to provide a refuge for the spawners from fishing to ensure sufficient recruitment in the following fishing season. However, the climate change has been hypothesized to alter the spawning season of the fish stocks, making temporal management of fisheries an increasingly cumbersome task. A study was conducted at Gujarat to identify the peak spawning season of the major commercial fisheries resources, including finfishes and shellfishes. The identified peak season was compared with the previous reports from the NW coast of India to visualize any shift in the breeding season. For most of the selected species, the post-monsoon or winter season were identified as the peak spawning season. Interestingly, the direction of shift in breeding season was different for pelagic and benthic resources. A marginal shift of peak breeding season towards winter is observed in demersal predator species, whereas a shift towards post monsoon is observed in some of the pelagic and crustacean resources. The study highlights the need to revisit the current temporal closure and its effectiveness towards ensuring sufficient recruitment for sustaining long-term harvest from the fishery.

Incidental occurrence of ALDFG in commercial trawls of Kerala, India (ID 82)

Damaris Benny Daniel[1], Saly N Thomas[1]

[1]*School of Industrial Fisheries, Cochin University of Science and Technology, Lake Side Campus, Cochin, India, damarisbenny@gmail.com*

Commercial fishing activities generate substantial marine litter through abandonment, loss, or discard of fishing gear (ALDFG). ALDFG is considered a stressor to the fishing industry that has the potential to reduce its resilience. However, the presence and impact of ALDFG have been assessed only in a few localized fisheries. The objective of the present study was to assess the quantity and composition of ALDFG in incidental plastic debris caught by commercial trawls in Kerala and to examine its impacts. Plastic debris incidentally captured during fishing was collected from 10 multiday trawlers operating in the Kollam region of Kerala from August 2017 to May 2018, in a participatory mode with the Suchitwa Sagaram mission team. The Suchitwa Sagaram mission is a project of the Government of Kerala and the Kollam District Fishing Boat Operators Association that involves the collection of debris caught during fishing operations by fishers. Among the collected plastic debris, major contributors (by number) were polythene bags (33%), food packaging (28%), plastic sack pieces (11%) and plastic bottles (9%). The major ALDFG was fishing net pieces (6%), synthetic ropes (4%) and floats & buoys (1%). Based on weight, the predominant item was fishing net (22%), followed by ropes (18%), and plastic bottles (13%). The most common problems of ALDFG, according to trawl operators, were restricted catch, hindrance to fishing operations, lost fishing time, and damage to fishing gear. Since multi-day trawlers landed a considerable amount of plastic debris after each fishing trip, expanding Suchitwa Sagaram type debris removal programs to other regions could be a cost-effective strategy to clean the ocean. Establishing proper collection and disposal mechanisms for debris caught during fishing operations can minimize the practice of it being thrown back into the sea, thereby reducing plastic accumulation in the aquatic environment.

Towards Electronic Monitoring (EM) in Indian marine fisheries: How far to go? (ID 87)

Akhilesh, K.V[1], Anulekshmi C.[1], Muktha M[1], Ajay D. Nakhawa[1], Santosh Bhendekar[1], Rajan Kumar[1], Shoba Joe Kizhakudan[1], Abdussamad E.M.[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala, India, akhikv@gmail.com*

In the last few years, the structure of ocean usage by mankind has changed significantly. The fishing industry has become increasingly regulated as awareness of the impact of fishing on marine resources has increased. Fisheries dependent data collection and monitoring has also increased, as more data is needed to assess the status of fish stocks, and evaluate impact of fishing and anthropogenic activities. The importance of marine capture fisheries to the Indian economy is increasing, especially in livelihood, nutrition support, and appropriate use of resources. For years, India has been focusing on increasing capture production from the EEZ, ABNJ and under-exploited regions of the sea to support nutrition, increase foreign exchange, and manage its fisheries sustainably.

Nearly 0.25 million fishing vessels venture into Indian seas from a coastline of over 8000 km and they operate in 2.02 m km2 EEZ. However, the fishing details in its EEZ and beyond namely area of operation, crew, duration, catch composition and discards are limited and collection of such information is challenging, putting a significant gap in Monitoring, Control, and Surveillance (MCS) systems in Indian seas. As the focus on sustainable fisheries is increasing and monitoring is emphasized by global, regional and national fisheries management bodies, it is the right time to focus attention and address the critical gaps in MCS in Indian marine fisheries which can affect maritime security and sustainable resource utilization.

Though some attempts have been made towards improving MCS systems in Indian marine fisheries, they have been limited to small trials or to a limited area. In this article, we review the MCS system currently existing in India with respect to the surveillance systems available, apps developed and fleets currently being subjected to MCS. In addition, we provide a plan for improving MCS systems in India. An improved and effective MCS system will facilitate enhanced traceability and ensure that an increasing amount of seafood is sourced from sustainable fisheries. Moreover, an effective MCS system will also improve sea safety particularly in the offshore, distant and high seas thereby ensuring security to life and livelihoods.

Keywords: Blue economy, maritime security, fisheries, livelihood, monitoring, High sea fisheries, surveillance, MCS

Augmenting commercial lobster fisheries through sustainable capture-based mariculture in open sea cages (ID 89)

Mayur Shivdas Tade[1,2,3], Damodaran Nair Divu[2,3], Suresh Kumar Mojjada[3], Jaishree Bhardwaj[3], Aarsha Subramanian[3]

[1]*Kerala University of Fisheries and Ocean Studies, Panangad, Kochi, Kerala 682506, INDIA, mayur.tade@gmail.com*

[2]*ICAR-Central Marine Fisheries Research Institute, Kochi-682 018, Kerala, INDIA.*

[3]*Veraval Regional Station of ICAR- Central Marine Fisheries Research Institute, Veraval-362 269, Gujarat, INDIA.*

Lobster is one of the highly valued seafood commodities with well-established export markets across the globe. Lobster fisheries are tremendously significant to the economies of many nations due to the ever-growing demand for this priced seafood. The wild lobster resources have been severely depleted through overfishing and poor enforcement of regulations. Globally, enormous efforts have been initiated to protect natural lobster populations through various means. The majority of lobster fishing along the Indian coast is limited to the northwest, southwest, and southeast areas of Indian seas. The annual catch of lobster has dramatically decreased owing to destructive fishing practices. Mud spiny lobster (Panulirus polyphagus) is one of the key potential species in India that commands a strong national and international market. Trawl nets are mostly used for the lobster fishing along the northwest coast of India, which is exclusively non-selective in nature leading to capture of large as well as small undersized lobster juveniles. These undersized lobster does not fetch good price in the market and reduces the economic income of fisherman. The value addition can be done by subjecting it for fattening in open sea cages which will allow fish farmer to gain good market value without putting any additional pressure over the wild stock. Additionally, as the hatchery produced seed availability of lobster lacks in India, the idea of Capture Based Mariculture (CBM) of lobster in open sea cages is proposed to meet the ever-increasing demand without affecting lobster fishery in a sustainable manner. Mariculture is not a cure, but technically sound sustainable management plans may contribute more to better economics, systematic management of dwindling resources and its resource efficiency while improving the livelihoods of dependent traditional fishers. The research done along the coast of Saurashtra in the Indian state of Gujarat revealed the potential of capture-based open sea cage mariculture of mud spiny lobster to enhance the wild lobster population through concerted scientific measures such as release of gravid females back to the open seas from the farm reared ones.

Keywords: Lobster fishery, trawl nets, open sea cage farming, capture-based mariculture, livelihood

Using Vessel monitoring technologies to detect the fishing ships in Mumbai Harbor (ID 91)

Abhishek[1]

[1]*Ashoka University, India, Abhishek_phd22@ashoka.edu.in*

Understanding the regional and global ecological impacts in marine ecosystem is directly linked with the patterns of human activities in the ocean. From a scientific perspective mapping and monitoring of these dynamic human patterns has played a crucial role in sustainably managing the oceanic activities. Use of vessel monitoring technologies has assisted in enforcing management measures to ensure the ecological and biological sustainability of the marine areas. AIS (Automatic Identification System) has been used in past for detection of fishing ships however, data for the Indian Exclusive Economic Zone (EEZ) is very limited due to small number of fishing vessels having AIS installed. Therefore, this study uses both AIS and SAR (Synthetic Aperture Radar) satellite images to detect the fishing vessels in Mumbai Harbor region. This poster will highlight the results of detected fishing ships using SAR and AIS data for the Mumbai Harbor.

This distinction of fishing vessels from other types of ships will aid in knowing the vessels involved in fishing. In addition, study is using the participatory GIS tools in order to improve the accuracy of the fishing ship detection. The poster addresses the conference objective focused on "examining the feasibility and impacts of current management and policy to tackle the illegal fishing by foreign fleets". The poster is presenting the initial research works conducted in Mumbai which will provide an outline of the long-term research focused in the Indian EEZ area.

Effect of 'J' hook shapes on Catch rate, Efficiency and Hooking position of Needlefish: Evidence from Palk Bay, India (ID 92)

Kathavarayan Vasanth[1], Kalaiarasan Muthupandi[1], Vinayagamoorthy Naganandhini[1], Manoj Kumar[1], Amrutha Krishnan[1], Harsha[1], Kalidoss Radhakrishnan[1]

[1]*Kerala University of Fisheries and Ocean Science,* kvasanthkvasanth29122@gmail.com

The efficiency of different shapes of 'J' hooks No.11 (non-offset straight hook, 10° offset kirbed hook and 10° offset reversed hook) in needlefish longline fishing gears were operated in 24 fishing grounds in Palk Bay, India from, February to July 2022. A total of 24 fishing trips were conducted for each experimental gear for the comparative study, with 14,400 hooks, with a total catch of 582 fish during the study. The result appeared that, the kirbed hook had the highest percentage composition of the needlefish (37.36%), followed by the reserved hook (31.79%), and the straight hook (30.75%). Further, the overall hooking rate was higher for the kirbed hook than for the straight hook (13.43% versus 8.60%). Considering the catch rate, the overall CPUE (individual/200 hooks) of the kirbed hook was higher (9.08 versus 7.45) than that of the straight hook, whereas for straight hook, the CPUE of non-target species (0.29) was much higher than that of kirbed hook (0.12). In terms of the targeted species, the Ablennes hians showed the highest CPUE of 3.78 individuals/200 hooks followed by Tylosurus crocodilus crocodilus (1.78), Strongylura strongylura (1.38), and least dominant CPUE was T. choram (0.94). The percentage of hooking position in the jaw was higher in kirbed hook than that of a straight hook (64.7% versus 39.1%), and was found lower in gut system (11.5% verses 28.5%). Among the three hook shapes tested, the overall performance of '100 offset kirbed hook' was found to be better than the other '100 offset reversed' and 'non-offset 'J' hook' in terms of higher catch efficiency, hooking rate, CPUE, and hooking position for needle fishes (<0.05).

Length-weight relationships of eight pelagic carnivore fishes by longlines of Gulf of Mannar, India (ID 94)

Kathavarayan Vasanth[1], Kalaiarasan Muthupandi[1], Vinayagamoorthy Naganandhini[1], Manoj Kumar[1], Amrutha Krishnan[1], Harsha[1], Kalidoss Radhakrishnan[1]

[1]*Kerala University of Fisheries and Ocean Science,* kvasanthkvasanth29122@gmail.com

The length-weight relationships were estimated for 8 pelagic carnivore species caught in the Gulf of Mannar, India using experimental longlines. The experimental study from January to October 2022 in fortnightly intervals, using longlines (3000 m for needlefish and 11,250 m for carangids) equipped with each 600 various "J" type fishing hooks (straight, reversed, kirbed). The hook sizes used were standard size numbers 8 and 11 were carangids and needlefish respectively. The longlines fabricated with polyamide monofilament line were operated from 1-2 m for needlefish and 20 to 25 m for carangids depth for 3 – 5 hours each time. Overall, 21,150 hooks were deployed in 24 fishing trials for each experimental longline. The total length and total weight of the combined sex group were recorded nearest to 0.1 cm and 0.01g, respectively. By using the logarithmic transformed data, linear regression analysis was performed to calculate a and b values for eight fish species to establish length-weight relationships. The parameters for the length-weight equations for three species are provided along with the respective coefficient of correlation and the 95% confidence intervals. A new maximum total length was recorded for four needlefish species, viz., for S strongylura strongylura (80), Tylosurus choram (91), T. crocodiles (97), Ablennes hians (96), and carangids species Caranx bajad (60.5), Alectis indicus (62), C. ignoblis (69), S. commersoninaus (74).

A survey on impact of Ghost net on Active and passive gear: Special reference to Trawl and Monofilament long line in coastal and deep-sea water respectively (ID 98)

Harshavardhan D. Joshi[1], Ashok S. Kadam[1]

[1]*Mumbai base of Fishery Survey of India, Sassoon Dock, Colaba, Mumbai-400005, harshjoshi-cofsn@gmail.com*

Fishery Survey of India having 11 vessels for research and survey purpose in which 4 vessels are long liners and 7 vessels are trawlers. As gears become more multifarious, it may necessitate apprising of vessels in size, power and design. A basic sympathetic of the properties, function and operation of the major fishing gears and methods is therefore vital. Hence this is suggested for decision making in fisheries management, chiefly when it comes to technical procedures in fisheries protocols. The misplaced gears referred to as abandoned, lost or otherwise discarded fishing gear (ALDFG) continue to catch fish's even though fishermen have missed the control over those gears, referred as Ghost fishing, which is mostly due to passive gears like gillnets, tangle nets, trammel nets, traps etc. This study shows the comparison of how much quantity and times the ghost fishing net entangled/caught during long line and trawler respectively.

Impact of 'J' hook shapes on Hooking rate, Catch rate and Hooking position of Carangids for the Gulf of Mannar, India (ID 99)

Kathavarayan Vasanth[1], Kalaiarasan Muthupandi[1], Vinayagamoorthy Naganandhini[1], Manoj Kumar[1], Amrutha Krishnan[1], Harsha[1], Kalidoss Radhakrishnan[1]

[1]*Kerala University of Fisheries and Ocean Science, kvasanthkvasanth29122@gmail.com*

A total of 15 fishing trips were conducted to analyze the efficiency of different 'J' hook shapes along the coastal waters of the Gulf of Mannar from February to August 2022. The percentage compositions of the carangids using kirbed hooks appeared to be 43.75%, 30.68% for reversed hooks, and 25.56% for straight hook, the overall hooking rate of carangids was higher for the kirbed hook (16.74%) than for the straight hook (7.76%). Considering CPUE (individual per 150 hooks) of the kirbed hook was (6.4 versus 3.75) higher than that of the non-offset 'J' hook, the percentage of hooking position in the jaw was higher in the kirbed hook than that of the straight hook (55.84% versus 37.76%), and it was found lower in the gut system (14.29% versus 24.07%). Among the three hook shapes of hook number 8 tested, the overall performance of 'offset kirbed hook' was found to be better than other offset reversed and non-offset 'J' hooks in terms of higher catch efficiency, hooking rate, CPUE, and hooking position for carangids.

Status of Mechanised Gillnet fisheries of Northern Maharashtra in challenging times (ID 102)

Ajay D Nakhawa[1], Anulekshmi C.[1], Akhilesh K. V[1], Santosh N Bhendekar[1], Ratheesh Kumar R[1], Thakurdas[1], Prathibha Rohit[1], Abdussamad E.M.[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Ernakulam North, P.O., Kochi-682 018, Kerala, India, ajaynakhawa@hotmail.com*

Maharashtra, having a coastline of 720 kilometers, is one of India's major contributors to marine fish production. The Satpati fishing village in northern Maharashtra is an important commercial center for the marine fishery, targeting high-value fishes such as pomfret, large pelagic, elasmobranch, and Hilsa shad by mechanized multiday gillnetters. Satpati gillnet fishers' fishing location is off northern Maharashtra and off southern Gujarat, where trawling operation is less intense due to the geographical patterns and intense use of fixed gears in the region. As the region is known for high-value fishes, the fishers from Northern Maharashtra mainly operate stationary bag nets and various types of gill nets to exploit these economically important fishes. The Satpati village and fishers adjacent to Satpati village have adopted gill net fishing since the 1960s as the major fishing practice, which led to the region's economic development. The Satpati Fisheries Cooperative Society is recognized as a model cooperative in the marketing of fish through the tender system, where a minimum price is assured for high-value fish. Self-imposed conservation measures adopted by the Satpati gillnet fishers, such as extended closed fishing season and the use of large mesh nets throughout the year to avoid juvenile bycatch and ensure the conservation approach to marine fauna. Fisheries Cooperative Society also engages in the welfare of the fisher's community through various social programs. Technological changes in craft and gear and its operations have taken since the introduction of the gill nets, which improved the community's socio-economic status. In recent years, extreme events, catch fluctuation, labor shortage, increased input cost, and sectoral conflicts over fishing-space affected fishery's profitability. The study presents the coping mechanism of mechanized gill netter fishery in the impact of dwindling catch, inflation in operation cost, and other sectoral issues affecting the cooperative sector while promoting sustainable fishing practices.

Keywords: Gill netter, fisheries, livelihood, Sustainability, cooperative, Arabian Sea

Comparative analysis on the impact of design on the drag resistance of trawls operated from different size class vessels of Thoothukudi, Southeast coast of India (ID 106)

J.Amala Shajeeva[1], N.Neethiselvan[1], S.Archana[1], T.Ravikumar[1]

[1]DFT&FE, FC&RI, Thoothukudi, India, jeeva.julin@gmail.com

A study was conducted to analyse the design features and drag resistance of trawl nets operated from three types of trawlers being operated from Thoothukudi fishing harbour, (8º47′N &78º9.5′E) viz Type 1 trawler (45′ OAL), Type 2 trawler (55′ OAL) and Type 3 trawler (65′ OAL). The drag resistance was estimated based on the twin surface area of the net and trawling speed. The study revealed that all the trawl designs of Thoothukudi have been evolved with excess twine surface area. Among the three types of trawlers, Type 3 trawler was found operated relatively with higher Head Rope Length (HRL). The HRL was found to be about 25.2 % longer than the optimal length recommended by Koyama (1970). The total stretched length of trawls operated from different size class vessels were found to be 1.48 to 1.77 times longer than the recommended length. Further, the stretched length of overhang of trawls operated from all the three size classes of trawlers were about 2 to 3 times higher than the recommended stretched overhang length. All the trawl designs were also found to have very low horizontal hanging co – efficient ranging from 0.05 to 0.25, leading to excess accumulation of webbing at the mounting region which lead to excess surface area of the net in trawls of all the three types of vessels. This error could be inferred as the excess drag resistance of 52%, 87% and 91% in Type 1, Type 2 and Type 3 trawlers during trawling. The study implied that the trawl nets of Thoothukudi have been designed with the objective of increasing the mouth opening so as to sweep a larger area and collect more fishes. However, excess mounting of webbing in the head rope has lead to the increased drag resistance and eventually resulted in excess drag and thereby found increased the fuel consumption.

Keywords: Trawler, HRL, twine surface area, drag resistance, stretched overhang length, stretched length of net, increased fuel consumption

Lost gear retrieval exercise through scuba diving and analysis on the fate of derelict gears in Tamil Nadu, India (ID 114)

Harsha K[1,2], Saly N Thomas[1], Sandhya K. M[1]., Aiswariya Ghosh K. A[1]., Mary Baby[1]

[1]*ICAR-Central Institute of Fisheries Technology, Kochi-29, Kerala, India*

[2]*Kerala University of Fisheries and Ocean Studies, Panangad, Kerala-682506, India. harshakrishna2018@gmail.com*

Globally, generation of Abandoned, Lost or otherwise Discarded Fishing Gears (ALDFG) have become a serious concern because these pave way for ghost fishing, entanglement of marine organisms and finally when accumulate on bottom a blanketing effect to the bottom substratum affecting the biological and ecological processes of ocean system. The higher probability of passive gears to become derelict gear and an agent of ghost fishing has been proved scientifically. Retrieval of lost gears is an exercise done to prevent the chances of ghost fishing. In this background, gear retrieval exercise was carried out in the trap fishing grounds along Enayam coast of Tamil Nadu. The dive sites were identified from the fisher's knowledge on the probable derelict gear accumulation areas. The scuba dive study by scanning an area of 700 m2 of sea bottom along Enayam and Enayam Puthenthurai (80 12.886'N ,770 10.874'E) coast within 20 m depth retrieved derelict traps (71%), gillnets (13.9%), long line (7.5%), trawl (4.1%), ropes (2.5%) and squid jig (1.0%) which totally weighed 33kg. The study also found prominence of geographic and local tidal and current patterns in the rate of gear loss. Occurrence of ghost fishing couldn't confirm in the study. However, examination of retrieved traps showed colonisation of benthic organisms including bivalves (59.14%), echinoderms (16.13%), gastropods (10.75%), chelicerates (8.6%), crustaceans (5.38%) and uncountable smaller parts of poriferans and cnidarians which provide meagre evidence for ghost fishing in these gears. Even if the study substantiates the gear loss rate at a lower level (<50%) from fishers' perception it demands a detailed impact assessment study. Observations from retrieved gears provide minimal evidence for ghost fishing, instead the derelict gears become an aggregating device which harboured organisms from other external influences especially during spawning and advancing stage. This study demands further research in the direction of assessment of gear loss, retrieval and impact assessment in different fishing systems in the Indian waters.

The operating management and maintenance strategy of an Indian Fishing vessel. The factual observance and practice of a case study (ID 123)

K.B. Bijumon[1], S. Shaji[1], A.S Arun[1], S. K. Sreekanth[1]

[1]*Central Institute of Fisheries Nautical and Engineering Training, (CIFNET), Fine Arts Avenue, Kochi-16, Kerala, India, cifnethq@yahoo.com, cifnet@nic.in*

The mechanized Fishing vessels are intended to operate various fishing gears such as trawls, long lines, gill nets, purse seines etc. Right from the construction to the operational stage, these fishing vessels has to comply with various rules and regulations exerted by competent Government authorities. First of all, the vessel has to construct with a registered boat building yard/ship building unit as per the regulations of Department of fisheries to avoid overcapitalization. Subsequently, irrespective of steel hulled or wooden hulled, the vessels are registered with concerned Department of fisheries wherein licensing of fishing is issued. With regards to safe manning requirements, a comprehensive rule is applied by Mercantile Marine Department (MMD), Govt. of India, in case of vessels with 20 m. Over All Length (OAL) and above or otherwise as per rules existing with Department of Fisheries. Since, the vessel is plying up to EEZ or in high sea, the safe manning requirement is mandatory for sea safety. As a conservative management measure and sea safety precautions, the fishing vessels need to obey an array of fishing regulations and rules implemented by various costal states of the country. Further, the trawling ban is implemented for a specific period in every year, along both east and west coast of the country, wherein the mechanized fishing is regulated/restricted as a conservative management and stock replenishment strategy. Regarding maintenance and repair of steel hulled or wooden hulled fishing vessels, it needs to be dry docked in every two years or once in every 5 years in case of fishing vessel with an OAL of 20 m and above as per MMD rules under the supervision of a surveyor or otherwise as per instructions/rules existing with State Fisheries Department to enable the vessel sea worthy. This paper discuss various issues and practices needs to be taken up with the operation of a fishing vessel on the basis of a case study.

Keywords: MMD, MFRA, OAL, Dry docking.

Analysis of the Technical Status and Economics of Operation of Deep-Sea Fishing Vessels of the Thoothukudi and Kanyakumari districts of Tamil Nadu (ID 127)

Jobin Jacobi[1], N. Neethiselvan[1], T. Ravikumar[1], S. Archana[1]

[1]*Fisheries College and Research Institute, Thoothukudi, India, neethiselvan@tnfu.ac.in , fishco.archana@gmail.com*

A study undertaken to analyse the technical status of Deep-Sea Tuna Gillnets operated from two different fishing harbours of Tamil Nadu Viz Tharuvaikulam (78.89° N 8.17° E) and Thengapattinam (77.16° N 8.23° E) revealed similarity in gear designs, however notable variations in the locations of fishing grounds could be observed. The fishing crafts included two sectors namely, Gill Netter cum Longliners (GNCL) of Thengapattinam and Gill Netters (GN) of Tharuvaikulam. Though GN belong to Tharuvaikulam, which is located in the South East coast of India, they were found operated in the South West coast in the deep-sea fishing grounds located relatively nearer to the coast (100-700 Nm). The GNCL of Thengapattinam were found involved in gill netting in the fishing grounds far off from the South West coast of India in fishing grounds (1500 Nm) off the coast. The GNCL of Thengapattinam in the South East coast were found operated in a depth ranging from 12m to 16m whereas, the GN of Tharuvaikulam in the South East coast were operated in a depth ranging from 10m to 14m. Among the 800 deep-sea tuna fishing vessels found operated from Thengapattinam, 500 boats were of GNCL, and the remaining 300 boats were found to be Exclusively Long Liners. In the case of Tharuvaikulam, all 220 fishing vessels of GN were found operated. There existed significant differences with respect to the CPUE of GNCL and GN. The total catch from GNCL of Thengapattinam and GN of Tharuvaikulam were estimated as 20,368.065 tonnes and 16, 760.95 tonnes respectively. During the year 2020, the CPUE for GNCL of Thengapattinam and GN of Tharuvaikulam were estimated as 769.40 kg/day and 590.963 kg/day, respectively. The economics of the operation of deep-sea gill nets operated from GNCL and GN worked out for a period of five months and the Benefit-Cost Ratio was estimated as 1.32 for the GNCL and 1.19 for the GN.

Keywords: Gill Netters (GN), Gill Netter cum Longliners (GNCL), Exclusively Longliners (EL), CPUE, Benefit-Cost Ratio

Can we use low-res satellite images to study the impact of COVID on fishing activity in a small-scale fishery? (ID 128)

David Stanley[1], Jose Cappelletto[1], Paul Kemp[2], Deepayan Bhowmik[3], Bindi V. Shah[4], Nikita Gopal[5], Bethan O'Leary[6], Richard James MacCowan[7], Madhu V R[4], Sandhya K M[4], Rejula K[4]

[1]*Centre for In Situ and Remote Intelligent Sensing, FEPS, University of Southampton, UK*

[2]*International Centre for Ecohydraulics Research Faculty of Engineering and the Environment, University of Southampton, UK*

[3]*School of Computing Newcastle University, UK*

[4]*Department of Sociology, Social Policy & Criminology, University of Southampton, UK*

[5]*ICAR-Central Institute of Fisheries Technology, Matsyapuri, Cochin, Kerala, India*

[6]*University of Exeter, Penryn Campus, Penryn, UK*

[7]*Biomimicry Innovation Lab, York, UK*

madhucift@gmail.com

We investigated how satellite imagery and machine learning (ML) techniques could be used to estimate the potential impact of COVID-19 restrictions in 2020 on small scale fishing activities off the coast of Kerala, India. A Before and After study was conducted by monitoring small fishing vessel activity during the period 2019-2022.

Gathering social science data on this impact is time consuming and difficult to do remotely. Meanwhile, manually labelling small vessels in typical satellite images (10m/pixel) is time consuming and difficult. ML models would allow us to automatically detect such objects in satellite images quicker than humans can and potentially more accurate.

We evaluated 4 different ML architectures against 4 loss functions for their suitability in detecting ships on a small set of RGB images from the ESA's Sentinel-2 satellite that we had manually labelled, before settling on the U-Net architecture combined with the Lovasz Softmax loss function. We trained this model and used it to infer detections of fishing vessels in 175 Sentinel-2 image products, across a region 28,258 km2 in size, and for 174 dates between February and July in the years 2019-2022.

These ML inferred detections were then filtered based on; whether their position is estimated as cloud by the Sentinel-2 scene classification data product, whether detection from the images would be more difficult due to rougher sea states expected during dates of cyclonic storms in the region, and whether few ships would be expected for the date of the image based on social science data for when fishing workers do not typically operate.

Our results show how fishing activity varies over the geographical region of interest and their temporal variation is suggestive of a possible slight decline in fishing activity in 2021 and 2022 compared to 2019 and 2020. We have demonstrated how satellite imagery can be combined with ML models to infer the presence of ships at a given location and how ancillary data sources can be used to filter out false-positives and otherwise improve confidence in temporal analysis.

Chronicles of deep-water shrimp fishery (2007-2020) along the southwest coast of India: trends & potential (ID 133)

Rekha Devi Chakraborty[1], Laxmilatha P[1], T. M. Najmudeen[1], Kuriakose Somy[1], Sindhu K Augustine[1], L. Sreesanth[1], N. Ragesh[1]

[1]*Central Marine Fisheries Research Institute, India, rekhadevi7674@gmail.com*

The annual average estimated shrimp landings were 43611 tons during 2007-2020 off Kerala. Deep-sea shrimp catch was 9137 tons with the penaeid group accounting to 51% and the rest by non penaeid shrimps exploited from the mechanised multiday trawlers (MDTN) at a depth of 200-500 m. Deep-sea shrimp resource formed a seasonal fishery from September to April with a peak in landings during December to February (46%) forming the most productive period in terms of catch and catch rate. Catch trend analysis showed highest landing in the year 2018

(17,486 t) and lowest during 2010 (4975 t). District wise deepsea shrimp landings during 2013-2020 from MDTN Kerala, revealed Kollam on top position (86%) followed by Ernakulam (11.2%). Species composition at Kollam (MDTN) during 2013-2020 revealed the dominance of M. andamanensis (32.4%), followed by H. chani (19.8%), A. alcocki (19.6%), P. quasigrandis (17.5%), H. woodmasoni (9.1%) and P. semilaevis (1.0%). Deepsea shrimps have longer life span and less fecundity in comparison to inshore shrimps which needs continuous monitoring for effective conservation and sustainable management of the resource.

Keywords: Deep-sea, trawl, fishery, trends, species diversity.

An Analysis on the Management of Navigation Aids onboard Research Vessels Based on Internet of Things [IoT] (ID 134)

Dr.D.Rajasekhar[1], D.Narendrakumar[1], P.S.Deepak Sankar[1], Ananthakrishna[1]

[1]*National Institute of Ocean Technology, Chennai, India, 600100, rajasekhar@niot.res.in*

Currently, most of the research activities at sea are being undertaken by dedicated research vessels. State-of-the-art research vessels make marine research in extreme sea conditions, which maximizes the frequency of accidents during research at sea. The risk of these marine research can be reduced by providing systematic and appropriate safety information about them. For this, navigation aids are actively being used. However, because navigation aids are managed and maintained by using a seafarer’s visual observation, as well as by using a lighthouse and a buoy tender, checking the position error of a mooring buoy and its real-time condition becomes impossible. In accordance with this, conducting an overall review and an advance research on maritime transportation system on coastal waters should be conducted to systematically manage maritime transportation conditions, which makes it is necessary to develop a method of systematic management and efficient operation of navigation aids to help guarantee safe navigation on both coastal and international waters.

As a solution, this study analyzed the problem of current navigation aids management by conducting a literature study and an interview with relevant field experts. It suggests a method to manage navigation aids, which is applicable to IoT (Internet of Things) technologies.

Investigation of the common defects and damages of the Fiberglass reinforce Plastic boats operated along the coast of Tamil Nadu (ID 138)

Thangaraji Ravikumar[1], Swaminathan Jayaraj[2], Pandian Krishnan[2], Munuswamy Krishnamohan[2], Neethirajan Neethiselvan[1]

[1]*Department of Fishing Technology and Fisheries Engineering, Fisheries College and Research Institute, Thoothukudi – 628 008, India, ravikumar@tnfu.ac.in*

[2]*Bay of Bengal Programme Inter-Governmental Organisation, Chennai – 600 018, India*

The study dealt with knowing the the current status of construction defects, operational and berthing damages of FRP boats being used along Tamil Nadu coast. A detailed survey was conducted along the coastal districts of Tamil Nadu such as Thoothukudi, Kanyakumari, Nagapattinam, and Chennai. The common defects found with respect to construction were, the use of unapproved designs of mold, low-grade FRP mats, resins, catalyst, accelerator and using improper tools, improper lamination practice for construction of FRP boats and also the construction was done by inexperienced personnel. The common damages observed concerning the operation were abrasion and delamination of the gel coat due to dragging of the boat on the beach, blisters and stringer damage due to crack and collision, stagnation of bilge water and fatigue, and damages on gunwale due to collision. It was very interesting to find some indigenous technologies developed by the fishermen during the study for protection engines and boats. However, proper training must be given to the fishermen to rectify the defects and damages of FRP boats.

Environmental profiling and life cycle impact assessment on Trawler operated in Thoothukudi, southeast coast of India (ID 144)

Kumarakannan Asokan[1], Pradeep Ramesh[2], Ayesha Jasmin[2], Mohammad Tanveer[2], Paras Nath Jha[3], Ravikumar Thangaraji[4]

[1]*Department of Fishing Technology, Faculty of Fisheries Science, Kerala University of Fisheries and Ocean Studies, Panangad, Cochin-682506, India.* kumarakannan.a@gmail.com

[2]*Department of Aquaculture Engineering, College of Fisheries Engineering, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Nagapattinam-611001, India.*

[3]*Fishing Technology Division, ICAR-Central Institute of Fisheries Technology, CIFT road Matsyapuri, Willingdon Island, Cochin-682029, India.*

[4]*Department of Fishing Technology and Fisheries Engineering, Fisheries College and Research Institute, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Thoothukudi-628008, India.*

The present study focused on establishing the environmental risk associated due to trawl fisheries in particular. The necessary inventory analysis was carried out for the computation of life cycle impact assessment. The case study was considered at the location in Thoothukudi region, Tamil Nadu, India. The steel hulled trawler with the length (LOA) of 21.3 m were considered to obtain necessary inventory values. The popular LCA software namely SimaPro was used for this study. The results presented the end point indicators contribution by the operation of a large trawler going for single-day fishing trip. The study also presented the GHG emission accounted due to usage of trawl fisheries, and comparison with culture fisheries emission values available through literature as special focus. The last part of the study discussed and suggested the possible mitigation measures to be executed through policy approach from government side in order to reduce environmental impacts. The study also provides the detailed view on different aspects of trawl fishing activity as environmental profiling.

Mapping of domestic shark trade chains and utilization in India with implications for sustainable management of coastal shark fisheries. (ID 147)

Shoba Joe Kizhakudan[1], Akhilesh K.V.[1], Sujitha Thomas[1], Muktha M.[1], Swatipriyanka Sen[1], Najmudeen, T.M.[1], Purushottama G.B.[1], Mahesh V.S.[1], Ambarish P.G.[1], Livi Wilson[1], Shikha Rahangdale[1], Subal Kumar Roul[1], Remya L.[1], Manojkumar, P.P.[1], Rekha J. Nair[1], Rajesh Pradhan[1], Zacharia P.U.[1], Kim Friedman[2], A. Gopalakrishnan[1]

[1]*ICAR-Central Marine Fisheries Research Institute, Kochi, India,* shoba.joe@icar.gov.in

[2]*Food and Agriculture Organization of the UN, Rome, Italy*

Sharks (including sharks, rays, skates, sawfishes, and guitarfishes) are exceptional fishes, among the earliest inhabitants of the seas, and highly vulnerable to overexploitation because they are long-living with slow growth and maturation rates, and low fecundity. In India, sharks are utilized fully and fetch good value whether caught as targeted catch or bycatch of multi-gear, multispecies fisheries. Though cursory information exists on shark utilization in India a detailed analysis was lacking. In 2017, as a part of an FAO Global study, ICAR-CMFRI undertook a study on non-fin shark and ray commodities in trade and utilization in India. This was the first study of

its kind with a pan-India coverage and with a specific focus on sharks and rays. A national level assessment of domestic demand for all shark products using structured questionnaires, and mapping of trade/marketing chain of all shark's non-fin products within India and export routes was carried out from 34 landing centers across all maritime states of mainland India. Here we present a bird's eye view of the results and future directions of study needed.

The study indicated that the key drivers encouraging the landing and trade of all sharks caught is increasing national and international demand for various shark and ray products, coupled with poorly controlled trade. Increasing consumer acceptance and a regular occurrence in the marine landings drive domestic shark markets, particularly for meat in fresh and dried forms. Around 39% of the landed sharks in the country are procured by auctioneers from the fishermen; wholesalers, retailers and local vendors procure 15, 18 and 24% respectively, directly from the fishermen at the landing center. About 4% of the elasmobranchs (mostly sharks) are taken home by the fishermen for their own consumption.

The study was able to elucidate the major shark species in domestic trade in the country along with pattern of utilization in the country. Sharks are primarily consumed fresh or dried, in the country. While the domestic trade chain within the country is supported by meat, other products like shark jaws, liver oil, ray gill plates, cartilage and dried skin are also traded. We were able to identify the major production hubs and trade hubs of sharks in India along with the trade chain across the country. There is considerable inter-state movement of sharks and their non-fin commodities; often export takes place from centers that are far away from the original source. Market chain structures also varied across the country and products, ranging from direct sale to auctioneers, to complex chains involving retailers, vendors, and wholesalers. The price structure of various non-fin shark commodities was also evaluated across the different states of India. The importance of sharks in different communities and societies was also highlighted.

With the expansion of fisheries and concerns of sustainability, there is a global consensus that trade and utilization of vulnerable groups such as sharks need to be monitored. The inclusion of several species of sharks under CITES Appendices since 2014 necessitates a close look at national and international trade movements of these resources, and calls for integrating trade chains and fishery drivers while evolving sustainable fishing practices and conservation measures for sharks.

Artificial reefs in coastal systems - productivity power stations and new avenues for community-based fishery management and conservation frameworks (ID 151)

Joe K. Kizhakudan[1], Shoba Joe Kizhakudan[1], L. Remya[1], V. Seetharamacharyulu[1]

[1]*ICAR-CMFRI, MRS of CMFRI ,75 Santhomme High Road CHENNAI, TN India 600028, jkkizhakudan@gmail.com*

Since 2005, ICAR-CMFRI, through its Madras Regional Station, has carried out deployment of artificial reefs in nearly 150 sites in the coastal waters of Tamil Nadu on the south-east coast of India. Impact assessments on productivity, fisheries, market avenues and socio-economics of the fishing communities indicate positive upscaling from pre-deployment status. Areas where reefs have been deployed have evolved into good productivity zones, with distinct succession in faunal assemblage, which serves the dual purpose of resource enhancement and improved fisheries, especially for the artisanal sectors operating line gear.

Discernible patterns of change in the fauna reefs and surrounding habitats include diversity of resources with incoming migrant and foraging groups as well as frequent appearances of rare and vulnerable species. The populations and densities are enviably greater than the ones noticed on the adjacent natural reefs and obviously greater than the plains with no reefs. Samplings and observations on the reef fauna assemblages and cycles of occurrence and movements provide possible cues for the aggregation and settlement of biota. The patterns of zooplankton blooms coinciding with clear waters and migration of large numbers of whale sharks over the reef sites is a typical example. The concept of forage and shelter in reef sites holds good for several less-mobile groups, while large pelagic fishes move in to these locations to prey upon aggregations of smaller fishes and plankton that constitute their preferred diet. Such behavioural patterns probably indicate the physical cues like the swarms of planktons glowing florescent in the new moon phases, and the possibility of the cumulative species-specific acoustic signature sounds travelling in water.

While fisheries management frameworks in India are directed towards judicious exploitation of target species with the primary goal of maximizing production through sustainable fisheries, artificial reef sites provide avenues to take these frameworks several strides further. Sustainable fishery management frameworks should ideally adopt an approach equally levelled at inter-linked fish stocks, habitats, and livelihoods. All these are easily achieved in artificial reef areas, where the active participation of fishing communities strengthens implementable regimes and ensures success stories that stand as examples for habitat enhancement, resource enhancement, community involvement, sustainable fishing methods and conservation actions. Each artificial reef site can stand as independent functional units and at the same time contribute to the larger picture. If developed in the right perspective, artificial reef sites can very well progress towards becoming “other effective area-based conservation measures” (OECMs) in India’s marine fisheries sector.

Crustacean Fishery along the North-eastern Arabian Sea Coast of India: Catch Composition, Species Monthly Wise Landing, Morphometric Relationship and Some Biological Aspects. (ID 152)

B. Sureandiran[1], T. H. Dave[1], K. Karuppasamy[2], N. K. Suyani[1], Shivani Tandel[1]

[1]*Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India – 362265, sureandiranbfsc@gmail.com*

[2]*Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Dr. MGR. Fisheries College and Research Institute, Ponneri, Tamil Nadu, India - 601204*

Crustaceans are the regular constituent in the commercial and bycatch of the mixed species harvested by the different gears from the Gujarat, north-west coast of India along the Veraval fishing harbour, forming approximately 20% of total marine fish production of Gujarat in past years. The crustacean fishery, catch composition analysis, species composition, species wise landing, morphometric relationship and some biological aspects of some species were studied during 1st June 2022 to 15th December 2022. During the study period average shrimp catch was 80.2 %, crab 18.7 % and lobster 1.1 % of total crustacean fishery, stomatopods are not forming much important fishery aspect hence our study not focused on that group. The highest catch was observed during the month of September to November with ~ 40885 kg and the lowest catch was observed during the month of July and August with ~ 7225 kg due to the implementation of the fishing ban by Government of India. A total of 50 species of crustaceans (shrimp, crab and lobster) belonging to 13 families of 22 genera were observed during the course of our study. The most dominant crustacean family in the landings were Sergestidae, Penaeidae, Portunidae and Solenoceridae in volume and number. The landings were dominated by Acetus indicus, Parapenaeopsis stylifera, Charybdis feriatus and Portunus sanguinolentus. The trawlers (multiday + single day trawlers) contributed a major share of the total landing of crustacean during the period, followed by gill net and dol net. The monthly wise species landing is described and some biological aspect of 2 species were determined. The morphometric relationship (Carapace Length, Carapace Width

and Total Length with respect to Total Weight) was computed for 10 species. The study provides the updated information on the crustacean fishery in the Veraval fishing harbour, Gujarat, North-west coast of India.

The Details of trawlers (Length Overall (LOA) of Trawlers and Engine horsepower) operated in the Cochin coast (ID 154)

Lalima inwati[1], Remesan M P[2], Dhiju das P.H[2], Manoj kumar B[1], Somashekara S.R.[3], Talib Mohammad[4]

[1]*Deparment of Fish Engineering and Technology, Kerala university of fisheries and ocean studies, Panangad, Kochi 682506, Kerala India, invatilali@gmail.com*

[2]*ICAR- Central institute of Fisheries Technology, Willingdon Island, Kochi, Kerala*

[3]*College of Fisheries, Mangaluru, Karnataka Veterinary, Animal and Fisheries Sciences University, (KVAFSU Bidar, Karnataka-585401*

[4]*ICAR-Central Institute of Fisheries Education*

Trawl fisheries is an important component in marine capture fisheries of the major contributing state of India like Kerala. Considering the importance of the trawlers operated, the present study attempted to study the composition of trawlers, operational details of single-day and multi-day fishing and changing trends of trawl fisheries along the Cochin coast. The study was conducted from 2021 to 2022 at the major 4 landing centers of the Cochin coast i.e., Thoppumpady fishing harbour (Cochin harbour), Kalamukku Fishing harbour, Murikkumpadam Fishing harbour, and Munambam fishing harbours, with a sample size of 128 vessel (32 from each harbour), Trawlers in the length-class of 16.1-24.0 were dominant at Thoppumpady fishing harbour with a contribution of 27.03%. The length of fishing vessels varied from 14.3 – 24 m. Length classes of 23-24 m were dominant at Kalamukku fishing harbour with a contribution of 20.59%. The length class of 17-19 m were dominant at Murikkumpadam fishing harbour with a contribution of 13.51% m, Length class of 22-23 was dominant at Munambam fishing harbour with a contribution of 25 %. Trawlers in the length range of 30-41 m were also constructed at Munambam and they may be engaged in trawling from Kerala waters or in the neighbouring state. The dominant installed engine horsepower at Thoppumpady, Kalamukku, Murikkumpadam, and Munambam was of 250 to 300 hp (37.5 %), 400-450 hp (21.88%), 400 to 450 hp (34.38%), The dominant installed engine horsepower at Munambam was between 400 to 591 hp (62.5%). The relationship between the length overall (LOA) of trawlers and engine horsepower showed that the value of installed engine power was not according to LOA. and indicates that the trawlers at Thoppumpady, Kalamukku, Murikkumpadam, and Munambam were installed with high-powered engines regardless of the size of vessels (LOA). The study suggested the need for restriction on the installed engine horsepower, the number of trawlers operated, for optimized utilization of resources.

Keywords – Trawler, Length Overall (LOA), Engine horsepower(hp)

Fish Diversity in Hooghly Matlah estuary near Sunderban, West Bengal (ID 162)

Amrutha R Krishnan[1], N A Talwar[2]

[1]*Kerala University of Fisheries and Ocean Studies, Kochi – 06, amrutha.ir@gmail.com*

[2]*West Bengal University of Fisheries and Ocean Studies, Kolkata - 94*

Winter migratory bagnet fishery is a seasonal fishery at the sea face of estuary in West Bengal, where the fishermen from the upper stretched of Ganges makes transitory camps during winter

season from October to February. The study was conducted to determine the catch composition and species diversity of indigenous Winter Migratory Coastal Set Bagnet (CSBN) operating in Hooghly-Matlah Estuary. A total of forty eight (48) hauls was made in twelve (12) days of fishing trials. Two complete days were expended with an average of four trials in every fortnight sampling during both flood current and ebb current. The soaking period was fixed to six (6) hours for each trial including the time of setting and hauling. Software 'PAST' was used to analyze the diversity indices and indices like Shannon Wiener diversity index (H'), Margalef richness index, Evenness index (e^H/S), Dominance index, (D) and Simpsons Index (1-D) etc are estimated to analyse the species diversity. The Shannon Wiener diversity index (H') and Simpsons Index (1-D) values were found maximum in December 2016 and the minimum in February 2017. The maximum value of Margalef richness index (d) 4.046 was recorded in November 2016. However, the minimum value was found during the month of December 2016 (3.685). The maximum value of evenness index (e^H/S) was recorded in January 2017 (0.6732). The maximum value of Dominance index, D was found in February 2017 while in case of, the maximum value was observed in December 2016.

Keywords: Winter migratory coastal set bagnets - fish diversity - diversity indices

A comparative study of mechanical properties of untreated rubber wood and rubber wood treated with nano CuO added Cashew Nut Shell Liquid. (ID 163)

Mosaraf Hossain[1], B Manoj Kumar[1], Leela Edwin[2], Devika Pillai[1], Manjulekshmi N[2], Amrutha R Krishnan[1]

[1]*Kerala University of Fisheries and Ocean Studies, Kochi – 06, manojkumarbnair@yahoo.com*

[2]*ICAR – Central Institute of Fisheries Technology, Kochi-682029, Kerala, India*

Although wood is one of the most widely used as a boat building materials, main problem is that wood when exposed to the marine environment is easily deteriorated by large density of bio deterioration agents. Wood is the most common material used for the construction of boats, especially for the traditional country crafts in many parts of India. But the material wood is very prone to deterioration due to its prolonged used in the marine and inland water bodies. So a good knowledge on the wood deterioration is very essential to increase the life of wooden fishing vessels. Cashew Nut Shell Liquid(CNSL) is an indigenous preservative used by the local fishermen in India. In this study CNSL is incorporated with Nano CuO to know the efficiency interms of its mechanical property while using in the estuarine environment for a period of four months. Rubber wood panels were treated with Colloidal suspension of CNSL with nano CuO at different concentrations viz., 0.05%,0.1% and 0.2%. Better mechanical properties were also observed in case Colloidal suspension of CNSL with nano CuO (0.2%) treated wood panels with highest maximum load and compressive strength at maximum load.

Keywords: Traditional wooden boats- nano CuO treated wood- Mechanical properties

4 TOPIC Group: Passive fishing gears (TG Passive)

Conveners:

- Lotte Kindt-Larsen (Denmark), lol@aqua.dtu.dk
- Peter Ljungberg (Sweden), peter.ljungberg@slu.se
- Isabella Kratzer (Germany), isabella.kratzer@bsh.de
- Gildas Glemarec (Denmark), ggle@aqua.dtu.dk
- Thomas Noack (Germany), thomas.noack@thuenen.de

4.1 Introduction

In 2109 an ICES-FAO WGFTFB topic group (TG) was started in order to evaluate current and past work of bycatch in relation to passive fishing gear. The 'Passive' TG was held as an continuation if the former TG 'Change' (2015-2017). The aim of the 'Passive' group was to first set the current passive gear reaserch front and share knowledge inbetween group members on bycatch mitigation in regards to the current fishery. The topic group was run trough in total three metings and was finished of in the 2023 meting in Kotchi, India.

4.2 Terms of Reference

1. Summarize current and past work in relation to fish pot and trap development, plus gillnet and longline modifications in order to avoid bycatch of protected species (hereunder marine mammals, sea birds and sea turtles).
2. Discuss and describe methods and their limitations, hereunder catch efficiency and depredations risks. Furthermore, compare newly developed bycatch mitigation efforts and their efficiency to standard gear and compare different types of passive gears (e.g. gillnets vs. fish pots/traps) and the processes of depredation.
3. Identify and make recommendations on how to improve passive gears including unwanted bycatch, high variability in catches and mitigation of depredation from different predators.
4. Identify potential synergies in developing new approaches to promote sustainability (economically and ecologically) of passive gears

4.3 Justification

Passive fishing gears such as gillnets, longlines, traps and pots, belong to the most common fishing methods worldwide. These methods have naturally advantages like efficiency, simple use and size selectiveness. Nevertheless, they have been criticized due to bycatches of higher taxa like sea turtles, sea birds and marine mammals, ghost fishing and their vulnerability to depredation by marine mammals. In recent years, a lot of effort has been put into the optimization of fish traps and pots, mainly due to gillnet-raiding seals and studies on how to mitigate bycatch in gillnet and longline fisheries have been carried out with differing success, but a scientifically proven management tool or technical solution working across taxa has yet to be developed. The "Passive" topic group will thus aim to investigate selectivity, efficiency and sturdiness of passive gears, such as gillnets and longlines (mainly species selectivity), fish pots and large scale fish traps (mainly efficiency and sturdiness). It will document and evaluate current and past work regarding gillnet and longline modifications as well as fish pot and fish trap development. This will include a wide range of fields such as species behaviour, gear design and hydroacoustics.

Ongoing and future projects regarding enhanced economical, ecological and social sustainability of passive gears will be discussed and potential synergies identified that will hopefully stimulate new ideas and innovation.

4.4 Work progress in relation to ToRs

The 'Passive' TG had its first meting at the annual WGFTFB conference meeting in Shinghai, China, 2019. With the Covid pandemic came a canceled and postponed meeting I Bergen, Norway that was held online in 2021. The 2022 meeting in Rostock, Germany, was redused to an one-day online meeting due to the war in Ukraine and no topic group was held. The last group meeting was held as a hybrid conference in Kochi, India in 2023. During the life-span of the TG, reaserchers involved in passive gear development and bycatch mitigation met and discussed around these questions. Also, every year, keynote speakers were invided to present on within year specific topics, as as a stimuli for discussions.

For the first year keynote presentations was on a recap on the TG 'Change', a summery of pot fisheries over the years, bait and pot trials in the upper Gulf of Caloforna, passive gear use in China along with experiences from Japan in the introduction of new and modified fishing gear (ToR 1). The keynotes also corresponded to issues in ToR 4 with synergies between development and promotion of sustainable gear. The following up discussions dealt with literature review/database of work within the field and how to deal with gaps in gear development caused by both knowledge and issues regarding how to spread also grey literature in an efficient way (ToR 1 & 2). Further the group isolated important issues like how to optimize gear design in regards to both target and bycatch species (ToR 2 & 3) along with general stratiges to incorporate passive fishing gear into the blue economy (ToR 4). For introducing part the discussions highlited the identification of influential individuals in a fishing community as crucial, for implementation along with a lack of suitable communication skills by scientists as a problem to perform outreach tasks (ToR 4).

The second year focused on how animals perceive and interpret gillnets underwater, with a specific focus on bycatch-vulnerable species like cetaceans or seabirds. The keynote presentations included behaviour and sensory ecology of these protected species (TG 2 & 3). The group discussions also focused on the sensory ecology and the interpretation of gillnets for either seabirds or harbour porpoise. The consensus of both subgroups on the implications from the presentations for cetacean and seabirds foraging ecology and behaviour were how they may be hard to use in bycatch mitigation (ToR 2). Further the group discussion focused on how sound could possibly be used as a deterrent to minimise incidental captures in net fisheries and reduce depredation in open-air aquaculture facilities. Nevertheless, that directional hearing underwater has not been demonstrated for aquatic birds at this stage, which may limit the pertinence of using sounds as a means to reduce bycatch (ToR 2 & 3).

For the third year the within year focus mainly connected to ToR 2-4. The four keynote presentations all focused on bycatch mitigagation within passive gears (see section 1.5), identifieng them in the ToR 2 and 3). The following up groupwise discussions included a tools list provided by Dan Watson (SN Tech) on bycatch mitigation tools available on the marked or under development. The discussion focused on both individual country regulations on bycatch but also what mitigation methods that ar used within the different countries in order to fullfiill these regulations (ToR 2). Further the discussions included how the mitigiation tools provided by Dan Watson have been evaluated or may be included in the fisheries on country level (ToR 3 & 4), (this report).

Participation numbers varied inbetween the three meeting years with 24 persons from 12 countries in 2019, 67 persons from 21 countries in 2021 and 65 persons from more than 15 countries in 2023. The numbers showed on a high interest withon the community regarding the subject of passive gear development and bycatch mitigation processes.

Table 4.1: TG Passive, Topic and keynote speakers over the three years

Topic	Title	Speaker, Affiliation, Country
Pots, traps and implementation	Pot fisheries – a recap	Peter Ljungberg, *Swedish University of Agricultural Sciences, Sweden*
Pots, traps and implementation	Fishing for alternatives - Bait and pot trials in the Upper Gulf of California	Lotte Kindt-Larsen, *Danish Technical University, Denmark*
Pots, traps and implementation	Passive gears in China	Xun Zhang, *Chinese academies of fishery sciences, China*
Pots, traps and implementation	Introducing new/modified fishing gear to the real world: Experiences in Japan	Yoshiki Matsushita, *Nagasaki University, Japan*
Pots, traps and implementation	Recap of Topic Group "Change"	Steve Eayrs, *Smart Fishing Consulting, Australia*
Behaviour and sensory ecology	What do we know about porpoise detections of gill nets?	Magnus Wahlberg, *Southern University of Denmark, Denmark*
Behaviour and sensory ecology	Tracking porpoises around gillnets	Jamie MacAulay, *Sct. Andrews University, UK*
Behaviour and sensory ecology	Visual and cognitive aspects of seabird bycatch	Graham Martin, *University of Birmingham, UK*
Behaviour and sensory ecology	Underwater hearing in Marine birds	Kirstin Anderson Hansen, *Southern University of Denmark*
Behaviour and sensory ecology	Interview: Thomas Tvedt	Thomas Tvedt, *Visioneers, Norway*
Bycatch mitigation methods	Beating bycatch by beads – Increasing the acoustic reflectivity of gillnets to reduce cetacean bycatch using the *PearlNet*	Thomas Noack, *Thünen Institut, Germany*
Bycatch mitigation methods	Review of seabird bycatch mitigation measures	Yann Rouxel, *BirdLife, The Royal Society for the Protection of Birds, UK*
Bycatch mitigation methods	Developing solar-powered net illumination to reduce marine megafauna bycatch	Jesse F. Senko, *Arizona State University, USA,*
Bycatch mitigation methods	Advances in Bycatch Reduction Technology for passive gear	Rob Enever, *Fishtek Marine, UK*

4.5 "Passive" Topic Group Meeting 2023

The 2023 meeting of the topic group on passive gear (TG Passive) discussed how bycatch mitigation may be improved in passive gear. Focus was on on cetaceans, seabirds and elasmobranches, turtles. Initially for presentations were held by four keynote speakers giving different views on bycatch mitigation. Lastley group discussions were held covering participiants from different conutries. The groups discussed topics if individual country regulations on bycatch mitigation and how non-regulated initiatives are tested the fisheries.

4.5.1 Presentations

Developing solar-powered net illumination to reduce marine megafauna bycatch (ID 167)

Jesse F. Senko[1]

[1]*School for the Future of Innovation in Society, Arizona State University, Tempe, AZ, USA, jesse.senko@asu.edu*

Gillnet fisheries are globally ubiquitous and vital for food security, nutrition, and livelihoods in coastal areas throughout the world's oceans. However, these fisheries incur high bycatch of marine megafauna that can lead to costly fisheries restrictions that result in important revenue losses in coastal communities with scarce economic alternatives. Over the past decade, net illumination – via battery-powered light emitting diode (LED) lights or chemical lightsticks – has emerged as a potential solution to reduce bycatch of sea turtles, seabirds, sharks, and marine mammals in coastal gillnet fisheries while maintaining target fish catch. However, batteries in most existing LEDs need to be changed bi-weekly to monthly to maintain their effectiveness and chemical lightsticks last for only 24 h, creating recurring costs for coastal fishers and concerns over battery disposal and marine pollution. In partnership with coastal fishers, we developed solar-powered net illumination by creating a buoy that houses a flexible solar cell, rechargeable lithium-polymer battery, and two green LED light-strips. The lighted buoy is constructed of a polycarbonate housing which allows for the integration of electronics for charging and discharging. The lighted buoy can self-charge in sunlight and be programmed to automatically emit static or flashing light, while remaining illuminated for up to a week with approximately 60 minutes of direct sunlight. In contrast to existing LEDs which require a complex locking mechanism to replace batteries, our design is sealed and can run for years without opening. Using controlled experiments, we tested the solar-powered lighted buoys with flashing green light (5 Hz (10% duty cycle); 20 ms on, 180 ms off) on sea turtle bycatch and target fish catch in the Gulf of California, Mexico. We found that the solar-powered lights significantly reduced sea turtle bycatch while maintaining target fish catch and value. Our results suggest that solar-powered net illumination and the use of flashing light represents a promising sea turtle bycatch mitigation solution with global applicability.

Summary of the Post-Presentation Discussion: *Based on a question by Lotte Kindt-Larsen, the presenter explained how the color of the used lights was chosen (good transmission of green light in water, good perception of green light by animals, energy-efficient) and highlighted again that green lights maintained the catches of target species, but reduced the bycatch of unwanted species (sea turtles as well as small fish). A question by Steve Eayrs moved the discussion from the biological perspective in a more technical way by asking if the fisher need to handle the mod-ified gillnets in another way than conventional nets. The presenter highlighted the followed ap-proach that fishers should not think about the lights when using them, which could be realized by a very short charging time (< 60 min). The next question was about costs of those lights could not be answered directly as the used lights were made specifically for those trials (production costs: ca. 100 USD a piece), thus required more effort than would be needed when manufacturing them on scale in future. Targeted price is 10 USD. Rob Enever asked about a potential reduction of the lights´ duty cycle to 1% and potential effects on the performance of the lights. Answering this question will be part of the future work similarly to investigating differences in spacing of the lights. Jasper Van Vlasselaer asked up to which depth the lights can be operated (tests down to 200 m were successful) and if the lights can recharge underwater (yes, but could not be quanti-fied yet, depends on water turbity though). Based on a question about experiences in relation to pinnipeds and cetaceans, the presenter said that data on those is not available yet. Afterwards, Lotte Kindt-Larsen asked which lights the presenter would* *recommend for bycatch mitigation of seabirds and harbour porpoises. He suggested flashing green lights as well. Within that part of the discussion, Lotte was mentioning some ongoing sea trials with white lights. Based on that question, Steve Eayrs asked about experiences of using green lights in turbid waters. The present-er answered that one by mentioning that it seemed like there were no problems, but more tests are needed here. The final question by Martin Oliver was about the vertical dimensions of the net (6 m height) and if it could be safe to say that the lights mounted to the floatline could illuminate the entire net (more research needed in that respect).*

Beating bycatch by beads – Increasing the acoustic reflectivity of gillnets to reduce cetacean bycatch using the *PearlNet* (ID 168)

Hannah Schartmann[1], Thomas Noack*[1], Uwe Lichtenstein[1], Sara Berzosa[1], Daniel Stepputtis[1]

[1]*Thünen Institute of Baltic Sea Fisheries, Rostock, Germany, thomas.noack@thuenen.de*

**presenting author*

The incidental catch in fishing gear, especially in gillnets, is one of the main threats to marine mammals around the world, including harbour porpoises. Since porpoises use echolocation for orientation, one way to reduce their bycatch might be to increase the acoustic detectability of the gillnets. This can be achieved by the so-called PearlNet – a gillnet equipped with small acrylic glass beads to it as those "pearls" were found to give a strong echo. Besides giving a brief overview of the history of the PearlNet development process, the first outcomes of the latest PearlNet experiments – a catch comparison study – will be presented. Within that study could be verified that catch efficiency of target fish species is similar for PearlNets and standard gillnets. Those positive results show that a large-scale bycatch trial is worth to be conducted as next step in the project. In order to reduce the effort required to plan and conduct such trial, two aspects need to be considered and shall be discussed: i) finding a suitable fishing location with high bycatch chances of porpoises (or other odontocetes); ii) automatized production of PearlNets for providing large amounts of them.

Summary of the Post-Presentation Discussion: *The presenter started the discussion by asking the audience for potential areas to repeat the bycatch comparison trials for PearlNets and conventional nets and by asking for companies that might be interested in working on an automatization of the pearl attachment to the gillnet. In relation to such potential companies no suggestions could be made, but several potential research areas were pointed out, e.g. Irish waters by Martin Oliver as well as waters around South America by Jesse Senko. Other questions by the audience started by asking about effects on the catch efficiency. The presenter referred to the plots showing no reduction of catches for at least three species. The discussion continued by a statement by Lotte Kindt-Larsen highlighting the high potential of the PearlNet and mentioning that some catch comparison trials are ongoing in DK right now. Jesse Senko asked if porpoises depredate on gillnets. The presenter explained that this does not seem to be the case in the Baltic Sea, but during the conference other talks showed that this is indeed the case e.g. in Indian waters. A question by the online audience about sexes of the bycaught animals could not be answered directly, but Lotte referred to a presentation by Jamie MacAulay at the previous WGFTFB meeting. The last question by Jasper Van Vlasselaer about Pros and Cons of Pingers vs. PearNet got replied by mentioning the potential problems of habitation and not working electronic equipment of the active methods. The habituation part got further discussed by Lotte and Rob Enever by, e.g. by also highlighting the potential "dinnerbell effect", i.e. animals get attracted by a signal.*

Review of seabird bycatch mitigation measures (ID 169)

Yann Rouxel[1]

[1]BirdLife International Marine Programme, The Royal Society for the Protection of Birds Scotland, Glasgow, UK, Yann.Rouxel@rspb.org.uk

Bycatch of seabirds in fisheries is a global conservation threat for many species. Fishers, scientists, conservationists and engineers have been collaborating over the years to develop technical solutions to this threat. In this presentation, we will explore the array of technologies that have been developed and their relative success, particularly in regard to static fishing gears. We will also discuss limits and alternatives to strictly technical solutions in tackling seabird bycatch from commercial fisheries.

Summary of the Post-Presentation Discussion: *The discussion started by a question from the Kochi audience asking how changing the net visibility affects the catch of target species. The presenter explained that changing the net visibility can of course affect catches of fish, but those effects need to be evaluated from case to case. Next Lotte Kindt-Larsen asked, what the presenter would recommend to be tested in the Baltic Sea gillnet fishery in terms of seabird bycatch mitigation. The presenter explained that this largely depends on the specific gillnet fishery (e.g. gillnet vs trammelnet, target species) as well as the bird species of interest. Additional to technical measures (e.g. kites), the presenter suggested gear switching and managemental solutions. Afterwards, Lotte highlighted the high relevance of the factor depth, which the presenter agreed on explaining that higher depths might be a helpful tool in reducing seabird bycatch. After Peter Ljungberg advertised to talk about the implementation of different methods in the group work planned for later, Thomas Noack asked about the fishers´ opinion on the hookpod. The presenter explained that this likely depends on the individual fisher as well as the fishery in general. The following question about the difference of above-surface tools (looming-eye buoy, kites), the pre-senter answered by saying that these tools are more to be used for smaller coastal gears. For trials done so far, they used a spacing of 100 m, but it needs to be considered as "work in progress".*

Advances in Bycatch Reduction Technology for passive gear (ID 170)

Rob Enever[1]

[1]Fishtek Marine, Dartington, Devon, UK, rob.enever@fishtekmarine.com

Whilst Fishtek Marine provide engineering support to bycatch mitigation projects across the globe, the team also undertake their own primary research and are developing solutions to some of fisheries biggest challenges. This talk focuses on two new innovations that are being developed. 1) An electric pulsed device called "SharkGuard" that is designed to deter sharks in pelagic longline fisheries and 2) A novel, low-impact method for catching scallops "Scallop Potting" – a discovery unearthed through a lucky accident!

Summary of the Post-Presentation Discussion: *Paul Winger started the discussion by asking if there is any size-selection of scallops in the pots, i.e. if there are any small individuals caught as well. The presenter replied by saying that this is the case, but as the animals are all alive, it does not pose any problems as they can easily be released. Lotte Kindt-Larsen asked if starting up that new kind of efficient fishery might affect the scallop stocks in the area of interest. The presenter replied that there is a fishery for that species existent by now (dredging), but potting is simply a more sustainable way of catching them. Her second question was about the reason behind being attracted by light. One potential explanation might be the avoidance of shadows as potential predator. Lastly, Lotte asked about future work with the SharkGuard. The presenter explained that the next step will be looking at the catches of target species. Pieke Molenaar was asking about implementing a new kind of fishing with electric fishing (SharkGuard) although another way of using electricy in fishing has just been banned (pulsetrawl). The presenter explained that the (very localized) electric field created is of much smaller dimension. The topic resulted in some discussion, concluding that an impact study might be necessary in the future. Yann Rouxel would like to know if the*

SharkGuard might be combined with the hookpod (i.e. in Asian fisher-ies) and if there are any plans for that. The presenter agreed that there is potential, but it´s not planned right now. An online question was about the reaction distance of the SharkGuard (ca. 20 cm). The last question by Thomas Noack was, how the few (but existant) bycatches could be ex-plained having in mind the rather strong reactions of the animals towards it shown on the vide-os. The presenter explained that this is likely caused by the nature of the signal (in pulses), wich cannot be changed to a continuous signal as the batteries would not be able to withstand that. Jasper Van Vlasselaer asked if different light colors were tested for the scallop pots. Tank tests showed that white lights are the best. Based on a question by Peter Ljungberg, the presenter ex-plained that catches of spider crab and different fish species also got increased. The discussion got concluded by promoting participants to get in touch with the presenter for future trials where a collaboration with Fishtek might be useful.

4.5.2 Group discussions /Progress

Discussion Topic 1: Group Work – Bycatch mitigation tools

After the first part of the TG´s work in 2023 (presentations and discussion) was done, the group work started. The aim was to collect participants´ experiences, future plans and ideas on available bycatch mitigation measures/tools. For doing this, the participants were split into three groups (two groups in Kochi, one group online) and each group discussed the above based on a list provided by Dan Watson (SafetyNet). Within each group it could be figured out rather quickly that experiences with many of the listed tools/measures is rather limited as many of them have been tested in only very few case studies so far. Nevertheless, the group work provided an excellent platform to exchange and discuss about ideas and thoughts about the listed tools/measures, which was particularly interesting when comparing the opinions from different regions. Table 4.3 and Table 4.4 provide a summary of the group work and can also be found online at the WGFTFB2023 sharepoint (“2023 Meeting Documents”-“03. Report 2023”-“WGFTFB23-TGpassive_groupwork.xlsx”)

Discussion Topic 2: Future directions

The final part of the TG´s work in 2023 (thus the TG´s work in general) consisted of a short summary of the day´s group work and a discussion about if and how the work with passive/coastal/small scale fisheries shall be continued to be taken up by WGFTFB´s topic group work. The participants agreed that such work is of very high importance and the interest in the community in continuing such work was high. The following discussion pointed out that the current approach excluded small active gears, which might be of relevance for fishers usually working with passive gears anyway (e.g. MiniSeine). It has therefore been suggested to present a proposal for a new topic group with the focus on small scale/artisanal fisheries at the WGFTFB plenum session about future topic groups. Besides others, Esther Savina presented the proposal for a new topic group dealing with the multifaceted use of the sea during that session. As one example presented was the use of alternative small-scale gears in certain areas, it has been decided by the TG Passive conveners, to deviate from the plan of proposing a new topic group, but to incorporate this idea in the topic group proposed by Esther instead. Esther and the conveners agreed afterwards to get in touch with each other in order to coordinate that integration.

Table 4.2: available tools and measures to reduce bycatch in passive gears; result of groupwork 2023; part 1/2

origin	Technology	Species group: Birds	Elasmobranchs	Fish	Mammals	Turtles	Application: Gillnet	Longline	Traps/Pots/Creels	Aquaculture	Desired Effect	Constraints	experiences	future plans	other comments	Examples
Dan Watson	Looming Eye Buoy	x					x	x			Scare birds away with spooky eyes	Poor visbility in rough seas	Denmark (DTU-Tommy): very fast habituation, Estonia (Yann)	Spain (AZTI-Mikel): interested to be used for small gillnetters	India: no birdbycatch in longlining, only turtles; maybe cheaper options available	https://wildlife.org/putting-googly-eyes-on-buoys-can-save-seabirds/
	Tori Lines/ Streamers	x						x			Flapping twine scares birds away from longlines as they are deployed from vessel	Requires additional carefullness; habituation?	Yann: well tested, pelagic it is ok.			https://www.conservationevidence.com/actions/285#:~:text=Streamer%20lines%20are%20long%20lines,swivel%20to%20the%20main%20line.
	Laser Bird Scarer	x					x	x			Scare birds away from longlines as they are deployed from vessel	Risk of blinding animals, habituation?	Netherlands (WUR-Pieke): strong habituation effects in farms			https://www.bmis-bycatch.org/index.php/references/a95iguxu
	Hookpod	x						x			Keep hook shrouded down to a set depth, prevents birds biting on hooks at the surface	Expensive, extra work,	Rob: very expensive, used in New Zealand.			https://www.hookpod.com/en/
	LumoLead	x						x			Reduce risk for fishers when equipping longline hooks with weigths	Semi-expensive	Rob: Increase the weigjt on the lines		Works good, but may be expensive	https://www.fishtekmarine.com/reduce-seabird-bycatch/
	SharkGuard		x					x			Repel species using electric field	Power hungry, might affect catch rates of targets			UK (Birdlife-Yann): combine with hookpod, Rob: ould work for pots and traps also2. Battery life may be a problem Denmark (DTU-Zita): in Greenland they use car batteries in halibut fisheries-->greenland shark avoided the gear, target stills caught	https://www.popsci.com/technology/shark-guard-electric-signals/
	PAL				x		x	x			Alert species to gear presence using (species-specific) sounds	habituation?		Spain (AZTI-Mikel): interested if it works for dolphins		https://www.thuenen.de/en/institutes/baltic-sea-fisheries/projects/fisheries-environment-baltic-sea/does-the-efficiency-of-pal-to-reduce-harbor-porpoise-bycatch-persist
	Acoustic Seal Scarer				x					x	Repel seals using very loud sounds	Seal ignore them very quickly	Sweden (SLU), Finland (LUKE), good results when used close to gear			https://www.seiche.com/underwater-acoustic-products/specialist-systems/acoustic-deterrent-device
	Pearl Net				x		x				Increase net visibility for species using echolocation	handling (entanglements while cleaning nets)	Germany (Thünen)	Spain (AZTI-Mikel): interested if it works for dolphins	Spain (AZTI-Mikel): spanish fishers interested in REM to prove low/no bycatches; Rob: Good idea for porpoises but not for dolphins.	https://www.thuenen.de/de/fachinstitute/ostseefischerei/projekte/fischerei-surveytechnik/stella2
	Remote release pot buoys				x				x		Remove buoy lines from the water column until retrieval	expensive				https://www.cleancatchuk.com/mitigation/ropeless-pot-creel/
	Luminous Twine	(x)	(x)		(x)	(x)	x	x	x		Increase visibility of gear to enable avoidance by non-target species	Needs to be charged by sunlight/lamps. Dims quickly.				https://www.researchgate.net/publication/334753922_Application_of_Luminescent_Netting_in_Traps_to_Improve_the_Catchability_of_the_Snow_Crab_Chionoecetes_opilio
	Degradable Twine	x	x		x	x		x	x		Reduce probability of ghost pots by reducing catchability after a period of time	Increases the maintenance scedule	India: degraded after 45 days (jute) (trial stopped because of covid), other trials tried cotton teine with good results.		Netherlands (WUR-Pieke): potential use of degradable ziptie; mandatory in UK?	https://zslpublications.onlinelibrary.wiley.com/doi/pdf/10.1111/acv.12298
	Lights	x	x		x	x	x	x	x		Alert species to gear presence using light	Requires external battery power	India: used to attract swordfish and others; John Wang: Many good results, compelded and may be found under the outcome of the light group. Spain (Azti-Mikkel): trawlers with SMP (hake, horsemackerel,blue whiting,meg)-->3 surveys-->no effect		India: usually attracts animals --> potential to even increase bycatch	https://www.cambridge.org/core/journals/journal-of-the-marine-biological-association-of-the-united-kingdom/article/artificial-light-improves-escapement-of-fish-from-a-trawl-net/8CC7D90C4B60FEB59EAAD6C1F6809053

Table 4.3: available tools and measures to reduce bycatch in passive gears; result of groupwork 2023; part 2/2

origin	Technology	Species group					Application				Desired Effect	Constraints	experiences	future plans	other comments	Examples
		Birds	Elasmobranchs	Fish	Mammals	Turtles	Gillnet	Longline	Traps/Pots/Creels	Aquaculture						
	Pingers	(x)			x		x	x			Alert species to gear presence using sound	Animals can become used to them and even use them as a signal to find gear	India: habituation after 3-4 months (Banana-pingers and FutureOcean pingers used); also used in purse seines and trawls; maybe use another sound-->PAL, Sweden (SLU) Pingers are used to a high extent. Netherlands (WUR-Pieke): used by large pelagic vessel (not scientifically followed)	India: try alternating frequencies or other sounds (PAL?)		https://www.sciencedirect.com/science/article/pii/S0165783622003411
	Fixed sized entrances	x	x		x	x			x		Prevent large animals from entering	Not all animals are the same size and can lead to lost commercial catch	Sweden (SLU); Tried this in pots to exclude seal and not to bycatch.			
	Ghost gear retrieval	x	x	x	x	x			x		Reduce probability of lost pots becoming ghost gear by enabling easier retrieval	Expensive	EU-founding for this in Europé from the fisheries found		India: "isn't a problem is there are none"	https://www.resqunit.com/
	Ghost gear location	x	x	x	x	x	x	x	x		Reduce probability of lost pots becoming ghost gear by enabling easier location	Expensive				https://pingme.no/solution/
	Escape hatches			x					x		Active selective measure to allow immature fish / shellfish from being caught	Takes time to install and not all fish are the same sizes				https://store.coastalnets.co.uk/products/lobster-crab-escape-hatch
	Variable mesh size			x			x		x		Prevents small target and non target catch from being caught and lost to the fishery	Not always accessible to tired fish. Effectiveness dependent on correct placement.				-
Netherlands (WUR-Molenaar)	Dead birds on boat	x						x			Dead bird hanging on vessel scares away others	Habituation? Looking cruel				-
	Magnetic field	(x)	x					x			Repel species using magnetic field	Not tested			India: likes the idea more than electric field	-
Denmark (DTU-Bak-Jensen)	Coloured netting	x	(x)		(x)		x				Alter non-target species to gear presence	Trial results inconsistant	Netherlands (Pieke): freshwater: colorful pieces Denmark (DTU-Zita): used in greenland to create contrast in bottom of gillnet (small survey-->doing it again this summer; might affect lumpsucker-catch efficiency)			
Germany (Thünen-Noack)	Acoustically visible netting				x		x				Alter non-target species to gear presence	Reduction of target catches				
India (various), Bangladesh	Hook design (circle hooks, etc.)	x	x			x					Species dependent hook selectivity	Outcomes of existing studies inconsistant				-
	Vessel speed during shooting	x	x								Reduce risk of bird and shark bycatch by reducing shooting time (most sharks are at surface)	Reduction in time possible?				-
	Sound instead of electrictiy		x					x			Repel sharks with noise instead of electricity	Not tested				-

4.5.1 Topic Group Participants

In addition to the participating conveners (Peter Ljungberg as well as Thomas Noack in person and Lotte Kindt-Larsen online), about 50 people participated physically and around 15 people online in the 2023 meeting, representing more than 15 countries (see 'List of Participants', 3.3.1.1). The backgrounds of the participants varied considerably, which allowed to start interesting discussions about a wide range of passive gears and bycatch mitigation tools. Addionally to the discussions after the core presentations, especially the group worked showed that experienc-es with the different tools are quite limited and further that although some tools like pingers are used, the intension of their use might differ (e.g. avoiding bycatch vs. reduced depredation).

Table 4.4: TG Passive, list of participants. In addition to the listed participants ca. 40 Indian representatives participated in the Topic Groups.

Participant	Affiliation	Country	E-mail Address
Alex Edridge	Marine Scotland Science	UK	alexius.edridge@gov.scot
Dan Watson	SafetyNet Technologies	UK	dan@sntech.co.uk
Hannah Schartmann	Thünen-Institute of Baltic Sea Fisheries	Germany	hannah.schartmann@thuenen.de
Jasper Van Vlasselaer	Research Institute for Agriculture Fisheries and Food	Belgium	jasper.vanvlasselaer@ilvo.vlaanderen.be
Jesse Senko	School for the Future of Innovation in Society, Arizona State University	USA	jesse.senko@asu.edu
Lotte Kindt-Larsen	Technical University of Denmark (DTU)	Denmark	lol@aqua.dtu.dk
Martin Oliver	Bord Iascaigh Mhara (BIM)	Ireland	martin.oliver@bim.ie
Mikel Basterretxea	AZTI	Spain	mbasterretxea@azti.es
Monika Szynaka	Center of Marine Sciences (CCMAR)	Portugal	mjszynaka@gmail.com
Neil Anders	Institute of Marine Research (IMR)	Norway	neil.anders@hi.no
Paul Winger	Fisheries and Marine Institute, Memorial University	Canada	Paul.Winger@mi.mun.ca
Peter Ljungberg	Swedish University of Agricultural Sciences (SLU)	Sweden	peter.ljungberg@slu.se
Pieke Molenaar	Wageningen Marine Research (WUR)	Netherlands	pieke.molenaar@wur.nl
Ranjith Lakshmanan	Central Marine Fisheries Research Institute (CMFRI)	India	ranjith@cmfri.org.in
Rob Enever	Fishtek Marine	UK	rob.enever@fishtekmarine.com
Roger Larsen	Arctic University of Norway (UiT)	Norway	roger.larsen@uit.no
Sara Alvarez Berzosa	Thünen-Institute of Baltic Sea Fisheries	Germany	sara.berzosa@thuenen.de

Steve Eayrs	Smart Fishing Consulting	Australia	smartfishing1@hotmail.com
Sukar Anjani	Costa Agua Private Limited	India	vibhav.fugro@yahoo.co.in
Theresia Eke	University of Rostock	Germany	theresia.eke@t-online.de
Thomas Noack	Thünen-Institute of Baltic Sea Fisheries	Germany	thomas.noack@thuenen.de
Yann Rouxel	BirdLife International	UK	yann.rouxel@rspb.org.uk
Zita Bak Jensen	Technical University of Denmark (DTU)	Denmark	zitba@aqua.dtu.dk
Liming Song	Shanghai Ocean University	China	lmsong@shou.edu.cn

5 TOPIC Group: The use of indicators to describe and compare the performance of fishing gears (Indicators) (TG Indicator)

Conveners:

- Valentina Melli (Denmark), vmel@aqua.dtu.dk (Physical)
- Jure Brčić (Kroatia), jure.brcic@unist.hr (Online)
- Chryssi Mytilineou (Greece), chryssi@hcmr.gr (Online)
- Jordan Feekings (Denmark), jpfe@aqua.dtu.dk (Online)
- Bent Herrmann (Denmark/Norway), bent.herrmann@sintef.no (Online)

5.1 Introduction

An ICES- FAO WGFTFB topic group on Indicators (TG Indicators) was formed to gather information on indicators used by fishing gear technologists and experts outside the field.

The opening session of the TG Indicators aimed at establishing a network of scientists challenged by the need to summarize the scientific information needed to compare fishing gears and communicate it to stakeholders. The idea for this year was to clarify the definition of indicators in relation to fishing gears, explore their potential and define a strategy to collect literature regarding their use within the field.

5.2 Terms of Reference

- Review and describe available indicators that enable comparison within and across gear types, including defining their purpose and terminology;
- Identify the need for additional indicators, for example to evaluate sustainability according to its three pillars (ecological, economic and social) ;
- Find data sources (e.g. population structure for target, bycatch and discards) and potential synergies with other fields (e.g. fisheries management, social sciences, fisheries economics);
- Discuss and describe the use of single and combined indicators as decision-making tools for the stakeholders (fishermen, scientists and managers);
- Identify reference points (thresholds) to support the fishery management decision-making process;
- Explore visualization and communication methods to convey both single- and multi-species gear performance to different stakeholders.

5.3 Justification

Scientists across many fields are faced with the challenge of synthesizing and communicating in a simple and accessible way complex scientific information to stakeholders. The field of gear technologies is no exception, with an increasing number of studies now including indicators of gear performance in addition to the traditional approach of presenting the species-specific, length-based selective properties of the fishing gear. Such indicators, which can convey the consequences of adopting a gear design in a specific fishery, have shown great potential to support stakeholders’ decision-making processes. They are a versatile tool that can be used for multiple purposes. To evaluate the effectiveness of individual gear designs, either active or passive, in relation to sustainability objectives (environmental, economic and social). To compare multiple gear options within a fishery and identify optimal solutions in relation to both single- and multi-species catch objectives. To compare different gear types in terms of outputs (e.g. economic, ecological etc.).

The “Indicators” topic group will aim at reviewing existing tools and identifying further needs for simple, robust, and overarching gear performance indicators under the frame of sustainability. It will explore potential synergies with other fields, including fisheries management, ecosystem modeling, and fisheries economics to maximize the use of existing data. Moreover, it will frame the discussion on what are useful reference points for fishery management and carefully provide guidelines on how to use and visualize the indicators to support decision-making processes.

5.4 “Indicator” Topic Group Meeting 2023

5.4.1 Work plan and participants

The TG session took place on Wednesday 15th of February, in hybrid format. Three time-slots of 1.5 hr each were allocated to the TGs, one at 11.30 a.m. local time, and two in the afternoon. The program was structured as follow:

First time-slot: This was dedicated to the introduction of the participants (Table 4.1), focussing on their experience and interest regarding the use of indicators, how satisfied they are with the indicators used so far and where do they see the need for further developments. The participants were then divided into groups and given the task to identify purposes, strengths and weaknesses/challenges of indicators.

Second time-slot: This session was dedicated to keynote presentations from experts both outside and within the WGFTFB group. The first two keynotes provided inspiration regarding the use of indicators to assess and compare the status of fisheries and to identify optimal mitigation strategies. Then 5 presentations from FTFB members promoted the latest developments in terms of gear performance indicators and how these can be used to compare across gear configurations.

Third time-slot: During the final session, participants were divided into groups, each discussing a different topic: the online participants were tasked with drafting a definition of indicator in line with the purposes identified in session 1; one group was challenged with summarizing which indicators we currently use in our field to compare the efficiency and environmental impact of different gear configurations; one group discussed how we could use indicators to compare across different metiér; and the last group was tasked with identifying other indicators that could be relevant to target users (e.g. managers and fishers).

5.4.2 Introduction and groups discussion

A total of 35 participants from 14 different countries attended the TG session (section 5.4.6). The participants came from a variety of backgrounds, spanning from gear development, fisheries management, general engineering, economics and biological sciences. This favored interesting discussions and led to the identification of the following purposes, strengths and weaknesses, as well as major challenges that the TG will need to address for future development and adoption of Indicators of fishing gears performance.

Purposes

Four different groups of purposes were identified when using indicators for gear development and to compare across fishing gears (Figure 5.1)

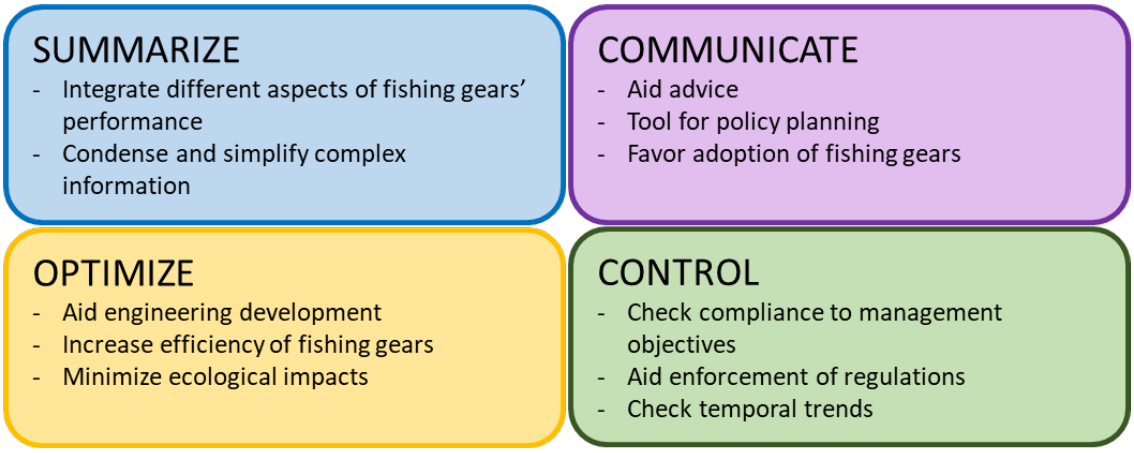


Figure 5.1: Purposes

Strengths

- Reproducibility (reproducible, comparable, can be standardized)
- Interpretability (intuitive, accessible, easy to interpret)
- Overarching (indicators can be used to provide a comprehensive and inclusive view of the performance of fishing gears) but also precise (each indicator can focus on one aspect and account for uncertainty)
- Adaptability (indicators can be weighted according to objectives/target users and used to identify a common ground)
- Data driven but economically viable to compute

Weaknesses

- Prone to bias (indicators are only as good as the data they are extrapolated from; they offer static pictures and needs to be re-estimated in conditions change, e.g. population structures)
- Subjective interpretation (Indicators can be easily taken out of context and overgeneralized, leading to misinterpretation and in some instances misuse or manipulation)
- Their relevance and ranking depends on the target users

Challenges for future developments and for this TG to discuss in the future

- How do we find a compromise between accuracy and simplicity?
- How do we rank the relevance of indicators and find a common ground with target users?
- How do we take into account the stakeholders' perspectives/expectations using indicators for communication purposes?
- How do we deal with the different levels of complexity between fisheries? (E.g. biodiversity level, management framework)
- How do we capture spatial and temporal differences?

5.4.3 Keynote presentations -abstracts and key points

The use of indicators to measure and compare performance in fisheries management (ID 171)

Håkan Eggert[1]

University of Gothenburg, Gothemburg, Sweden, hakan.eggert@economics.gu.se

Fisheries Performance Indicators (FPIs) have the overall objective to provide a low cost, easily accessible and rapid assessment tool that measures an overall status of a particular fishery anywhere in the world where all three sustainability pillars; ecology, community, and economics are considered.

Assessing global fisheries' performance along ecological, economic, and community dimensions is essential to understanding the current state of our resources and the progress brought about by reform. The FPIs are designed for evaluating and comparing the world's fisheries management systems. The FPIs were developed in recognition of the fact that an effective management system is one that is ecologically sustainable, socially acceptable, and generates profitable stable firms and employment directly in the fisheries as well as in service and processing industries. Hence, FPIs can be used to evaluate the effectiveness of management systems at aligning ecosystem health and human well-being. The FPIs have been used in various other contexts; for example, in assessing specific species groups like tunas and in measuring the impacts of investment projects.

The FPIs metrics fall into two categories. The first category is of indicators of outputs that identify and measure whether the fishery is delivering economically viable and socio-ecologically sustainable results. The 68-output metrics may also be aggregated into 11 different dimensions. The second category is of input metrics or enabling conditions that contribute to the process of incentivizing socio-ecologically sustainable use of fish resources.

Take-home message: *Given that a sustainable fishery is ecologically sustainable, socially acceptable, and generates profits and employment, multiple indicators can be combined and result in an overall score for each of the three pillars of sustainability, as a means to provide a quick overview of the status of a fishery under a given management framework.*

Criteria for evaluating alternative management strategies for fisheries bycatch of threatened species (ID 122)

Eric Gilman[1], Milani Chaloupka[2]

[1]*The Safina Center, 3661 Loulu Street, Honolulu, Hawaii USA, EricLGilman@icloud.com*

[2]*Ecological Modelling Services Pty and Marine Spatial Ecology Lab, University of Queensland, Brisbane, Australia*

Fisheries targeting highly productive species can have profound impacts on co-occurring species also susceptible to capture that have long generation lengths, low fecundity and other life history traits that make them vulnerable to anthropogenic mortality. There has been increasing concern over the sustainability of bycatch mortality of marine megafauna given their vulnerability to exploitation, ecosystem-level cascading effects from declines in abundance and reduced population fitness from fisheries-induced evolution. There has also been increasing attention to risks from bycatch to food, nutrition and livelihood security. The presentation identifies key criteria for the development of evidence-informed, integrated bycatch management strategies. We introduce the following criteria that can be applied to determine which alternative bycatch management measures best meet fishery-specific ecological and socioeconomic objectives:

- Contribution to achieving objectives: The predicted contribution towards meeting ecological and socioeconomic objectives defined for a fishery at various spatial scales. This includes the predicted relative size of reduced catch and mortality risk responses to the measure.

- Relative strength of evidence of a reduced catch or fishing mortality response.
- Costs to commercial viability: Some bycatch management measures may cause costs to economic viability, practicality and fisher safety.
- Tradeoffs from multispecies conflicts: Some measures can benefit one threatened bycatch species but exacerbate the catch or mortality risk of others. Bycatch management strategy evaluation can account for these conflicts so that tradeoffs are planned and acceptable.
- Tier in a sequential bycatch mitigation hierarchy: Interventions that avoid capture are considered before those that minimize catch risk. These are then followed by remediation interventions that reduce fishing mortality and sublethal impacts. Finally, either direct, compensatory banking or in lieu fee-based offsets of residual impacts that were not possible to avoid, minimize and remediate can be implemented as a last resort.
- Likelihood of compliance: The probability that a prescribed bycatch management measure will be implemented, determined by the fishery-specific enabling environment.

Policy guided by these criteria promises to achieve ecological and socioeconomic objectives of bycatch management strategies.

Take-home message: *When comparing the effectiveness of different mitigation strategies in a fishery by using indicators, it is critical to establish a ranking system (e.g. Interventions that avoid capture are considered before those that minimize catch risk) and also include indicators that inform us about the solidity of the data.*

A shiny app to compare the performance of different legal gears in the *Nephrops*-directed fishery in Kattegat (ID 172)

Valentina Melli[1], Tiago Veiga-Malta[1]

[1]*DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, Hirtshals, Denmark, vmel@aqua.dtu.dk*

Scientific advice plays a key role during both the setting of annual Total Allowable Catches (TACs) and the introduction of national technical regulations regarding fishing gears. However, while the stock assessment process has been highly standardized over the decades, with organization such as ICES processing the data and providing short notes to fisheries managers and stakeholders, this is not the case for gear-related advice. When it comes to setting which gear design can be legally used in a fishery, fisheries scientists are typically requested by their local fisheries managers to provide a summary of the scientific knowledge available to aid the stakeholders' discussion around the choice. Faced with the challenge of synthesizing and communicating complex scientific information to stakeholders, we as scientists have increasingly relied on Catch Performance Indicators. Such indicators express the percentage of undersized and commercial sized individuals caught for a given species by a gear with known length-based selectivity. They can, therefore, convey the consequences on TACs of adopting a gear design in a specific fishery, and have shown great potential to support stakeholders' decision-making processes. However, they can also easily lead to misinterpretations as they provide only a temporary picture of the gear performance, under a given catch scenario. To facilitate a safe and optimal use of the Catch Performance Indicators when providing advice to stakeholders, we developed a set of interactive Shiny Apps, one for each of the major trawl fisheries in Denmark. As an example, we will demonstrate the app for the Nephrops (*Nephrops norvegicus*) directed fishery in Kattegat. The app has been pre-loaded with the known length-based selectivity for each of the legal gear options currently available to the industry, while alternative options can be manually added for comparative purposes. All gears are then compared using single-species Catch Performance Indicators, as if they were fishing simultaneously on the same population. A dynamic tool allows to control the length structure of the fished population, enabling a more thorough comparison of the gears, at different scenarios, and highlighting which gears could be more susceptible to a change in the structure of the population encountered. The apps are currently being developed to include the main species of relevance for each fishery, thus crossing the bridge from single- to multi-species assessment of performance. The apps will be made open access and their format can be applied to whatever fishery of interest, granted that knowledge of the length-based gears selectivity is available.

Take-home message: *One way to compensate for the weaknesses of indicators when it comes to population-dependencies and the static picture of gear performance that they offer is to use interactive and dynamic tools like Shiny Apps. These can demonstrate to stakeholders how the performance of legal and alternative gears would change when the structure of the populations changes, allowing a more thorough comparison of gear performance.*

Catch efficiency of EZ baiter hook for Needlefish in the Gulf of Mannar coast, India (ID 148)

Vinayagamoorthy Naganandhini[1], Kalaiarasan Muthupandi[2*], Kathavarayan Vasanth[3], Neethirajan Neethiselvan[4], Pandurangan Padmavathy[5]

[1]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, naganandhiniv31@gmail.com*

[2]*Directorate of Incubation and Vocational Training for Fisheries, Ramanathapuram, Tamil Nadu, India, kalaiarasan@tnfu.ac.in*

[3]*Department of Fishing Technology, Kerala University of Fisheries and Ocean Studies, Kochi – 682 506, Kerala, India, kvasanthkvasanth29122@gmail.com*

[4]*Department of Fishing Technology and Fisheries Engineering, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, neethiselvan@tnfu.ac.in*

[5]*Department of Aquatic Environment and Management, TNJFU-Fisheries College and Research Institute, Thoothukudi – 628 008, Tamil Nadu, India, padmavathy@tnfu.ac.in*

The J hooks are extensively used in longlines in the Indian region to capture carnivore fishes, including needlefish. In this context the standard J hook No 11 was compared with the modified needlefish longline (MNL) with EZ baiter hook No. 8/0. The MNL were operated in locations along the Gulf of Mannar coast from April to October 2022. Throughout the study, 14 trials with 5,600 hooks were carried out which yielded a total catch of 276 fishes. The highest contribution of Ablennes hians (42.8%) followed by Tylosurus crocodiles (25.8%), Strongylura strongylura (17.3 %) and T. choram (10.5 %) in terms of number whereas, T. crocodiles crocodiles (39.8 %) was dominant followed by A. hians (36.5 %), S. strongylura (12.1%) and T. choram (7.2%) in terms of weight. The result showed that EZ baiter hook contributed 169 fishes (62.3%) and the J hook contributed 97 fishes which accounted for 37.7%. Considering catch rates, the CPUE of EZ baiter hook was 12.2 individual/200 hooks and the J hooks was 7.6 individual/200 hooks. Further, the percentage of hooking position in jaw (desirable hooking position) was higher in EZ baiter hook than that of straight hook (80.9% versus 43.3%).

Take-home message: *When comparing catching efficiency of passive gears we should not be limited to CPUE but we can also consider additional indicators of performance such as hooking rate and percentage of preferred hooking position.*

Development of a catch composition indicator to assess the performance of fishing gears in relation to area closures or exemptions to discard bans (ID 84)

Tiago Veiga-Malta[1], Juan Santos[2], Daniel Stepputtis[2], Jordan Feekings[1], Valentina Melli[1]

[1]*Technical University of Denmark, DTU Aqua, Niels Juelsvej 30, 9850, Hirtshals, Denmark, timat@aqua.dtu.dk*

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

Traditional catch performance indicators, such as single-species discard ratios and percentage of individuals retained, are an effective way to summarize the performance of a given fishing gear. However, in a management system that is turning more and more towards multi-species fisheries management, single species indicators cannot answer questions such as "what gear provides the best ratio of bycatch to target catch, with regards to current regulations/quota compositions?". Therefore, additional indicators need to be developed for a more comprehensive assessment of the performance of gear designs. Here, we present a new indicator that combines population structures from fishery-independent surveys with the length-based absolute selectivity rates, to simulate realistic multi-species catch compositions for different gear designs. By running the simulation 10000 times, we are able to quantify and compare across gears the risk of exceeding bycatch limits that would trigger area closures or revoke discard exemptions. To demonstrate the new indicator, we use a case-study the demersal trawl fishery in the Baltic Sea, which is a relatively simple multi-species fishery with three species of interest: plaice (Pleuronectes platessa) and flounder (Platichthys flesus) as target species, and cod (Gadus morhua) as unwanted bycatch. In this fishery, a discard exemption is in place stating that catches of cod should not exceed 10% of the commercial catch of plaice and flounder combined. Eight gear designs were compared, including the two currently legislated codends (T90 120 mm and BACOMA 120 mm) and alternative designs developed by the Thünen Institute in Germany (e.g. ROOFLESS). Multiple fishing areas and years were considered in terms of population structures to better understand the effect variability in population structures on the fishing performance of the different gears. The results show that for some areas and years, maintaining cod bycatch below the 10% threshold would be almost impossible when fishing with the legislated gears. On the other hand, the use of ROOFLESS in conjunction with a T90 120 mm codend and shortened lastridge ropes showed a consistently better catch composition. Thus, the use of this type of multi-species catch indicator can be a valuable tool for fishers and managers when deciding for which gears to use/enforce.

Take-home message: *There is the need for multi-species indicators that address regulations such as real time closers or exemptions from discard bans, i.e. rules that limit the catch of few species in relation to the catch of other species. To identify which gear design is more likely to respect such regulations, it is not possible to use single-species catch performance indicators. A possible solution is to simulate catch composition outcomes by combining the selectivity of fishing gears with data regarding species abundance and population structures.*

Is biodiversity affected by bottom trawl fishing? It's time to take decisions? (ID 59)

Ch. Mytilineou[1,2*], B. Herrmann[3,4,5], C.J. Smith[1], D. Mantopoulou-Palouka[1], A. Anastasopoulou [1], A. Siapatis[1], A. Sala[6], P. Megalofonou[2], K. Papadopoulou[1], V. Vassilopoulou[1], C. Stamouli[1], S. Kavadas[1], E. Lefkaditou[1], A. Nicolaidou[2]

[1]*Institute of Marine Biological Resources & Inland Waters (IMBRIW), Hellenic Centre for Marine Research (HCMR), Anavyssos, Attica, Greece, chryssi@hcmr.gr*

[2]*Faculty of Biology, Department of Zoology-Marine Biology, National and Kapodistrian University of Athens (NKUA), Athens, Greece*

[3]*SINTEF Ocean, Fishery Technology, Foundation for Scientific and Industrial Research, Hirtshals, Denmark*

[4]*The Norwegian College of Fishery Science, UiT The Arctic University of Norway, Tromsø, Norway*

[5]National Institute of Aquatic Resources (DTU Aqua), Technical University of Denmark, Hirtshals, Denmark

[6]Italian National Research Council (CNR), Institute of Marine Biological Resources and Biotechnologies (IRBIM), Ancona, Italy

The severe impacts of fisheries on marine biodiversity are quite well known. Biodiversity is a key element in ecosystem functioning and its maintenance is also very important, with positive relationships for commercial fish stocks and consequently, fisheries. In the present work, the abundance, species richness, diversity indices, species composition, trophic level and vulnerability index were investigated for the first-time to detect differences in five units related to trawl fishing: the total fish assemblage entering the trawl codend, and the escaping, retained, discarded and landed fractions, derived by gear and fisher selection processes. The case study was conducted in the Mediterranean Sea. Three different meshes (40 mm - 40D and 50 mm - 50D diamond meshes, and 40 mm - 40S square meshes) were used in the trawl codend and the cover-codend method. Results showed that trawl fishing produced an escaping fraction that was always lower in abundance, richness, and vulnerability index, similar in diversity indices and trophic level, and different in species composition compared to the total fish assemblage entering the codend. Fishers selected a landings fraction which had the lowest diversity indices, but highest trophic level; they discarded a fraction with the highest diversity and vulnerability. The 40S codend showed better values for some of the indicators studied. It was suggested that an innovative modification of the trawl for the elimination of the discarded fraction, and in particular the highly vulnerable species (e.g. Elasmobranchs), is needed if biodiversity losses should be minimized. Moreover, emphasis on species-selectivity and discarded species behaviour should be given to our future studies to achieve this goal.

Take-home message: *The studies on the effects of fisheries on biodiversity should be part of the gear performance studies. The abundance, number of species, diversity, species composition, trophic level, and vulnerability of the total community and the derived by fisheries fractions are indicators that may show a series of impacts of fishing on the community. More research on species-selectivity (instead of size-selectivity) is needed if mitigation of biodiversity losses is expected under the frame of ecosystem-approach to fisheries management.*

The use of indicators to supplement the information on the size selection of clams in hydraulic dredge fisheries

Antonello Sala, contact: antonello.sala@cnr.it

In hydraulic dredge fishery two selection processes can be distinguished. The first selection process that takes place underwater and the second selection process that takes place on board the fishing vessel. The onboard size selection can be considered as the main size selection process and is performed by the vibrating sieve made of a series of grids with decreasing hole diameters. The study investigates the effect of grid hole diameter and sorting speed on the clam size selection. Apart from obtaining a predictive model for sieve size selection, a set of indicators were also calculated. These indicators included: the mean percentage of individuals below and above the minimum landing size (MLS) and the number of retained individuals under MLS to each retained individual above the MLS. Using the obtained model for sieve size selection and the size structure of the clam population captured during the study, it was possible to predict which grid hole diameters are needed to obtain specific fisheries management goals.

Take-home message: *An indicator should not only be a number or a percentage but it could also be a graph, designed to combine multiple scientific results and provide guidelines on e.g. the optimal size-selection mechanism to optimize selectivity.*

5.4.4 Group discussions /Progress

It is a challenge to cover the multitude of questions and challenges that this TG aims to address, especially with the limited time available. Therefore, each group was tasked with a different discussion topic, which allowed us to increase the outcomes achieved in this first year of TG.

Figure 5.2: Participants in deep discussion during group sessions

Outcome 1: definition of Indicators in relation to fishing gears

An Indicator should summarize and simplify reality, reducing the complexity. Indicators determine whether we have achieved objectives for a specific program or project, or whether we have reached a threshold or trigger for action. Good indicators need to be easily understood and meaningful to those who seek to use the information they provide (European Parliament, 1998; CoastAdapt, 2017). They should also provide a measure of the current state that can also be used to monitor temporal trends of that measure.

Indicators need to be:

- **Available** - the data must be readily available from existing sources.
- **Acceptable** - the indicators must be accepted by those who will use and apply them and ultimately be judged on them.
- **Comparable** - there must be standard methods for defining, collecting and reporting
- **Clear** – must be simple and unambiguous

Indicators have a prominent role in monitoring, assessing, understanding the current situation, demonstrating the achievement of an objective, and evaluating the effectiveness of a measure, arguing for incompatible actions or the need of new ones.

So, indicators may be used to report:

- Current state
- Dynamics of the state
- Judgements about the state (well/poor)
- Judgements about the dynamics (improving/worsening)

Extended definition:

Indicators are quantitative or qualitative data or combination of data collected and processed for a clearly defined analytical or policy purpose. That purpose should be explicitly specified and taken into account when interpreting the value of an indicator. Indicators have a prominent role in monitoring, assessing, understanding the current situation, demonstrating the achievement of an objective, and evaluating the effectiveness of a measure, reflect the changes connected to an intervention arguing for incompatible actions or the need of new ones. Fisheries indicators should provide practical and cost-effective means for the evaluation of the state and the development of fisheries systems and the effects that policy changes have on those systems and they have a growing role in rule-based decision-making (le Gallic, 2002; Kusek & Rist, 2004; Rice & Rochet, 2005).

Fishery management should pursue the triple bottom line of economic, community and ecological sustainability. So, indicators should provide information in the frame of these three dimensions (Anderson et al., 2015). The main purpose in developing a set of sustainability indicators is to assist in assessing the performance of fisheries policy and management and to stimulate action to better pursue sustainability objectives (le Gallic, 2002).

Note: The definition is a work-in-progress and it will evolve over the 3 years of the TG to be finalized during the last session.

Outcome 2: terminology

To aid the task of building an overview of the use of Indicators in the field of fishing gear development and management, it is critical that the TG participants, as well as the broader FTFB community, agrees on the terminology used and possibly adopt a keyword to facilitate the search and collection of literature.

The participants of this first TG session propose the term: **FIshing Gears Indicators (FiGI)**

The reasoning is that the term clearly refers to the gear (thus distinguishing it from the FPI framework) but broad enough to avoid the involuntary exclusion of some indicators we may want to include. And the acronym is catch, which always help!

Outcome 3: indicators in use

The group discussed the main indicators in use to express catch efficiency and impact of fishing gears. A challenge was identified in categorizing them, due to the overlapping in terms of effect (e.g. selectivity can be interpreted as both efficiency and impact) and in finding indicators that can be combined to build an overarching assessment of the performance.

We concluded that before next year's session we will collect literature regarding the different indicators used in our field, to compile a list that will hopefully support the identification of gaps and necessity for further developments.

Outcome 4: how we compare across metiér

The group identified a few possibilities that already exist in terms of economic comparison (costs vs quantity and quality of catch, where costs include the number of gears, their maintenance, crew required, fuel consumption etc.) and ecological comparison (e.g. carbon footprint/Kg target catch, which could be extended to not only consider fuel consumption but also Life Cycle Analyses considering materials, transportation etc.). It was highlighted that these approaches require a lot of data.

The group also concluded that the topic needs to be investigated in literature to identify best practices and areas that require improvement.

Outcome 5: what other indicators could be of interest to our main stakeholders?

The group started by identifying user groups, aside from fishers and managers:

NGO, consumer group, certification, social economics, manufactures

In addition to the indicators in use or discussed by the previous group, they identified the need to look at impact of fishing gears from the point of view of the interaction with the seabed (e.g. carbon released/Kg catch, Kg of sediment disturbed/Kg of catch) and to represent the social component of a sustainable fishery (e.g. No. of jobs/Kg of catch).

Finally, it was mentioned in follow-up discussions with some of the participants that the recent developments in real-time observation technologies offer the opportunities to develop real-time FiGI, to assess for example if it is worth continuing fishing in a given area or rather move elsewhere.

5.4.5 Conclusions and plans until FTFB 2024

Overall, we had some great discussions and realized how big the challenge is going to be. We made some critical steps in the right direction, by clarifying our work-in-progress definition and came to a consensus on the term to use in future publications.

Before we meet next year, we aim to:

- establish a mailing list;
- discuss specific deliverables that the group aim to achieve at the end of the TG;
- establish a share point for collection of literature and discuss the possibility of a paper on "How to assess and compare the efficiency of fishing gears" – state-of-the-art + future needs;
- discuss the possibility of involving social scientists and design a short interview for our stakeholders, in preparation to next year's topic of "selecting and ranking indicators in relation to objectives and target users";
- discuss synergies with the TG on ALDFG, which is also interested in using indicators as part of their work.

Plan for TG INDICATORS 2024:

Inspired by Rice & Rochet (2005), we will attempt to apply the following procedure in order to select from the long lists of diverse, potential indicators the most suitable ones that will be used for each specific objective-task:

- Step 1. Identify the user group/define the objectives to describe-indicate
- Step2. List of candidate indicators
- Step 3. Criteria for the selection of indicators among the candidates
- Step 4. Scores of indicators based on the criteria
- Step 5. Summarize scoring results

- Step 6. How many indicators are needed-Interaction with the user group
- Step 7. Final decision
- Step 8. Report on the suite of indicators

We look forward to seeing you!

5.4.6 Topic Group Participants

Table 5.1: TG Indicator, list of participants 2023.

Participant	Country	Affiliation	E-mail Address	Participan-tion
V. Venkatesan	India	CMFRI	venkatcmfri@yahoo.co.in	In-person
Rekha Devi Chakraborty	India	CMFRI	rekhadevi7674@gmail.com	In-person
Barry O'Neill	Denmark	DTU	barone@aqua.dtu.dk	In-person
Tiago Veiga Malta	Denmark	DTU	timat@aqua.dtu.dk	In-person
Daragh Browne	Ireland	BIM	daragh.browne@bim.ie	In-person
Sarath K Karumathil	Spain	UC	sarath.karumathil@udc.es	In-person
Shyam Salim	India	CMFRI	shyam.icar@gmail.com	In-person
Noelle Yochum	USA	Trident Seafoods	nyochum@tridentseafoods.com	In-person
Mette Svantemann Lyngby	Denmark	DTU	msvly@aqua.dtu.dk	In-person
Allard van Mens	Netherlands	WMR	allard.vanmens@wur.nl	In-person
Ganga U.	India	CMFRI	ganga66@rediffmail.com,	In-person
KB Bijumon	India	CIFNET	bijumonkbdr@gmail.com	In-person
GVA Prasad	India	FSI	gummadiprasad09@gmail.com	In-person
Junita D Karlsen	Denmark	DTU	jka@aqua.dtu.dk	In-person
Vipin PM	India	CIFNET	vipinpm83@gmail.com	In-person
Madhu VR	India	CIFT	madhucift@gmail.com	In-person
Karsten Bredderman	Germany	University of Ros-tock	karsten.breddermann@uni-ros-tock.de	In-person
S K Pattnayak	India	FSI	sunubeta@gmail.com	In-person
Vinodkumar Mudumala	India	FSI	vmudumala@gmail.com	In-person
Dam Roy	India	ICAR-CIARI	sibnarayan@gmail.com	In-person
Velmurugan R	India	TNJFU	rvelmurugan@tnfu.ac.in	In-person
Kalaiarasan M	India	TNJFU	kalaiarasan@tnfu.ac.in	In-person

Mattias Van Opstal	Belgium	ILVO	mattias.vanopstal@ilvo.vlaan-deren.be	In-person
Antonella Sala	Italy	CNR	antonello.sala@cnr.it	In-person
Daniel Stepputtis	Germany	Thuenen	daniel.stepputtis@thuenen.de	In-person
Valentina Melli	Denmark	DTU	vmel@aqua.dtu.dk	In-person
Jordan Feekings	Denmark	DTU	jpfe@aqua.dtu.dk	Online
Chryssi Mytilineou	Greece	HCMR	chryssi@hcmr.gr	Online
Muktha Menon	India	ICAR-CMFRI	muktham@gmail.com	Online
Håkan Eggert	Sweden	University of Gothenburg	hakan.eggert@economics.gu.se	Online
Andrea Petetta	Italy	CNR	andrea.petetta@irbim.cnr.it	Online
Jasmin Felix	India	ICAR-CMFRI	Jasmin.f.cmfri@gmail.com	Online
Liming Song	China	Shanghai Ocean University	lmsong@shou.edu.cn	Online
Melanie Underwood	New Zealand	NIWA	melanie.underwood@niwa.co.nz	Online
Jure Brčić	Croatia	UNIST	jure.brcic@unist.hr	Online

6 TOPIC Group: Abandoned, lost or otherwise discarded fishing gear (TG ALDFG)

Conveners:

- Amparo Perez Roda (Italy), Amparo.PerezRoda@fao.org
- Kelsey Richardson (Italy), Kelsey.Richardson@fao.org
- Haraldur Einarsson (Iceland), Haraldur.Einarsson@fao.org

6.1 Introduction

As abandoned, lost, or otherwise discarded fishing gear (ALDFG) is a priority area of work of the FAO Fisheries and Aquaculture Division's fisheries technology and operations team (NFIFO), a topic group focused on this subject was proposed to and accepted by WGFTFB Chairpersons. The ALDFG Topic Group was convened for the first time at the WGFTFB23 meeting and is expected to function for three years with inter-sessional activities as required.

The purpose of the topic group was to collect state of the art knowledge about ALDFG as it relates to fishing technology and fish behaviour, and to line up recommendations for further research, as well as the collection of facts and direct measures that counter ALDFG in the world's fisheries. Given the nature of gear technologists largely comprising the WGFTFB participants, special focus was afforded to examination of fishing gear designs and modifications that aim to prevent, reduce and mitigate impacts from ALDFG.

6.2 Terms of Reference

- Review and summarize current and past work to redesign and modify gears to prevent and reduce gear abandonment, loss and discard during fishing operations, including from weather events, gear conflicts, normal wear and repairs and wildlife interactions.
- Review and summarize current and past work to redesign and modify gears to reduce ghostfishing.
- Review and summarize current and past work to redesign and modify gears to increase overall circularity of gears, as well as the potential for repurposing and recycling.
- Map the requirements for and challenges around end-of-life fishing gear collection, sorting and transport to repurposing, recycling or disposal facilities.
- Investigate and summarize gear marking technologies.
- Seek synergies with the Indicators TG around identification and development of ALDFG-related indicators that can inform different aspects of fishing gear design, manufacture and use, and prevent and reduce ALDFG and related impacts.
- Investigate and summarize best methods to promote and facilitate behavioural changes that support ALDFG prevention and reduction.

6.3 Justification

Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a substantial source of sea-based marine plastic pollution with a wide range of environmental and socioeconomic impacts. Some of these impacts include: wildlife entanglement in and ingestion of ALDFG, ghostfishing (the continued catch of target and non-target species after gear loss), fouling of benthic habitats, transport of invasive species, hazards to navigation and safety at sea, and economic costs and losses to fishers from losses of gear and associated catch. Gear modifications and changes in gear designs can decrease the potential for gear abandonment, loss and discard, as well as ghostfishing, and can support gear marking and tracking technologies. Gear modifications and changes in gear design can also enable better circularity of gears and can enable gear repurposing and recycling efforts.

This topic group will review, discuss and investigate gear modifications and designs that aim to prevent and reduce the occurrence of ALDFG, reduce ghostfishing when ALDFG does occur, enable gear stewardship through the inclusion of gear marking and tracking technologies and systems, and support the responsible discard of recovered ALDFG and other end of life gears. Synergies will also be sought with the Indicators TG to identify gear indicators for ALDFG that can inform fishers/administrators on different aspects of fishing gear that contribute to ALDFG prevention and reduction and minimize ghostfishing, as well as the potential for gear marking and tracking, and circularity of gear designs. The topic group will also discuss best available mechanisms and methods to drive behavioural change towards ALDFG prevention and reduction.

6.4 "ALDFG" Topic Group Meeting 2023

6.4.1 Presentations

This section summarises the presentations shared during the 2023 ALDFG TG meeting. Presentations are summarised using the abstracts provided by participants. The abstracts have been edited in some cases for grammar and spelling but otherwise represent nearly exactly the summaries shared by the presenters themselves.

Dynamic indicators to estimate gear efficiency and leakage of plastic into oceans: a case from commerical fishing in Norway (ID 13)

Paritosh Deshpande[1]

[1]*NTNU Norwegian University of Science and Technology, Alfred Getz vei 3, 7491 Trondheim, Norway,* *paritosh.deshpande@ntnu.no*

Abandoned, Lost, or Discarded Fishing Gears (ALDFG) continue to trap marine life for years upon release, causing ghost fishing. However, the lack of scientific data on the loss of fishing gear (FG) and associated reasoning hinders the management of FG across the globe. The problem of ghost fishing is especially threatening in the Nordic context as commercial fishing in Norway alone contributes to around 35% of that total catch from the EU-EEA region, implying the country's heavy reliance on the blue economy.

Material Flow Analysis (MFA) is an established environmental accounting tool used to assess flows and stocks of materials in industrial and natural systems. Accordingly, we present a system life cycle of typical FGs used by commercial fishers in Norway and model the flows of plastics polymers (PP, PE, and Nylon) used as building blocks of advanced FGs. Based on extensive data collection spanning six years (2016-2021), we present the static and dynamic indicators to track the mass of plastic entering the ocean through commercial fishing in Norway.

Critical indicators are developed and measured using the survey of local fishers' to capture their knowledge of FGs. These indicators include the typical life span of FGs (in years), rate of gear repair, frequency of gear purchase, disposals, and rate of gear loss upon deployment. Additionally, the gear effectiveness was quantified to determine the typical rate of macro plastic loss in the oceans per ton of biological catch by the six commercial FGs deployed in Norway, namely, trawls, seines (Danish and Purse), longlines, gillnets, and traps.

The analysis shows that commercial fishing in Norway contributed to an estimated 130 to 480 t/yr of plastics as ALDFG in the ocean annually from 2016-2022. Gillnets, longlines, and traps are the main contributors to ALDFG in the ocean, as these gear types are more susceptible to getting lost due to gear design, practice, and ground deployment.

Studying the indicator 'gear efficiency', we conclude that an estimated 0.2 kg of plastic is lost in the ocean per ton of biomass caught by the commercial fishers of Norway. The FGs such as crab pots (3.3 kg/ton), Danish Seine (1.1 kg/ton), and longline (0.5 kg/ton) provide the worst gear efficiency.

The MFA and local stakeholder-based indicators on FGs provide a holistic decision support tool for industry and policy-makers in devising and exercising sustainable strategies for FG resource management. The case and learnings from Norwegian fishing practices can be transferred to other fisheries with necessary local adaptations.

Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) in Sri Lanka - A pilot study collecting baseline data (ID 44)

Anthony Gallagher[1], Peter Randall[2], David Sivyer[2], Umberto Binetti[2], Gayathri Lokuge[3], Mohamed Munas[3]

[1]*Evolved Research and Consulting Ltd, Heatherlands, Jordan's Lane, Sway, Lymington, SO41 6AR, United Kingdom, anthony.gallagher@evolvedresearch.co.uk*

[2]*Cefas, Pakefield Road, Lowestoft, Suffolk NR33 0HT, United Kingdom*

[3]*Centre for Poverty Analysis, 16, Jawatta Road, Colombo 05, Sri Lanka*

Despite increasing attention globally, there has been only limited data collected on the extent of abandoned, lost and otherwise discarded fishing gear (ALDFG) globally. This pilot study was conducted using a fisherfolk survey to quantify the scale of the problem and identify contributory factors in Sri Lanka. Funded through the Ocean Country Partnership Programme (OCPP), and delivered under the Blue Planet Fund, the survey took place in February and March 2022, and involved sampling 325 vessels categorised by vessel type and gear.

Based on this survey, 22,593 kg plastic fishing gear was estimated to have been 'lost' to the marine environment over the previous year. This averages 116 kg per vessel from those vessels that admitted ALDFG events and provides an indication of the scale of ALDFG from the Sri Lankan fishing industry.

The survey identified ALDFG drivers, including oceanic and meteorological conditions; a lack of education and awareness amongst fishers; and poor waste management facilities both onboard and onshore. The significance of the drivers varied spatially. Gear conflict was universal though the interaction between Sri Lankan fishers and Indian bottom trawlers in the north was highlighted as was the interaction between fishers and the international shipping lane in the south and west.

Changes in national and international policy, as well as more direct national engagement with the issue are recommended, including training, capacity building and the development of better waste infrastructure. Further evidence is required to explore gear conflict and the interaction between ALDFG and international shipping.

Preliminary Investigation to Estimate the Abandon, Lost, and Discard Gillnet and Traps (pots) along the Coast of Thailand (ID 145)

Santiphong Putsa[1], Nopporn Manajit[1], Nakaret Yasook[1], Watcharapong Chumchuen[1], Taweekiet Amornpiyakrit[1], Isara Chanrachkij[1]*

Training Department, Southeast Asian Fisheries Development Center, P.O. Box 97 Phrasamutchedi, Samut Prakan 10290, Thailand, isara@seafdec.org

Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) is widely recognized as a significant component of marine litter and has serious impacts on habitats, and marine species in particular Endangered, Threatened and Protected Species (ETP Species). The Southeast Asia regional concern on the marine debris includes ALDFG has been raised in SEAFDEC Meetings. With that, SEAFDEC under supported by FAO improved the knowledge and skill on ALDFG survey by conducting the survey on the ALDFG, gillnets and traps, at Phang Nga and Krabi Province of Thailand, by using the FAO Fishing Gear Loss Questionnaires for gillnet and trap fisheries.

Three (3) survey trips had conducted during May to October 2021. Total number of questionnaires are one hundred and sixty (160) comprise one hundred and eleven (111) gillnets and forty-nine (49) traps interviewed from small-scale fishers. Results show that estimated total trap loss is 5,154 traps with an associated economic loss of 64,805.08 USD/year. Estimated loss of gillnets is 458.50 units/year with an estimated associated economic loss of 13,467.14 USD/year.

The main cause of the gillnet loss is nets becoming snagged on an obstruction, and the main cause of the trap (pot) loss is conflict with other gears. Due to the survey conducted in two provinces of Thailand, authors recommend expanding the survey to all coastal province of Thailand, both in the Gulf of Thailand and Andaman Sea, as well as to apply to both small-scale and commercial scale fisheries. The result could provide guidance for the development of management actions to reduce ALDFG in the future.

Ghost fishing efficiency in snow crab (Chionoecetes opilio) pot fishery (ID 27)

Kristine Cerbule[1,2], Bent Herrmann[1,2,3], Eduardo Grimaldo[1,2], Jesse Brinkhof[1,2], Manu Sistiaga[1,4], Roger B. Larsen[1], Zita Bak-Jensen[3]

[1]*UiT The Arctic University of Norway, Tromsø, Norway, kristine.cerbule@uit.no*

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

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

[4]*Norwegian Institute of Marine Research, Bergen, Norway*

Lost, abandoned and discarded fishing gear has a negative impact on the ecosystem through continuous capture of marine animals of target and non-target species (often termed "ghost fishing"). Pot fisheries are generally associated with high ghost fishing risk. The snow crab (Chionoecetes opilio) pot fishery in the Barents Sea is conducted in harsh weather conditions that can cause loss of fishing gear, increasing the potential ghost fishing. Due to non-degradable materials in pot design, the gear can remain intact for long periods. In commercial fishery, snow crabs are attracted to pots using bait. The bait decays over time as would happen in case the pots are lost, abandoned or discarded. The ability of non-baited pots to continue ghost fishing is unknown. This study adapted a method for quantifying the ghost fishing efficiency by lost pots relative to the catch efficiency of actively fishing snow crab pots. The results showed that ghost fishing pots on average attracted 5.79% (CI: 4.72-7.10%) snow crab when compared to actively fishing pots demonstrating continued ghost fishing even when the bait is decayed. This in turn cause concerns about resulting self-baiting of the pots and the efficiency that ghost-fished dead snow crab can further attract conspecifics in this fishery.

Introduction to the Manual for Marking Fishing Gear (ID 120)

Haraldur Einarsson[1]

[1]Fishing technology and operations team (NFIFO), http://www.fao.org/responsible-fishing/ Fisheries Division (NFI), Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla Rome 00153, Italy, haraldur.einarsson@fao.org

The manual for marking fishing gear we introduce is a supplement to the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG; FAO, 2019) and provides practical instructions on marking methods for the main types of fishing gear to identify ownership. Gear marking has been recognised since the 1990s as a tool to contribute to sustainable fisheries, improve the state of the marine environment, assist fisheries management, and prevent and reduce negative impacts related to abandoned, lost or otherwise discarded fishing gear (ALDFG) and ghost fishing. It also contributes to improved safety at sea and assists in identifying illegal, unreported and unregulated fishing activities (IUU). Marking fishing gear is necessary to ensure effective traceability to the owner and operator. To date, gear marking has mainly been confined to marking surface marker buoys to locate stationary gears such as gillnets, longlines and pots. However, there are examples of marking the fishing gear units, for example, pots. Even though the benefits for the owner and management purposes are generally well recognised worldwide, relatively few nations have made the marking of fishing gear mandatory. This manual is intended to assist fisheries managers, fishing gear manufacturers and the fisheries sector in meeting the relevant international, regional or national obligations for gear marking. More specifically, it enables all stakeholders to comply with the specific gear marking requirements outlined in the FAO Code of Conduct for Responsible Fisheries and other international instruments and agreements. Organisations or parties concerned with or actively addressing the issue of ALDFG may also find helpful information in this publication.

Fishing gear marking tests in Argentina (ID 28)

Ricardo R. Roth[1]

[1]Instituto Nacional de Investigación y Desarrollo Pesquero - INIDEP, Paseo Victoria Ocampo N° 1, 7600 Mar del Plata, Argentina, rroth@inidep.edu.ar

Marking of Fishing Gear is a tool to contribute to sustainable fisheries, to improve the state of the marine environment, and to enhance safety at sea by combatting, minimizing and eliminating abandoned, lost or otherwise discarded fishing gear (ALDFG) and facilitating the identification and recovery of such gear. Also, can be used as a tool in the identification of illegal, unreported and unregulated (IUU) fishing activities (FAO, 2019).

Following the series of "FAO Expert Group Workshops on the Marking of Fishing Gear" that took place towards the end of 2021, in July 2022 a new meeting took place in Ancona (Italy) in which in which results of gear marking trails and related developments were discussed. From that meeting, tags acquired by FAO were obtained.

In recent months in Argentina have carried out experiments with some of those tags, placed in different parts of a bottom trawl net, operated by a commercial fishing vessel.

Also, two meetings were held in with the participation of netmakers, businessmen, fishermen and government officers to discuss the feasibility and manner of implementing a fishing gear marking system.

This paper shows the state of the marks after three months of work, which, according to their location, show different degrees of deterioration.

Pluto, Eco-friendly fishing doors

Haraldur Einarsson[1]

[1]*Marine and Freshwater Research Institute of Iceland, Fornubúðum 5. 220 Hafnafjörður, Iceland. haraldur@mfri.is*

On behalf of the company MarEco Solutions Haraldur gave an extra presentation as the time allowed about plastic-made trawl doors named Pluto. Those doors are made mainly of plastic, but 80% recycled plastic can be used to make them by adding the virgin powder to it to keep up the strength needed. Those doors are designed to be replacing old fashion trawl doors for smaller trawling vessels worldwide mainly using wooden and flat type of doors. With replacing them the fuel consumption can be reduced from 18 to 30%. Those trawl doors are designed as semi-pelagic doors and are therefore not impacting the bottom as conventional trawl doors. The hydrodynamic design on the doors ensures higher power to open the trawl horizontally very well without needing more towing power from the vessel. As possible use worn-out fishing nets to make those trawl doors it fits into the circular economy of fishing gear made of plastic material. As metal-made and hydrodynamic trawl doors for small trawling vessels are costly, few if any companies are entering this market of fishery. Plastic doors are only suitable for small vessels but are much less costly than metal ones and are still hydrodynamic. Further questions about the product can be pointed at atli@mar-eco.eu +354 898 66 77.

6.4.2 Group discussions /Progress

The topic group met on 16th February after the morning coffee break, from 11:00 to 17:00, with a lunch break and afternoon coffee time. The agenda included an introduction of the topic group followed by six presentations. One presentation (ID 44, around ALDFG in Sri Lanka) was cancelled due to the unavailability of the presenter. After all the presentations were delivered and followed by Q&A, the remaining time was allocated to break-out group discussions.

Participants were split into three groups to discuss the topic group ToR from different stages of the fishing gear life cycle (Figure 6.1), provide an overview of what is known according to the ToR, current/planned work, what needs to be done (recommendations), and define what we would like to achieve as a Topic Group. Some groups also tried to address ALDFG-related indicators for all stages to connect to the TG-Indicator. The main focus for each sub-group was:

- Manufacturing / fishing gear makers (i.e., pre-fishing gear use stage)
- Fishing (users) (i.e., fishing gear use stage)
- Collecting old fishing gear, sorting and transporting, and reusing, repurposing and recycling (i.e., post-fishing gear use stage).

On the first day of the WGFTFB23, the chairs received a proposal for a new Topic Group named TG-Marine Litter. The proposal was presented to the TG during the introduction. The decision made by the TG was to run the TG-ALDFG as planned for the current session, and before the next annual meeting of WGFTFB, the conveners of TG-ALDFG and the group proposing the TG-Marine Litter will discuss the possibility of merging both TG proposals into one and possibly add one or more conveners to the group.

Given the high interest from the participants in the matter and the broad knowledge about the ALDFG within the group, the conveners decided to run the TG for one to three more years (TBC). The outcome of this year's TG-ALDFG will be included in the end report after the last year of this Topic Group.

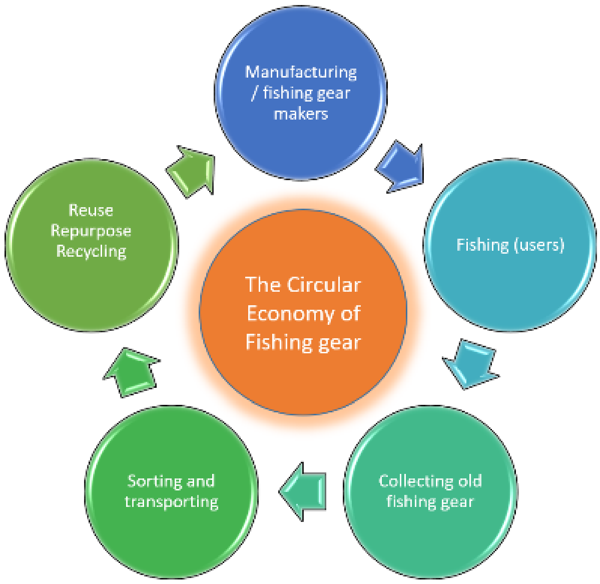


Figure 6.1: Life cycle of fishing gear

6.4.3 Topic Group Participants

Of the total 31 TG participants, 29 attended in person and two online, representing nine countries. The online connection was unstable throughout the meeting. Participants were involved in research around ALDFG (rates, causes, impacts, etc.), fishing gear marking and end-of-life fishing gear management. Many participants came from India, which provided strong insight into India's experience in addressing ALDFG.

Table 6.1: TG ALDFG, list of participants

Participant	Affiliation	Country	E-mail Address
Ansuman Das	FSI	India	ansuman@fsi.gov.in
A.G. Ponniah	Former Director, ICAR-CIBA	India	agponniah@gmail.com
Abuthagir Iburahim	ICAR-CIFE	India	iburahim@cife.edu.in
Akansha Tiwari	Captain Fresh	India	akansha13.work@gmail.com
Antonello Sala	CNR, FAO	Italy	antonello.sala@cnr.it
Damaris Daniel	CUSAT	India	damarisbennydaniel@gmail.com
Dhiju Das PH	ICAR-CIFT	India	dhijudas@gmail.com

Divya V	ICAR-CMFRI	India	divyaarinu@gmail.com
Drake Ssempijja	UMass	Uganda	drakesempijja@gmail.com
Elsa Cuende	AZTI	Spain	ecuende@azti.es
Georg Haney	Hampiðjan	Iceland	georg.haney@gmail.com
Haraldur A Einarsson	FAO	Italy	haraldur@mfri.is
Harsha K	ICAR-CIFT	India	harshakrishna2018@gmail.com
Ignacio Soler	Kongsberg	Spain	ignacio.soler@km.kongsberg.com
Kelsey Richardson	FAO	Italy	Kelsey.Richardson@fao.org
KK Ramteke	ICAR-CIFE	India	kkramteke@gmail.com
Kristine Cerbule	UIT	Norway	kristine.cerbule@uit.no
Latha Shenoy	Pr. Scientist (Rtd) , ICAR-CIFE	India	shenoylatha1@hotmail.com
Manju Lekshmi N	ICAR-CIFT	India	manjuaem@gmail.com
Maria Amparo Pérez Roda	FAO	Italy	amparo.perezroda@fao.org
Mathew McHugh	BIM	Ireland	matthew.mchugh@bim.ie
Mini Sekharan	CUSAT	India	minisekharan@cusat.ac.in
Nimit Kumar	INCOIS	India	nimitkumar.j@incois.gov.in
Paritosh Deshpande	NTNU	Norway	paritosh.deshpande@ntnu.no
Pravin Putra	Former ADG, ICAR	India	pravinp2005@gmail.com
Ricardo Roberto Roth	(online)	Argentina	rroth@inidep.edu.ar
Roger B. Larsen	(online)	Norway	roger.larsen@uit.no
Saly N Thomas	ICAR-CIFT	India	alynthomas@gmail.com
Sandhya KM	ICAR-CIFT	India	sandhyafrm@gmail.com
Thaweesak Thimkrap	SEAFDEC	Thailand	thaweesakt@seafdec.org
Ulf Lundvall	OSAC	Norway	ulflundvall@gmail.com

7 National Reports

WGFTFB-members were asked prior to the meeting to prepare summaries of current and expected research related to the activities of the WG within their country. Eighteen national reports were received: Argentina, Belgium, Canada, China, Denmark, England, France, Germany, Iceland, Ireland, Italy, Japan, The Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom (England, Scotland, Northern Ireland) and the United States of America.

This section lists the national reports submitted by WGFTFB members, alphabetically sorted by country name.

The contents of the individual national reports were NOT discussed by the group and not edited by chairs, and as such they do not necessarily reflect the views of the WGFTFB.

7.1 Argentina

7.1.1 Contact person

- Ricardo R. Roth, National Fishery Research and Development Institute (INIDEP) rroth@inidep.edu.ar

7.1.2 Summary

- Design of a device to reduce the capture of rays in the Hake fishery.
- Square and diamond mesh selectivity.
- Use of underwater camera to determine species behavior.
- Use of LED lights to determine the behavior between hake and shrimp fisheries.
- Use of a modified beam trawl towed at different speeds to reduce hake catch in shrimp fishery.
- The durability of different threads will be studied to determine the degradation time and thus reduce ghost fishing.
- Marking fishing gears

7.1.3 Projects

7.1.3.1 Project: Rays in hake fisheries

Project Full Title: Reduction the catch of rays in the hake fisheries

Project Timeframe: June 2020 – July 2024

Institution(s): INIDEP

Contact person: Franco Rubio, frubio@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Due to the vulnerability of chondrichthyans (sharks and rays) to fishing exploitation, in our country management measures were established for their bycatch, determining a maximum landing limit per tide, the prohibition of target fishing of chondrichthyans, the prohibition of the practice of “finning” and the prohibition of the use of “fish hooks” for the return of these species (Res. CFP No. 4/2013 and No. 7/2013). For this reason, in the aforementioned Workshop, the evaluation of a selective device aimed at reducing bycatch of rays in the hake fishery was also proposed, which was designed by INIDEP.

7.1.3.2 Trawl gear codend selectivity for Hake

Project Full Title: Study of square and T90 mesh selectivity

Project Timeframe: May 2020 – July 2023

Institution(s): INIDEP

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: During the workshop for the preparation of the 2019 Annual Operational Plan, of the Program "Strengthening the Management and Protection of Marine Coastal Biodiversity in Key Ecological Areas and the Application of the Ecosystem Approach to Fisheries (EEP)". It was agreed to work together with the private sector in the development of selective devices that adapt to their re-quirements and to the biological demands for the conservation of the resource.

In principle, it was agreed to carry out selectivity experiments with a square mesh codend and a T90 mesh codend.

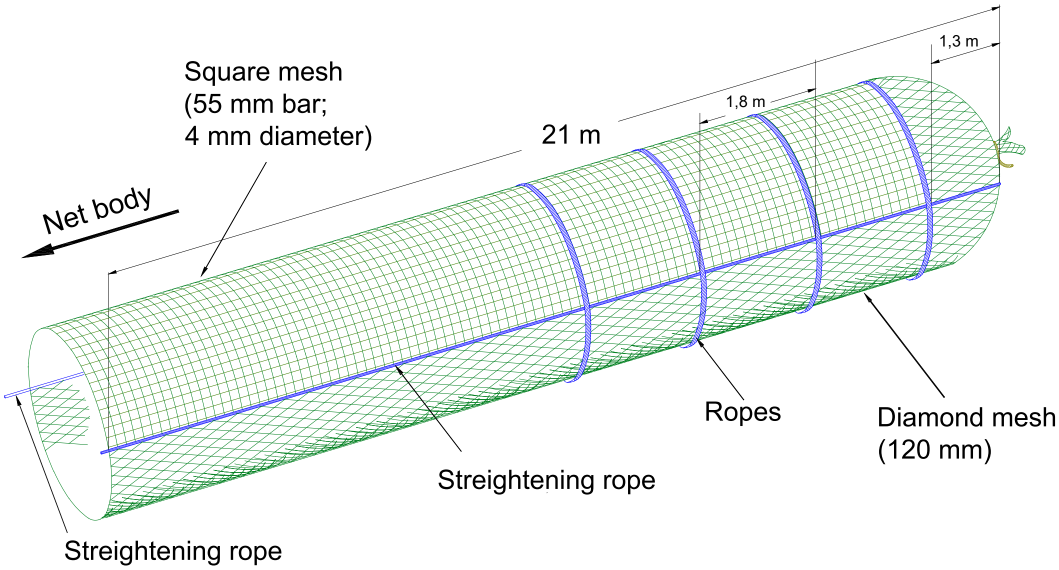


Figure 7.1: Square mesh codend

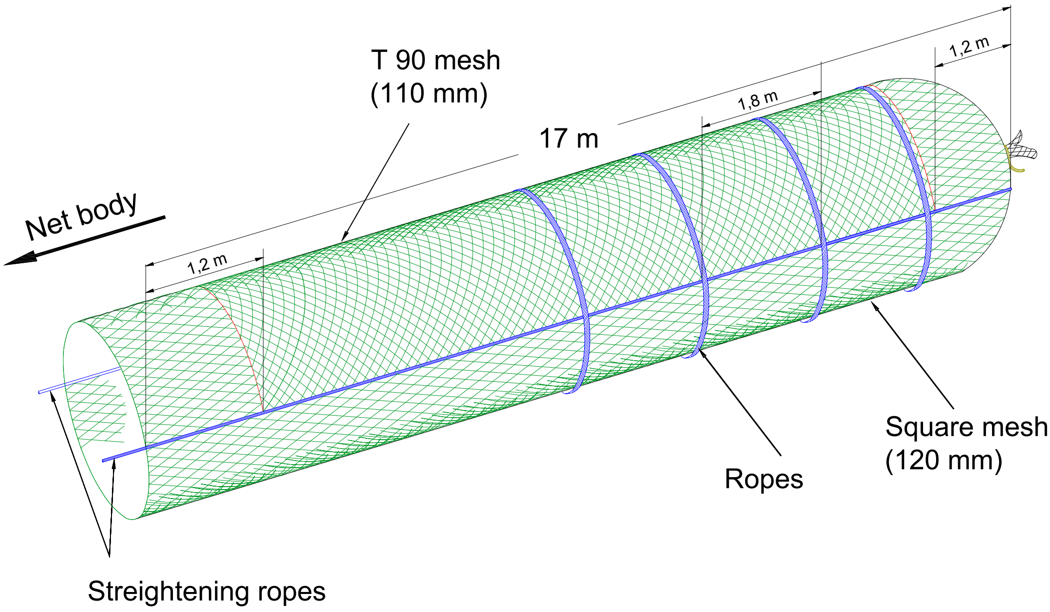


Figure 7.2: T90 mesh codend for Argentine hake fishery.

7.1.3.3 Project: Towing speed

Project Full Title: Use of a modified trawl net towed at different speeds to reduce hake catch in shrimp fishery.

Project Timeframe: September 2022 – October 2023

Institution(s): INIDEP – Pesquera Deseado A.S.

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Based on a proposal made by PESQUERA DESEADO S.A the use of a modified trawl net was towed at different speeds and the catch of hake and shrimp were studied in a first experience. Modifications to the net will be done for future experiences.

7.1.3.4 Project: fishing gear marking

Project Full Title: Fishing gear marking tests.

Project Timeframe: September 2022 – October 2023

Institution(s): INIDEP – Solimeno e hijos A.S.

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Tests of durability and detection of problems in the fishing operation are being carried out with the use of tags placed in different parts of a commercial bottom trawl net.

Marking of Fishing Gear is a tool to contribute to sustainable fisheries, to improve the state of the marine environment, and to enhance safety at sea by combatting, minimizing and eliminating abandoned, lost or otherwise discarded fishing gear (ALDFG) and facilitating the identification and recovery of such gear. Also, can be used as a tool in the identification of illegal, unreported and unregulated (IUU) fishing activities (FAO, 2019).

Following the series of "FAO Expert Group Workshops on the Marking of Fishing Gear" that took place towards the end of 2021, in July 2022 a new meeting took place in Ancona (Italy) in which in which results of gear marking trails and related developments were discussed. From that meeting, tags acquired by FAO were obtained.

In recent months in Argentina have carried out experiments with some of those tags, placed in different parts of a bottom trawl net, operated by a commercial fishing vessel.

Also, two meetings were held in with the participation of netmakers, businessmen, fishermen and government officers to discuss the feasibility and manner of implementing a fishing gear marking system.

This paper shows the state of the marks after three months of work, which, according to their location, show different degrees of deterioration.

In Figure 7.3, bottom trawl net used in the tests and marks position is shown. Four marks were put on the net.

The marking started on 14 September 2022 in the net used by the fishing vessel "Virgen María", a 57 m total length stern Trawler (Figure 7.4).

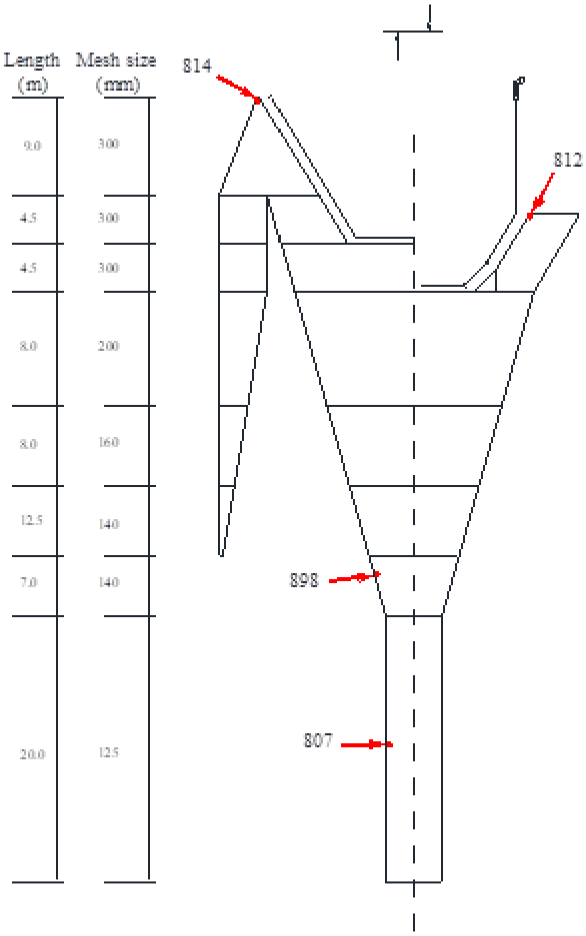


Figure 7.3: Bottom trawl net drawing and marks position.

Figure 7.4: Stern trawler “Virgen María” and trawl net on net drum.

Since 14 September until 30 November 2022, when the first check of the marks was made, the vessel made 7 fishing trips, a total of 131 hauls with a towing time of 350 hours and a total catch of 1786.12 MT, mainly of Argentine hake (*Merluccius hubbsi*).

In the Figure 7.5 the marks condition is shown. In them it can be appreciated that the information is readable so far. As can be seen, there is the possibility of losing the marks due to hooking. In this case, the mark of the upper wingtip could have been crushed when the net was stowed on the net drum in one of the hauls and then got snagged in the meshes of the net.

The marks are still placed in the trawl and the tests continue until the information in the markings cannot be read.

14 September 2022	30 November 2022	14 September 2022	30 November 2022
Codend mark (807)		Lower wingtip mark (812)	
			
Net body mark (898)		Upper wingtip mark (814)	
			

Figure 7.5: Condition of different gear marks. Explanation in text

Furthermore, in 2022 two meetings were held with the participation of businessmen, net makers, captains and Argentina government representatives to discuss fishing gear mark-ing. They took place in the two main fishing ports of the country, Mar del Plata and Puerto Madryn.

Conclusions of the meetings can be summarized as:

- Complexity of marking due to trawl nets are repaired and modified numerous times in their lifetime.
- As only parts of the trawl are usually lost and not the complete equipment, it is necessary to work on the choice of the marking points. Most participants only recommend marking three points (including codend).
- Material and durability of the marks.
- Registration and control, who and how should do it.

7.1.4 Future projects and Ideas

7.1.4.1 Project: Fish behaviour regarding selectivity devices

Project Full Title: Use of underwater camera to determine species behaviour.

Project Timeframe: July 2023 – November 2025

Institution(s): INIDEP

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The behaviour of different species will be studied through the footage and videos provided by an underwater camera incorporated to INIDEP.

Two Rayfin Sub-C underwater cameras were incorporated; one through an agreement with the FAO and another through a donation from a fishing business association.

7.1.4.2 Project: Use of LED lights

Project Full Title: Use of LED lights to increase selectivity of hake in shrimp fishery.

Project Timeframe: March 2023 – November 2023

Institution(s): INIDEP

Contact person: Franco Rubio, frubio@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The problem of hake bycatch in the shrimp fishery in Argentina dates to the 1980s. Different ex-periences with selective devices have been carried out, from 1988 to date. Devices with single and double grids were mainly tested (Nordmore Grid type, and DISELA II type (designed by INIDEP). They have had acceptable and varied results, according to the concentrations of hake and shrimp and, also to the sizes of them.

Currently, the size of the shrimp has increased, reaching the size of juvenile hake. For this reason, grid devices have decreased their efficiency, capturing more juvenile hake and letting the largest shrimp escape.

Faced with this situation, it was proposed to investigate the use of LED lights, in order to observe if there is any change in the behaviour of the species involved, which may collaborate in reducing the catch of hake in the shrimp fishery.

7.1.4.3 Project: biodegradability

Project Full Title: biodegradability of yarns for king crab pots

Project Timeframe: February 2023 – June 2023

Institution(s): INIDEP

Contact person: Sebastian Pisano, spisano@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The durability of different yarns will be studied to determine the degradation time and thus reduce ghost fishing in the Argentine king crab fishery.

7.2 Belgium

7.2.1 Contact person

- Mattias Van Opstal, ILVO – Institute for Agriculture Fisheries and Food Research, Mattias.vanopstal@ilvo.vlaanderen.be

7.2.2 Summary

- SYMAPA: finished (December 2022);
- LED there be light: Investigating possibilities of light in reducing bycatch or increasing catches in different fishing metiers on commercial vessels and research vessels;
- The accurate selection: Refining sorting device, evaluation of final version on accuracy and bycatch survival expected in spring 2023;
- VISTools: Expansion of five vessels to entire beam trawl fleet and further development of a business intelligence tool for commercial fishing vessels.

7.2.3 Projects

7.2.3.1 Project: SYMAPA

Project Full Title: SYnergy between MAriculture and PAssive fisheries

Project Timeframe: 2019 - December 2022

Institution(s): ILVO – Institute for Agriculture Fisheries and Food Research

Contact person:

Mattias Van Opstal mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer jasper.vanvlasselaer@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG ? No

Summary: In SYMAPA (SYnergies between MAriculture and PAssive fisheries) we investigated how mari-culture and passive fisheries can thrive in the Belgian Part of the North Sea. We deployed pots next to a mariculture site growing mussels, oysters and seaweed. Different types of pots were tested and innovations were made to them to increase their catch efficiency. Based on what we caught in the zone, we focused on *Cancer pagurus*, Sepia officinalis, Necora puber, *Palaemon serratus* and *Trisopturus luscus*. The innovations were visual, acoustic or olfactory stimuli to lure animals to the traps. Visual stimuli included LEDs and fluorescent netting. With the fluorescent netting we had a tenfold increase in catches of *S. officinalis* in 2021, but less so in 2022 although our overall catches of cuttlefish were significantly increased using a different type of pot. For crabs, little effect was noticed. Use of LEDs had a strong and significant effect on P. serratus. For round-fish, such as *T. luscus* and *M. merlangus*, we used acoustic stimuli consisting of recordings of crabs being “crunched”. With this technique, we saw a slight increase in catches. In the last set of experiments we tested different types of odour, mainly to see if we could attract flatfish but more research is necessary on this topic.

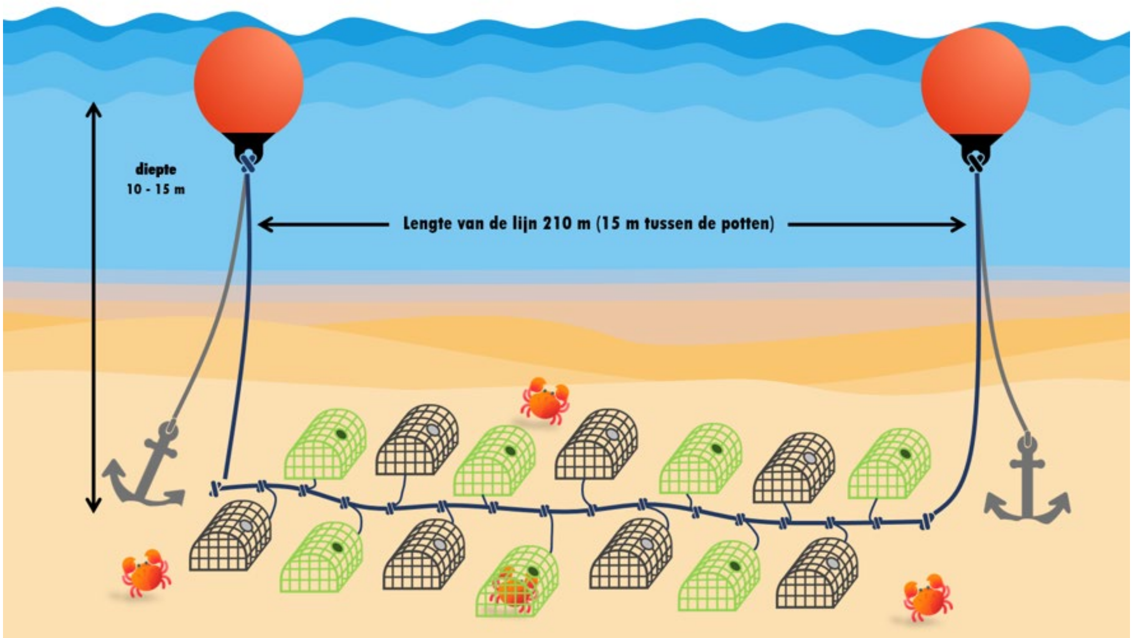


Figure 7.6: Illustration of pot deployment

7.2.3.2 LED there be light

Project Full Title: Led there be light

Project Timeframe: 2021 - 2023

Institution(s): ILVO

Contact person:

Mattias Van Opstal mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer jasper.vanvlasselaer@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? No

Summary: The project 'LED there be Light' aims to develop and optimize innovations in different fisheries practiced by Belgian fishermen in order to reduce bycatch and/or to optimize commercial catches. In this way, the project assists fishermen in dealing with the landing obligation and Brexit.

Trajectory A: Innovative ideas from the beam trawl sector are tested and further developed. Innovations have to focus on:

- prevention of bycatch from entering the net;
- ensuring that bycatch species can escape from the net;
- catches of target species (and thus their relative share in the catch) are increased;
- reduce fuel consumption.

First sea trials with 'tikkers', rolling elements replacing parts of the chainmat, are currently ongoing. This innovation aims at the reduction of fuel consumption, without negative effect on the catch composition.

Trajectory B: Light in fishing gear – Development and testing of innovations. We aim to incorporate luminescent net material, LEDs, and other light sources into different net designs in different fishing techniques practiced within the Belgian sector (beam trawl, otter board, flyshooting and passive fisheries) in order to reduce bycatch and/or to optimize commercial catches. Sea trials show that light can be used to significantly reduce bycatch of plaice and other flatfish in beam trawl fisheries. We are now conducting trials where we further optimise the use of the LEDs (colour, position,…). On board of flyshooters and otter trawlers we still face many practical problems, but preliminary results indicate that light can be used to increase catches of squid.

Figure 7.7: Light in a trawl

7.2.3.3 Project: The accurate selection

Project Full Title: The accurate selection

Project Timeframe: 2020 - 2023

Institution(s): ILVO

Contact person:

Mattias Van Opstal mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer jasper.vanvlasselaer@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG ? No

Summary: In this project, machine builder de Boer RVS, the Research Institute for Agriculture, Fisheries and Food (ILVO) and commercial vessels WR289 and WR 9 are working together in a study that focusses on an onboard innovative processing line for shrimp fishing vessels.

In 2016 – 2020, the prototype sorting device was tested. In this project we evaluate a new design, more detailed information will be acquired on the functioning of the on-board sorter. It uses a detection line, based on camera images and automatic image recognition, which sorts the catch into marketable shrimp, shrimp that are too small and other bycatch. Shrimp smaller than 6.8 mm and other bycatch are returned to the sea as soon as possible. Market worthy shrimps are further divided into three market classes that are stored separately on board.

The goals are to optimize the sorting of shrimp into commercial fractions, map the losses of bycatch and shrimp throughout the process and evaluate the immediate and short term survival of the bycatch. We are now finishing the optimisation process based on both self-sampling and observer trips. In 2023, the final version of the sorting device will be evaluated during two observer trips.

Figure 7.8: Screenshot of shrimp detection

7.2.3.4 Project: VISTools III

Project Full Title: VISTools III

Project Timeframe: 2018 - June 2022

Institution(s): ILVO

Contact person: Lancelot Blondeel, lancelot.blondeel@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? No

Summary: A skipper of a fishing vessel has access to various sources of information that help him manage his work. Navigation instruments and sensors track the location (e.g., GPS/VMS), monitor any fishing activity (e.g., towing force, depth), fuel consumption and register landed

catch (i.e., via an electronic weighing scale). These sensors gather valuable data, but none of that are of any use, if data are not integrated, stored or processed.

This is achieved by the VISTools-projects by automating data collection from conventional on-board equipment, adding additional sensors (CTD, TBD) and coupling this information with economic parameters (e.g. fish prices and fuel prices).

The hardware development of a central hub for the automatic data gathering on board of a fishing vessel (concentrator). This includes data from conventional on-board equipment (towing force, fuel consumption, catches, GPS and depth) and additional sensors fixed to the fishing nets (CTD) or other parts of the vessels (for instance, fish hold temperature)

The development of a business intelligence tool for fishers presenting the processed data in a simple and accessible way on graphs and maps, ready for in fisheries evaluation and planning (VISTools Analytics)

The groundworks for private and protected information exchange for research purposes.

The upscaling of the system to 5 vessels as part of the pilot study

The construction of data processing infrastructure that can offer services to the entire Belgian fleet (60 vessels)

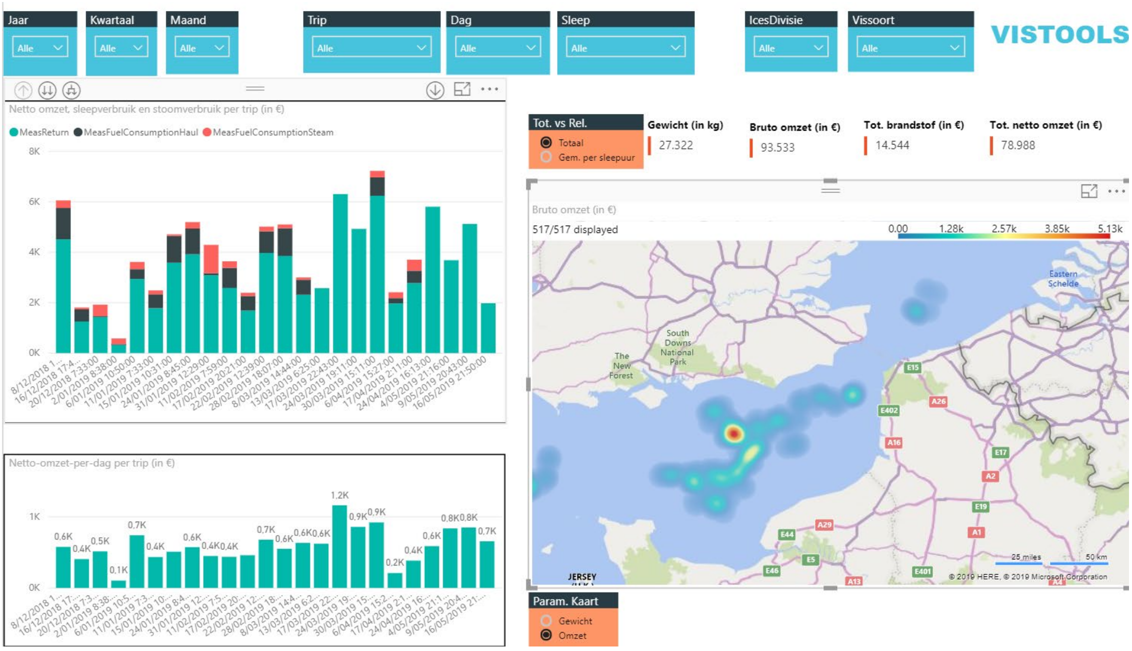


Figure 7.9: Screenshot of VISTools User Interface

With this approach, fishers gain new insight in the economic performance of their fishery, while exchanging valuable, high resolution oceanographic data with research institutes. This is a fully automatic process that does not entail unnecessary burdens on the fishers themselves and has been fully operational on a fishing vessel for over a year.

This increased insight of fishing activities could trigger behavioral changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. Additionally, the business intelligence tool incentivizes fishers to keep gathering information that have great scientific relevance, and share this information under clearly defined conditions. This data could open new research possibilities including catch prediction models, decision support tools, avoidance of sensitive areas, and real time closures. This high resolution of spatial information can also lead to better advice to fisheries management and governmental bodies (e.g., real time monitoring of quota usage).

Recent developments: The current system is operational on 5 vessels, with a planned upscaling to the entire Belgian fleet in 2023 (pending project approval). The fleet-wide coverage of the data offers new avenues for research including catch prediction and fuel-efficiency models. To develop this case, ILVO is participating as a pilot in the development of the Digital Twin of the Ocean, where the fuel data from VISTools will be enriched with oceanographic and meteorological data to better understand the fuel consumption of fishing vessels within the marine environment. With these models, decision support tools can be developed that balance the trade-offs between the profitability of a vessel, and reducing fuel consumption and the impact on the environment.

7.2.4 Future projects and Ideas

7.2.4.1 Project: Innovative pot fishing in OWF

Project Full Title: Toolbox for innovative pot fisheries in offshore development sites

Estimated Project Timeframe: 2023/2024 – 2025/2026

Institution(s): ILVO

Contact person:

Mattias Van Opstal, mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer, jasper.vanvlasselaer@ilvo.vlaanderen.be

Collaboration welcome?: Yes

Funding secured?: No

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? No

Summary: Continuation of project SYMAPA. Explore the possibilities to continue fishing with "low-impact fishing methods" in areas with limited access such as wind farms, including consultation with the sector.

7.3 Canada

7.3.1 Contact person

Paul Winger, Paul.Winger@mi.mun.ca

7.3.2 Projects

7.3.2.1 Project: Whalesafe Fishing Gear

Project Full Title: Evaluating the fishing performance of various technologies designed to detach fishing gear from entangled whales.

Project Timeframe: Jan 2022 – Jan 2025

Institution(s): Fisheries and Marine Institute

Contact person: Paul Winger, Paul.Winger@mi.mun.ca

Is the project directly addressing bycatch of PETS ? Yes

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? Yes

Summary: Several experiments are underway to evaluate the performance of whalesafe fishing gear in Canada. The research responds to a recent government regulation requiring all fixed untended fishing gears to be "whalesafe" by 2024 in order to protect endangered cetaceans such as the North Atlantic Right Whale. This includes features that allow gear to break-away or cut-away in the event the gear is entangled with a whale. We are evaluating various weak ropes, weak links, weak sleeves, time-tension line cutters, as well as rope-on-command systems.

7.3.2.2 Project: Aligned Rolling Footgear

Project Full Title: Reducing seabed impacts of bottom trawls in Canada's Arctic Ocean.

Project Timeframe: April 2018 – March 2024

Institution(s): Fisheries and Marine Institute; Nunavut Fisheries Association

Contact person: Paul Winger, Paul.Winger@mi.mun.ca

Summary: A 6-year project is currently underway to design and test novel footgear concepts to reduce seabed impacts of bottom trawls in Canada's eastern Arctic. This is a partnership with factory freezer trawlers operating in NAFO Division 0A/B between Baffin Island and Greenland. Fisheries of interest include Northern shrimp and Greenland halibut. To date, novel footgear designs have been conceived and evaluated using physical models in a flume tank. Building on previous research on "aligned" footgears (e.g., Winger et al. 2018), our latest designs are now both "aligned" and "rolling". Full-scale prototypes have now been constructed and were tested at sea in April 2022. Four aligned rolling footgear components were attached to the traditional footgear by replacing four bobbins. Prototypes performed well when fishing, however, during haul back some components were damaged as they impacted the trawl lane walls. A new and more rouged prototype was developed to overcome this issue. Currently, a complete aligned roll-ing footgear (with 18 wheels) has been built and sea trials will take place during winter 2023 onboard a commercial fishing vessel.

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

7.3.2.3 Project: Shaking Codend

Project Full Title: Developing a codend to increase selectivity and decrease discard mortality in the Newfoundland redfish fishery

Project Timeframe: Nov. 2018 – Jul. 2023

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: This project developed a shaking codend with the goal of motivating redfish to escape out of a codend at depth. A flume tank test was performed to quantify the codends movement, and a small-scale sea trial was completed to measure size selectivity. Results show that placing a tarp on the posterior of a codend can lead to steady movement, and there is some indication that size selectivity was improved for redfish when compared to a non-moving codend.

7.3.2.4 Project: Semi-pelagic Trawl for Redfish

Project Full Title: Optimizing semi-pelagic trawling for Redfish in Unit 1

Project Timeframe: Sept. 2019 – Nov. 2023

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: In the 1990s, prior to the redfish moratorium in Unit 1 (Gulf of St. Lawrence), a popular trawl design to target redfish was a semi-pelagic design where the doors are on bottom, bridles are connected to the warps, and the trawl is off-bottom; the so-called "French Rigging". This project aims to re-establish and optimise this design with flume tank tests of a model, and sea trials of a full-scale trawl to optimize the design and quantify fish behaviour to the trawl.

7.3.2.5 Project: How Increased Luminescence Affects Snow Crab Capture

Project Full Title: Using luminescent twine to improve conservation goals in the Canadian snow crab pot fishery

Project Timeframe: Jan. 2020 – Nov. 2023

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: Using luminescent fibers in snow crab pot twine has been shown to increase the capture of snow crab. Here, we will test twine with x2 and x4 the amount of luminescence to see if increased luminescence can further increase the capture of snow crab in pots.

7.3.2.6 Project: when do redfish escape from a T90 codend?

Project Full Title: When do redfish escape from a T90 codend?

Project Timeframe: Jan. 2022 – Nov. 2023

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: Previous research showed that using a T90 codend could reduce the retention of small redfish. However, it is unclear if redfish are escaping at the sea bottom, haulback, or the surface. Since redfish are physoclistous, they will not survive escape at the surface. Thus, to fully evaluate the effectiveness of using a T90 codend in the redfish fishery, the timing of redfish es-cape is required. This project will use video to determine when redfish escape.

7.3.2.7 Project: Approaches to address by-catch of juvenile redfish in Northern shrimp trawls

Project Full Title: Using smaller bar spacings in a Nordmøre grid to reduce bycatch of redfish (*Sebastes spp.*) in the offshore Northern shrimp (*Pandalus borealis*) fishery of eastern Canada

Project Timeframe: Dec 2020 – March 2022

Institution(s): Fisheries and Marine Institute

Contact person: Tomas Araya-Schmidt, Tomas.Schmidt@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: A recent rebound of juvenile redfish (*Sebastes spp.*) has led to increased levels of bycatch in the fishery. To address this concern, this study investigated the effectiveness of reduced bar spacing Nordmøre grids using comparative fishing experiments during commercial operations, as well as direct observation of redfish behaviour on the grid systems using underwater video. The project also includes a morphometric analysis of shrimp and redfish to understand which size animals fit through the spacings of the different grids being tested. Results show that reduced bar spacing grids can significantly reduce juvenile redfish bycatch while maintaining shrimp catches. However, there is a proportion of redfish that is extremely similar in size to shrimp and cannot be excluded using a size sorting BRD. The underwater video showed that a considerable proportion of redfish are still active and exhibit swimming behaviours at the grid section, therefore, additional research of behavioural BRDs that could facilitate redfish escapement is recommended to further reduce the bycatch of this important species.

7.3.2.8 Project: Behavioural Approaches to Reduce Redfish Bycatch

Project Full Title: Evaluating Behavioural Approaches to Reduce Redfish Bycatch in Offshore Shrimp Trawling

Project Timeframe: August 2022 – September 2023

Institution(s): Fisheries and Marine Institute

Contact person: Tomas Araya-Schmidt, Tomas.Schmidt@mi.mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: Beginning in 2020, DFO science surveys determined that redfish (Sebastes mentella) biomass and recruitment (redfish smaller than 150 mm in length) have been increasing considerably in recent years in the Davis Strait region, throughout the Labrador Shelf southward to Northern Newfoundland in 3K. The emergence of large redfish biomass has resulted in increasing volumes of juvenile redfish being caught by offshore vessels targeting Northern shrimp. The project will develop a new behavioural bycatch reduction technology for the fishery, including functional prototypes developed and tested aboard commercial vessels.

7.3.2.9 Project: Testing Green LEDs for influences on Handline Catch Efficacy

Project Full Title: The effects of green LED fishing gear modifications on Atlantic Cod (*Gadus morhua*) behaviour and catch in the Newfoundland inshore cod fishery.

Project Timeframe: September 2019 – Dec 2021

Institution(s): Memorial University of Newfoundland; Fisheries and Marine Institute

Contact person: Robert Blackmore, rblackmore@mun.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: Handlines are a traditional gear type used by inshore fishers in Newfoundland and Labrador. Previous pilot research has shown that LED handline attachments that target the visual sensitivity of cod increased the catch rate of Atlantic cod. The present study builds upon this finding, incorporating three participating commercial crews and vessels. We found no significant effect of LED handline modifications on catch efficacy or bycatch parameters for Atlantic cod. The findings are relevant to small-scale fishers and provide an empirical reference regarding the use of such devices in the commercial fishery.

7.3.2.10 Project: Whalesafe Fishing Gear

Project Full Title: Whalesafe Fishing Gear

Project Timeframe: Jan 2021 – March 2023

Institution(s): Fisheries and Oceans Canada

Contact person: Edward Trippel, Edward.Trippel@dfo-mpo.gc.ca

Is the project directly addressing bycatch of PETS ? Yes

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? No

Summary: To help protect North Atlantic right whales and other whale species, DFO is working closely with the fishing industry, Indigenous groups and other partners to make fishing gear safer for whales. Whalesafe gear falls into two general categories:

- Low breaking-strength rope or links that are designed to break at 1,700 lbs. of force. This gear will make it easier for entangled whales to free themselves and reduce the risk of se-rious injury; and
- Systems that allow fishing gear to be deployed without vertical line in the water, either rope-on-demand systems that stow buoy lines at the sea floor, or inflatable bag systems that eliminate buoy lines. These are released by an acoustic signal sent from the fishing vessel.

The timeline to test and implement requirements to use low breaking strength fishing gear in non-tended, fixed gear and trap and pot commercial has been extended to 2024 for fisheries in Atlantic Canada and Quebec. DFO's main objective is to prevent entanglements from happening. We are doing this by opening fisheries before North Atlantic right whales arrive in our waters, by closing fishing areas where and when whales are detected, and by removing ghost gear. Fisher-ies and Oceans Canada's Whalesafe Gear Adoption Fund (WSGF) is providing up to $20 million towards the purchase, testing and refinement of whalesafe gear with the goal of making this innovative equipment ready to use in 2024. We want to make sure that low breaking-strength fishing gear is safe, effective at protecting whales, and readily available to support har-vesters with the transition to new gear, and to support the advancement of rope-on-demand gear tech-nology. The Whalesafe Gear Adoption Fund also provides support to Canadian manufac-turers to increase the domestic supply of commercially-ready whalesafe gear.

7.3.2.11 Project: End-of-tow Sampling Biases in a Snow Crab Survey

Project Full Title: Assessing and correcting for end-of-tow biases in the southern Gulf of Saint Lawrence snow crab survey

Project Timeframe: July 2019 – Sept. 2020

Institution(s): Fisheries and Oceans Canada

Contact person: Tobie Surette, Tobie.Surette@dfo-mpo.gc.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: Trawl swept area is used to standardize southern Gulf of Saint Lawrence snow crab survey catch data and produce estimates of annual biomass estimates on which quota levels are directly set. However, two sources of bias in the swept area estimates have been highlighted: possible asymmetry in the trawl configurations and the existence of latent phase of trawling after active trawling is supposed to have ended. Acoustic trawl monitoring probes, Doppler water current probes, depth-pressure probes and tilt angle probes are affixed to the trawl and used to characterize individual trawl behaviour and explore correctives for the identified biases.

7.3.2.12 Project: NL-DFO Multi-Species Survey Trawl

Project Full Title: Modifications to the Campelen 1800 Shrimp Survey Trawl

Project Timeframe: December 2019 – December 2023

Institution(s): Fisheries and Oceans Canada

Contact person: Truong Nguyen, Truong.Nguyen@dfo-mpo.gc.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: This project aims to make our survey trawl more user friendly and less susceptible to damage. This increases cost effectiveness, improves productivity at sea (e.g., optimizing use of vessel time when on program, i.e. reduce overall repair time) as well as the financial and human resources that are required to maintain the surveys. The proposed trawl modifications will be evaluated using numerical simulations, flume tank testing, and comparative fishing. In 2021, comparative paired-trawl experiments were conducted at-sea between the CCGS Capt. Jacques Cartier and CCGS Teleost. Trials were continued in 2022, with an additional comparison between CCGS John Cabot and CCGS Alfred Needler. The comparative trawl performance results are under investigation. More comparative fishing is expected for the 2023 annual Spring and Fall surveys.

7.3.2.13 Project: Low Biological Impact Fishing Gear

Project Full Title: Mitigating the negative impact of commercial fishing on endemic Atlantic cod population using collapsible pots.

Project Timeframe: 2019 – 2021

Institution(s): Fisheries and Oceans Canada

Contact person: Corey Morris, Corey.Morris@dfo-mpo.gc.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: The Gilbert Bay Marine Protected Area (MPA), located along the southeast coast of Labrador, Canada, was created in 2005 to protect a distinguishable and endemic bay population of Atlantic cod (Gadus morhua) from commercial fishing for northern cod. Some adult bay-cod migrate beyond MPA boundaries during summer increasing their susceptibility to commercial fishing in areas outside the MPA. The project compared the catch efficiency of traditional gillnets and a newly developed collapsible pot design. Results showed that collapsible pots have a comparable catch to the traditional gillnets and permit the live-release of protected cod, thereby mitigating against the negative effects of fishing on this population and helping to meet MPA objectives.

7.3.2.14 Project: Minimizing groundfish bycatch in the redfish fishery

Project Full Title: Building a sustainable redfish fishery in the Gulf of St. Lawrence: minimizing groundfish bycatch and seabed impacts

Project Timeframe: April 2018 – March 2021

Institution(s): Fish, Food and Allied Workers Union

Contact person: Erin Carruthers, ecarruthers@ffaw.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? No

Summary: A series of side-by-side trawl comparisons are being used to test modifications to minimize environmental impacts, such as reduced seabed impacts and unwanted groundfish bycatch, while maintaining catch rates of targeted redfish species. Additionally, midwater trawls are being fished concurrently to determine redfish catch rates relative to bottom trawl gear. Initial results include comparable redfish catch rates from bottom trawls fished with semi-pelagic doors compared to standard bottom doors. Midwater trawl catch rates were highly variable but overall catch rates were comparable to bottom trawl during the winter 2020 fishery. Ongoing field trials during May-September 2020 will be used to determine seasonal differences in catch rates of target and bycatch species.

7.3.2.15 Project: Improving Lobster Safety

Project Full Title: Safety design criteria of working stations like pot hauler and supporting rack on board lobster boats in Quebec LFA

Project Timeframe: April 2019- March 2020

Institution(s): Merinov

Contact person: Colin Gauthier-Barrette, Colin.Gauthier-Barrette@merinov.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Since 2012, an important research program concerning lobster boat crew safety was undertaken in the Quebec Gaspe Peninsula and Magdalen Islands fisheries. In cooperation with Laval University ergonomists, we analysed the risks and determined factors involved in overboard falls; we documented collective and individual prevention solutions that can be adapted to lobster boats; and we identified, with the most promising risk reduction scenarios. In 2015, we developed, tested at-sea, and implemented practical integrated technical solutions for the pot hauler and the supporting fishing lines rack. Both of these are most used by crewmen for easing their work. Attention has been paid to reduce ropes entanglement risks and body efforts when hauling and launching the fishing gear. A full-scale mobile demonstrator was built on a trailer in order to allow fishermen to test the equipment and devices in order to measure their efficiency relative to their current tools.

7.3.2.16 Project: Feasibility of Weak Links to Reduce Whale Entanglement

Project Full Title: Entanglements of right whales – Weak links for snow crabs fisheries

Project Timeframe: August 2019- July 2021

Institution(s): Merinov

Contact person: Jerome Laurent, Jerome.laurent@merinov.ca

Is the project directly addressing bycatch of PETS ? Yes

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

Summary: This feasibility study aims to design and manufacture a weaklink prototype capable of snow crab fishing activities, but which can break in case of a North Atlantic Black Whale entanglement in vertical ropes to facilitate its release. We measured tensions in the vertical ropes of snow crab traps, in all fishing situations encountered by harvesters in the Gulf of St. Lawrence. The data collected will be used to determine the minimum breaking load of the rope for a use without risk of trap loss. These data will be compared with theoretical tensions that a right whale would impose on the rope in its efforts to become disentangled. The first prototype will be tested during the next snow crab season.

7.3.2.17 Project: Detecting and Recovering Lost Crab Pots

Project Full Title: Ghost Gear, detect and recovery lost or abandoned fishing gears

Project Timeframe: September 2019 – March 2023

Institution(s): Merinov

Contact person: Jerome Laurent, Jerome.laurent@merinov.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? Yes

Is the project addressing ALDFG ? Yes

Summary: As part of a 4-year project started in 2019, Merinov and its partners are working on ghost gear issues. They are developing methods for detecting and recovering snow crab pots lost or abandoned by fishermen. Two recovery gears have been designed and manufactured, including a circular model, allowing to cover a large surface on the seabed, while minimizing the impact on the bottom. In 2021, we will continue to develop detection and recovery technologies and we will conduct detection and recovery campaigns in targeted areas.

7.3.2.18 Project: Improving Handling and Storage of Redfish

Project Full Title: On board redfish catch quality enhancement with a new pelagic trawl by development of conservation methods

Project Timeframe: October 2017- December 2020

Institution(s): Merinov

Contact person: Lise Chevarie, lise.chevarie@merinov.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? No

The upcoming reopening of the commercial redfish fishery in the Gulf of St. Lawrence (Quebec, Canada) is generating renewed interest in the Magdalen Islands. Before 1994 commercial fishing moratorium, quotas share allowed to the Magdalen islanders was 75% of the Quebec total. This project aims to test new fish catch storage and handling techniques. Single trays will be compared to in ice bulk storage. Fishing vessels will use semi pelagic trawls.

7.3.2.19 Project: End of Life Fishing Gear Utilization

Project Full Title: Lost or Abandoned Fishing Gear: Recirculation Introduction

Project Timeframe: July 2020- March 2022

Institution(s): Merinov

Contact person: Jerome Laurent, Jerome.laurent@merinov.ca

Is the project directly addressing bycatch of PETS ? No

Could this project indirectly decrease bycatch of PETS ? No

Is the project addressing ALDFG ? Yes

Summary: Merinov wishes to draw up an inventory of fishing gear at the end of its useful life. This inventory will be the basis for the development of a circular economy by organizing the transportation of this fishing gear to Quebec sorting centers, and by working on the valorization of the materials that compose it. Dismantling tests on various fishing gear and identification of materials from “plastic” components with various chemical and physical analyses are being conducted. The goal of this initiative is to potentially generate additional income for harvesters by developing end-of-life fishing gear collection logistics from hypothetical scenarios.

7.4 China

7.4.1 Contact person

- Shenmao Zhang, East China Sea Fisheries Research Institute Chinese Academy of Fishery Sciences, zhangsm@ecsf.ac.cn

7.4.2 Summary

- The East China Sea Fisheries Research Institute of the Chinese Academy of Fishery Sciences was founded in October 1958. It is China's national comprehensive fishery research institu-tion for the East China Sea and the distant sea. In 2019, it began to cooperate with Jiangsu Marine Fisheries Research Institute, Marine Fisheries Research Institute of Zhejiang and ocean companies to carry out EM-based fishing management research. Progress has been made in the EM research of *Acetes chinensis*, *Engraulis japonicus* , *Scomber japonicus* and Tuna longline

7.4.3 Projects

7.4.3.1 Project: Acetes chinensis quota

Project Full Title: *Acetes chinensis* quota fishing based on electronic monitoring

Project Timeframe: January 2021 – December 2023

Institution(s): Jiangsu Marine Fisheries Research Institute, East China Sea Fisheries Research Institute Chinese Academy of Fishery Sciences

Contact person: Shenmao Zhang, zhangsm@ecsf.ac.cn

Link(s): www.ecsf.ac.cn/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In the present study, a method for identifying the status of *Acetes chinensis* fishing vessels based on a 3D convolutional neural network is proposed, so as to protect marine biodiversity, monitor the working status of *Acetes chinensis* fishing vessels and assist in the realization of quota fish-ing. The Vessel Monitoring System (VMS) was installed on the quota fishing vessels to collect work data from June 16, 2021 to July 13, 2021. According to the characteristics of the fishing vessels, the work status of the fishing vessels was divided into five statuses such as stopping, sailing, putting net, waiting and pulling net. The 3D convolutional neural network Acetes3DNet was designed to extract the multi-dimensional and multi-level features of the data and trained in the training set. Finally, the effectiveness of the model was verified in the validation set. The training results were combined with the Beidou ship position data to restore the working process of the fishing vessel. The experimental results reveal that after 150 epochs of training, the precision, recall, and f1 score of Acetes3DNet on the training set reached 99.02%, 99.19%, and 99.09%, re-spectively, while the precision, recall, and f1 score on the validation set reached 97.09%, 96.82%, and 96.68%. Research shows that Acetes3DNet can circumvent the limitations of traditional 2D neural networks in dynamic target detection, complete recognition of the working status of *Acetes chinensis* quota fishing vessels, and show the historical work process of the ship in an intuitive manner. The experimental results are conducive to standardizing the management of fishing vessels and protecting marine life.

The video monitoring data in 2022 is being sorted out, and it focuses on the extraction of fishing yield information. In 2023, we will focus on the study of discarded materials.

Reference: Wang S, Zhang S, Liu Y, et al. Recognition on the working status of Acetes chinensis quota fishing vessels based on a 3D convolutional neural network[J]. Fisheries Research, 2022, 248: 106226.

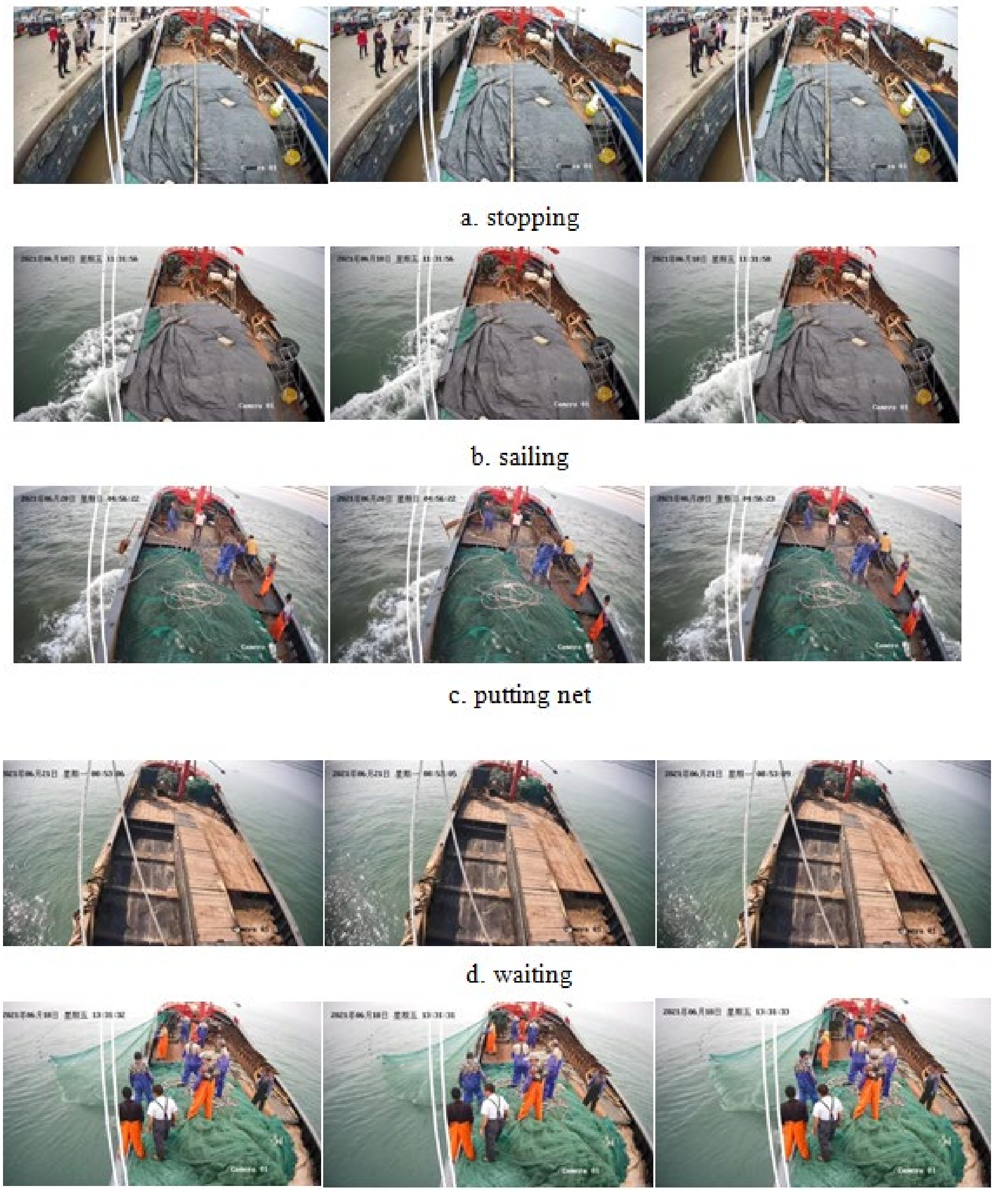


Figure 7.10: Sampling diagram of five states

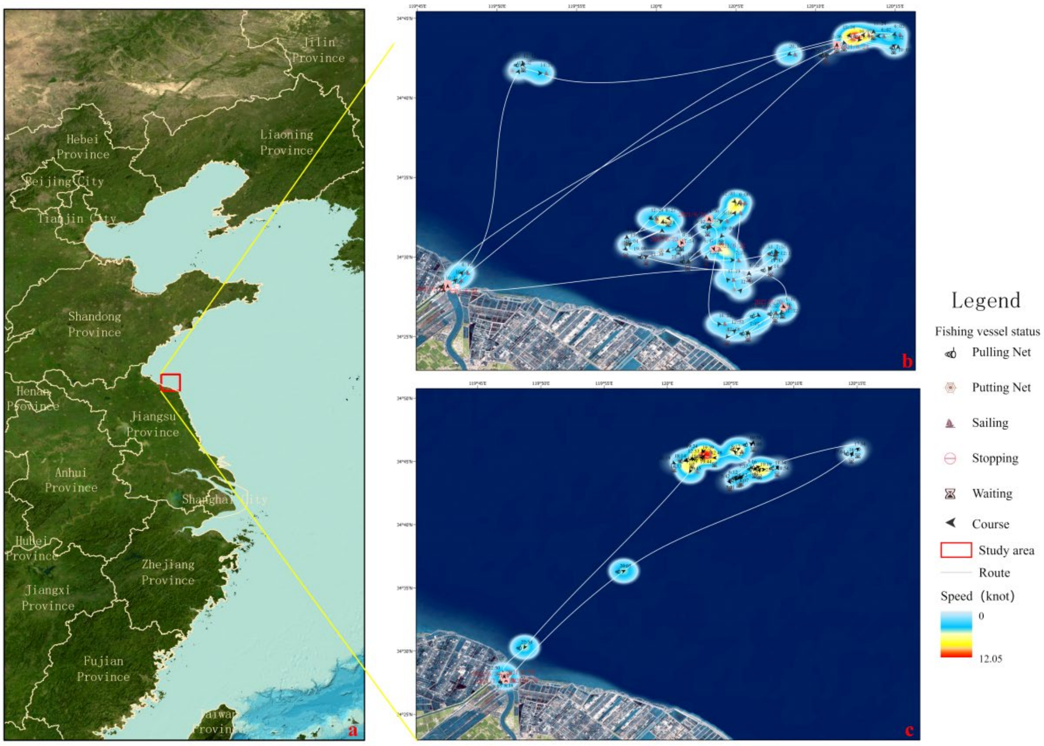


Figure 7.11: Result of fishing vessel working status.

7.4.3.2 Project: Engraulis japonicus quota

Project Full Title: Engraulis japonicus fishing based on electronic monitoring

Project Timeframe: January 2021 – December 2023

Institution(s): Marine Fisheries Research Institute of Zhejiang. East China Sea Fisheries Research Insti-tute Chinese Academy of Fishery Sciences

Contact person: Shenmao Zhang, zhangsm@ecsf.ac.cn

Link(s): www.ecsf.ac.cn/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The refined monitoring and identification of fishing operations by fishing vessels is of great sig-nificance and value to fishing vessels. In order to solve the problem of inaccurate statistics of current *Engraulis japonicus* fishing quota and classification, this paper proposes an improved identification algorithm of YOLOv5. This method introduces the SENet attention mechanism into the YOLOv5 backbone network structure, integrates the target information in different peri-ods of fishing operations, reduces the interference of complex backgrounds, im-proves the preci-sion of model detection, and ensures real-time detection efficiency. Using the manual shooting video of engraulis japonicus operation was used as experimental data, and the video is convert-ed into a picture format to realize pre-labeling and processing. The 5550 images are divided into the training set, validation set, and test set according to 8:1:1. In order to verify the validity of the data, a set of in the control experiment, the YOLOv5 backbone network was replaced by MobileNetV2 and the SENet attention mechanism was introduced, and four models were imple-mented for comparison. The experimental results show that the research algorithm can obtain a mean average precision (mAP) of 99.3%, a precision of 98.9%, and a recall of 98.7%, which are improved by 1.4%, 1.7% and 2.5% respectively compared with the original model. The experi-mental results are good. According to the statistics of some categories, the Kalman filter and the Hungarian matching method are used to count the main categories of fishing baskets, and an accuracy of 96.5% can be obtained. The threshold method for fishing nets and processing vessels can obtain 85.8% and 75% accuracy. The results are good, which can provide new ideas for job identification of *Engraulis japonicus* and provide auxiliary means for job statistics.

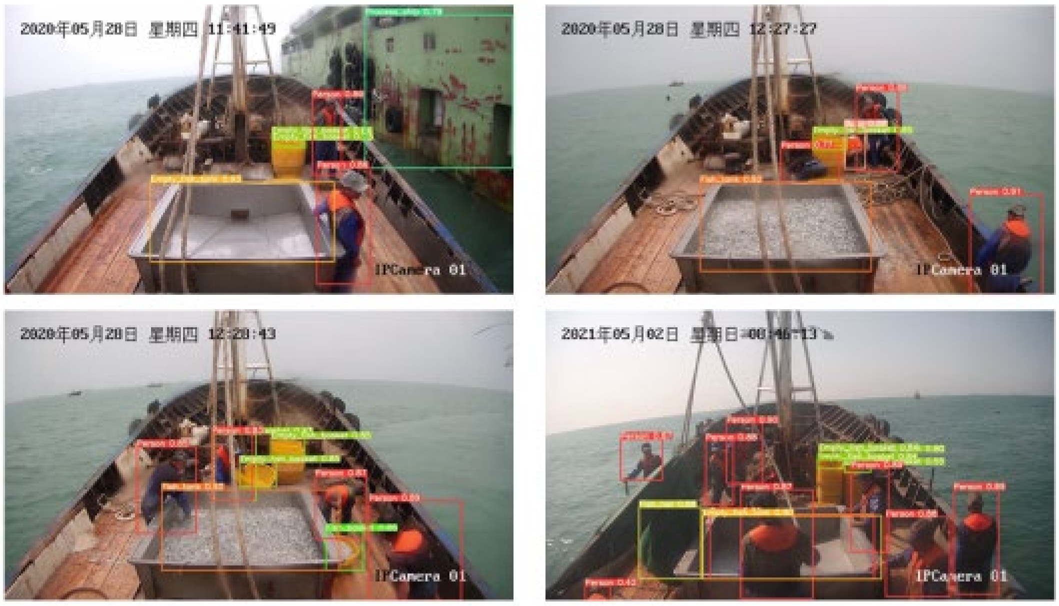


Figure 7.12: Model checking results

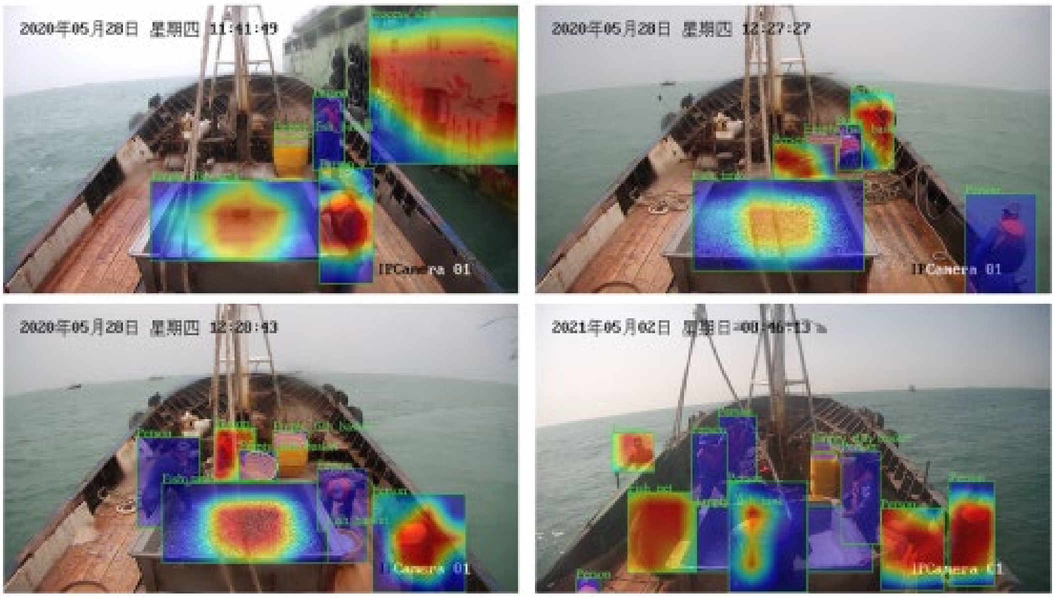


Figure 7.13: Heat map display

7.4.3.3 Project: Tuna longline fishing

Project Full Title: Tuna longline fishing based on electronic monitoring

Project Timeframe: January 2021 – December 2023

Institution(s): Liancheng Overseas Fishery (Shenzhen) Co.,Ltd. East China Sea Fisheries Research Insti-tute Chinese Academy of Fishery Sciences

Contact person: Shenmao Zhang, zhangsm@ecsf.ac.cn

Link(s): www.ecsf.ac.cn/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In order to evaluate the operation quality of the tuna longline fishing system, reduce labor costs, and extract information such as float and tuna quantity from the electronic monitoring system of the tuna longline fishing system, this paper proposes a method for detecting floating ball and tuna target in tuna longline fishing electronic monitoring system based on deep learn-ing YOLOV5 network model. Intercept 15578 key frames containing target float or tuna from the video surveillance data of the HNY722 ocean-going fishing vessel EMS , divide all key frames and their mark files into 14,178 training data and 1,400 verification data, based on YOLOV5s, YOLOV5l, YOLOV5m and TOLOV5x deep learning neural network models , and design group training tests to compare training effects. The results show that the four neural network models trained in this article can all complete the target detection task of the tuna longline electronic monitoring system. However, the choice of the network model has a highly significant impact on the parameters of GioU Loss, Objectness Loss, Precision, Recall, mAP@0.5, mAP@0.5:0.95, and has no significant impact on the Classification parameters. The models with better detection results are YOLOV5l and YOLOV5m network models. The mAP values of the two are 99.13% and 99.16%, and the recall rates are 98.4% and 98.3%, respectively. However, YOLOV5m is infe-rior to YOLOV5l in performance such as GIoU loss. Research shows that YOLOV5l is the most suitable network model for target detection in tuna longline electronic monitoring system among the four network models of YOLOV5s, YOLOV5l, YOLOV5m and YOLOV5x.

Reference: Wang Shuxian, Zhang Shengmao, Zhu Wenbin, etc Target detection application of electronic monitoring system for tuna longline fishing based on deep learning YOLOV5 network model [J] Journal of Dalian Ocean University, 2021, 36(5): 842-850. DOI : 10.16535/j.cnki.dlhyxb.2020-333

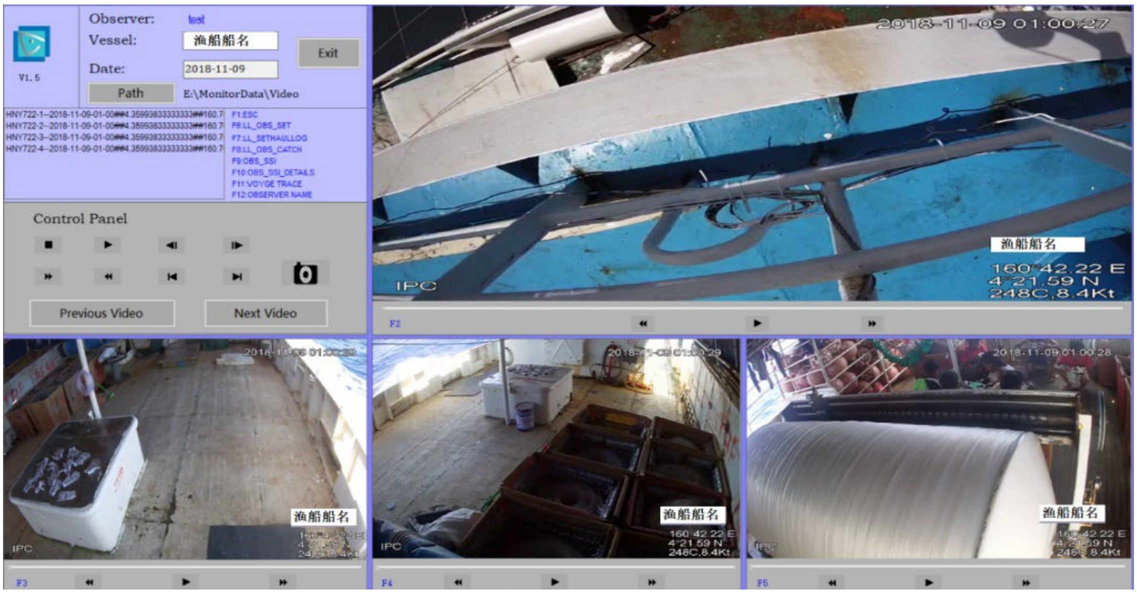


Figure 7.14: Electronic monitoring

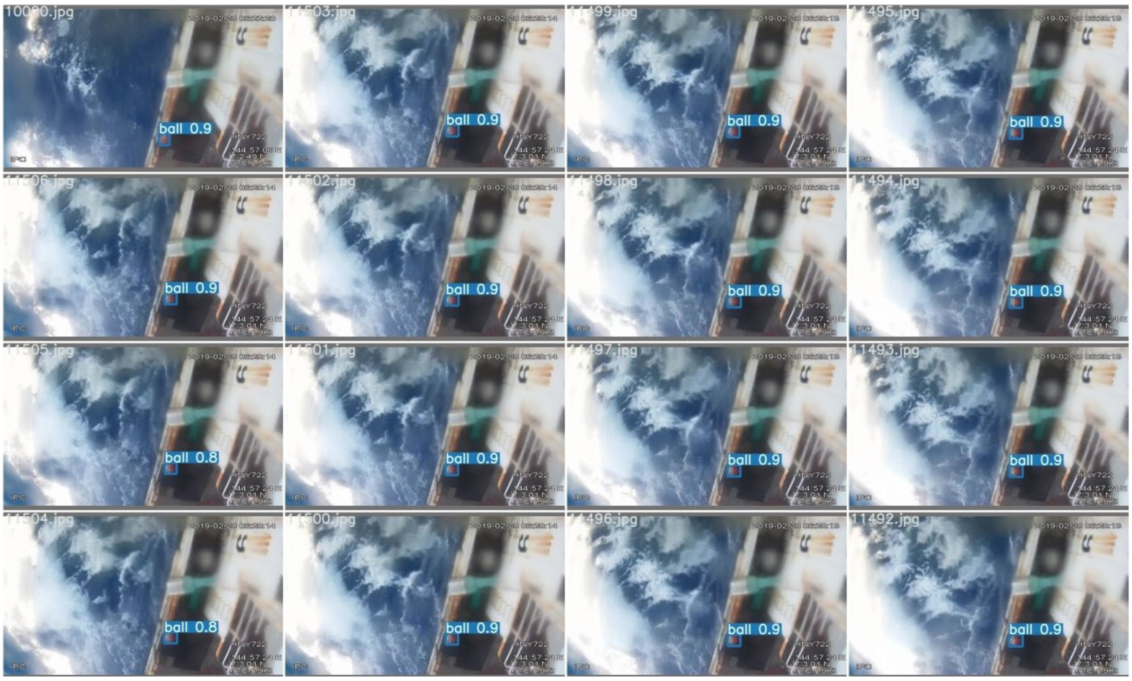


Figure 7.15: Object detection

7.4.3.4 Project: Scomber japonicus fishing

Project Full Title: Scomber japonicus fishing based on electronic monitoring

Project Timeframe: January 2021 – December 2023

Institution(s): Zhoushan Xinhai Fishery Co., Ltd. East China Sea Fisheries Research Institute Chinese Academy of Fishery Sciences

Contact person: Shenmao Zhang, zhangsm@ecsf.ac.cn

Link(s): www.ecsf.ac.cn/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Fishing vessels with a higher degree of automation have gradually begun adopting a fishing monitoring method that combines human and electronic observers. However, the objective data of electronic monitoring systems (EM) has not yet been fully applied in various fishing boat sce-narios such as ship behavior recognition. In order to make full use of EMS data and improve the accuracy of behaviors recognition of fishing vessel, the present study proposes applying popular deep learning technologies such as convolutional neural network, long short-term memory, and attention mechanism to Scomber japonicus fishing vessel behaviors recognition. The operation process of Scomber japonicus fishing vessels was divided into nine kinds of behaviors, such as "pulling nets", "putting nets", "fish pick", "reprint", etc.. According to the characteristics of their fishing work, four networks with different convolutional layers were designed in the pre-experiment. And the feasibility of each network in behaviors recognition of the fishing vessels was observed. The pre-experiment is optimized from the perspective of the data set and the net-work. From the standpoint of the data set, the size of the optimized data set is significantly re-duced, and the original data characteristics are preserved as much as possible. From the perspec-tive of the network, different combinations of pooling, long short-term memory (LSTM) network, and attention (including CBAM and SE) are added to the network, and their effects on training time and recognition effect are compared. The experimental results reveal that the deep learning methods have outstanding performance in behaviors recognition of fishing vessels. The LSTM and SE module combination produced the most apparent optimization effect on the network, and the optimized model can achieve an F1 score of 97.12% in the test set. The current research is of great significance to the management of intelligent fishery vessels and can promote the devel-opment of electronic monitoring systems for ships.

Reference: Wang S, Zhang S, Tang F, Shi Y, Sui Y, Fan X and Chen J (2023) Developing machine learning methods for automatic recognition of fishing vessel behaviour in the *Scomber japonicus* fisheries. Front. Mar. Sci. 10:1085342. doi: 10.3389/fmars.2023.1085342

Figure 7.16: 9 kinds of ship behavior reflected in EMS

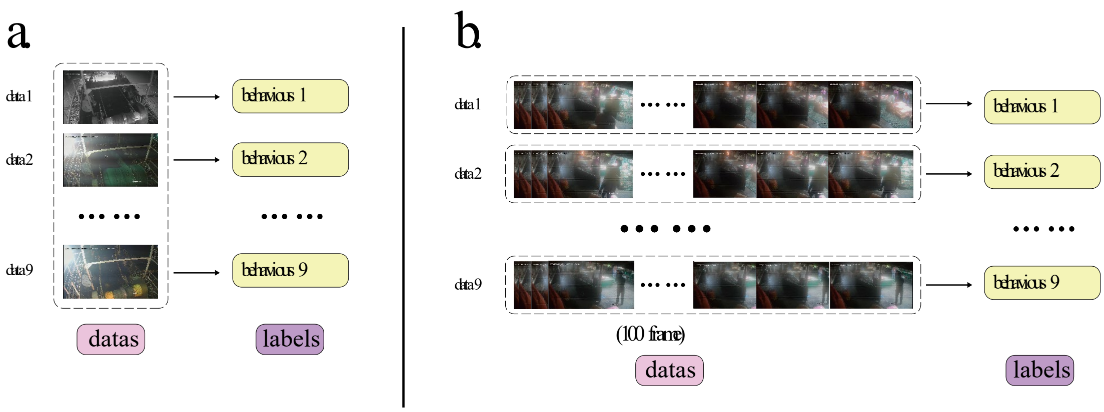


Figure 7.17: The structure of two types of the dataset of single-frame samples and multi-frame samples

7.5 Denmark

7.5.1 Contact person

- Jordan Feekings, DTU Aqua, jpfe@aqua.dtu.dk

7.5.2 Summary

The following areas represent the core-activities of DTU Aqua in 2022:
- the development of fishing gear modifications in collaboration with the industry: from steerable trawl doors, to selective devices, to novel gear designs and materials;
- the potential of biodegradable materials for gillnets fisheries;
- machine vision, camera technology, and video processing for real-time information during fishing and on board fishing vessels using Electronic Monitoring;
- the hydrodynamic performance of different gear components, as well as the quantification of their physical impact on the seabed;
- the use of acoustic methods for observation of fish behaviour in relation to fishing gears
- the interactions between protected species (PETS) and fisheries.

7.5.3 Projects

7.5.3.1 Project: Developing selective fishing gears and technologies for commercial fisheries (SELEKT)

Project Full Title: Udvikling af SELEKTive redskaber og teknologier til kommercielle fiskerier (SELEKT)

Project Timeframe: July 2022 – December 2023

Institution(s): The project is coordinated by DTU Aqua and funded by EMFF.

Contact persons: Jordan Feekings, jpfe@aqua.dtu.dk

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The objective of the project is to develop and test new selective fishing gears and technologies, and document their selective effect with the outlook that they can be implemented in the com-mercial fisheries in the North Sea, Skagerrak, Kattegat and the Baltic Sea. In addition, there will be developed modelling tools that quickly and precisely can indicate the selectivity in a given fishing gear for the relevant commercial species. The project has a specific focus on reducing unwanted catches of cod.

7.5.3.2 Project: Smart fisheries technologies (SMARTFISH)

Project Full Title: Smart fisheries technologies for an efficient, compliant and environmentally friendly fishing sector

Project Timeframe: January 2018 – December 2022

Institution(s): The project is coordinated by SINTEF and is funded by EU through Horizon 2020 Framework Programme.

Contact persons: Ludvig Ahm Krag, lak@aqua.dtu.dk and Barry O'Neill, barone@aqua.dtu.dk

Link(s): http://smartfishh2020.eu/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The objective of SMARTFISH is to develop, test and promote a suite of high-tech systems for the EU fishing sector, to optimize resource efficiency, to improve automatic data collection for fish stock assessment, to provide evidence of compliance with fishery regulations and to reduce eco-logical impact. SMARTFISH exploits technological developments in machine vision, camera technology, data processing, machine learning, artificial intelligence, big data analysis, smartphones/tablets, LED technology, acoustics and ROV technology to build systems for moni-toring, analyzing and improving processes for all facets of the fishing sector, from extraction, to assessment, to monitoring and control.

The SMARTFISH systems will:

- assist fishermen in making informed decisions during pre-catch, catching, and post-catch phases of the extraction process. This improves catch efficiencies and compositions in fisheries across the EU, leading to improved economic efficiency while reducing unintended fish mortali-ty, unnecessary fishing pressure and ecosystem damage.
- provide new data for stock assessment from commercial fishing and improve the quality and quantity of data that comes from traditional assessment surveys. This provides more accurate assessment of currently assessed stocks and allow the assessment of data-poor stocks.
- permit the automatic collection of catch data to ensure compliance with fisheries management regulations.

The SMARTFISH systems are tested and demonstrated in several EU fisheries. This contributes to promoting the uptake of the systems by extraction sector and fisheries agencies. An interdisciplinary consortium with technology developers and instrument suppliers, fishing companies, research and fisheries management institutes and universities will realize SMARTFISH. They are active at national and international levels and well placed to ensure the uptake of SMARTFISH systems by fishing industry and fisheries managers and stock assessment scientists.

7.5.3.3 Project: Real-time camera in the Danish trawl fishery (TECHNO-FISH)

Project Full Title: Real-time camera observation in the Danish trawl fishery – technology based intelligent fishery

Project Timeframe: December 2018 – November 2022

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Contact person: Ludvig Ahm Krag, lak@aqua.dtu.dk

Link(s): https://orbit.dtu.dk/en/projects/real-time-camera-observation-in-the-danish-trawl-fisherytechnolog

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The aim of the project is to develop and commercially test an innovative real-time camera system on board Danish trawlers. The system will allow fishermen to observe, evaluate, and if relevant, actively react on information about the fishing process. A reaction could be to terminate the haul or to shift to alternative depth or fishing ground. Through innovative use and combination of existing technology, the project will develop a real-time tool for decision making. The tool will make the trawl fishery a more knowledge-based process, where decisions can be made on better grounds.

7.5.3.4 Project: Autocatch

Project Full Title: Development of a real-time catch monitoring system with automatic detection of the catch composition to minimize catch of unwanted species and sizes (AutoCatch).

Project Timeframe: 2020-2023

Institution(s): The project is coordinated by DTU Aqua, involves DTU ELECTRO and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency

Contact person: Ludvig Ahm Krag, lak@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The purpose of the project is to develop algorithms for an automatic catch information system that provides detailed information on the catch entering the trawl to enable fishers in real-time to make informed decisions based on the ongoing catching process. The development and estab-lishment of a high-resolution decision-making tool that facilitates the avoidance of unwanted catches will ensure the best possible economic and biological sustainability of the fish stocks and the success of the CFP. Developing a more intelligent fishery that facilitates the avoid-ance of un-wanted catches will improve the fisheries competitiveness and quota capitalization under the landing obligation.

7.5.3.5 Project: RightFish

Project Full Title: Reducing environmental impact and greenhouse gas emissions in commercial fisheries.

Project Timeframe: 01/11/2022 - 01/11/2025

Institution(s): DTU Aqua (coordinator), SINTEF OCEAN, National Research Council of Italy, Hampiðjan, Iceland

Contact person: Barry O'Neill, barone@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: RightFish will develop generic methodologies that will improve our ability to design and devel-op low impact towed fishing gears.

It will advance the state of the art in the design of commercial trawl gears by establishing criteria for small scale modelling that incorporate the contact forces associated with fishing gears being towed over the seabed.

It will apply these approaches in two case studies, which characterise European demersal trawl fisheries, and demonstrate the environmental and economic benefits that can be achieved. These gears will be more fuel-efficient, disturb fewer carbon-rich sediments and penetrate less into the seabed. Accordingly, they will ensure that marine resources are managed and harvested in a sustainable way that maintains ecosystem integrity and resilience and reduces greenhouse gas emissions.

They will also have reduced fuel costs and are likely to lead to increased fishing opportunities, improved market access and higher prices. Hence, they will contribute to sustainable production in the Blue Bioeconomy. They will allow the development of transparent, certifiable and traceable standards and processes which can be used to establish consumer trust and increase marketing opportunities.

7.5.3.6 Project: Hydrodynamics and more selective fishing gears. (Hy-droSel)

Project Full Title: Using hydrodynamics to develop more selective fishing gears.

Project Timeframe: June 2019 – October 2022

Institution(s): DTU Aqua, DTU Mek, Rostock University

Contact person: Barry O'Neill, barone@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The hydrodynamics of the flow in and around fishing gears will be used to improve the selective performance of the gears themselves. Hydrodynamics influences the mesh opening and shape of a fishing gear, the swimming performance of fish and their location in and their passage through a gear. It can be used to prevent blockages in a gear, improve escape opportunities and can en-hance a fish's ability to respond to other stimuli.

We will investigate the hydrodynamics at critical points of the fish capture process and in particular examine the hydrodynamics at the (i) the footrope and groundgear, (ii) the headline, (iii) at guiding panels, (iv) square mesh panels and (v) in the codend. Numerical simulations with high performance computers and scale models in flume and towing tanks will be used. Case studies will be carried out in collaboration with the industry to show how hydrodynamics can improve fishing gear selectivity.

7.5.3.7 Project: ReFigure

Project Full Title: Quantifying and reducing the physical impact of mobile fishing gears

Project Timeframe: June 2020 – October 2023

Institution(s): DTU Aqua, SINTEF, AU, DFPO

Contact person: Barry O'Neill, barone@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project will quantitatively assess the physical impact, at the gear component level, of the main gears used by the Danish and European demersal fishing industry on a range of sediment types. In particular, it will, quantify the amount of sediment mobilised by towed fishing gears, measure the depth to which the components of a given gear penetrate the seabed, develop predic-tive models of the physical impact of trawl gears, identify which elements or components of fish-ing gears cause the most impact, produce guidelines for the fishing industry on how to modify their gears to reduce impact and evaluate indicators of good environmental status of descriptor 6 on seabed integrity.

This will allow policy makers and fishery managers to implement the Common Fisheries Policy (CFP) by promoting competitive, environmentally sustainable and economically viable fisheries. It will contribute to the EU's Marine Strategy Framework Directive (MSFD) by helping evaluate the indicators relating to the physical impact of fishing and how it effects habitat and seabed integrity. It will inform decision making with regard to permissible fishing activities in Marine Protected areas. It will allow the fishing industry to prepare for and respond to future management measures, to modify their gears, develop gears of reduced impact and choose their fishing methods appropriately. Thus permitting continued access to fishing grounds, and ensuring that the fishery is exploited in an environmentally sustainable and economically viable manner.

7.5.3.8 Project: STEER

Project Full Title: Steerable trawl doors that reduce bottom contact and improve fuel efficiency

Project Timeframe: August 2020 – July 2024

Institution(s): DTU Aqua, MLD ApS

Contact person: Barry O'Neill, barone@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: MLD have developed a patented steerable trawl door that can be used in both pelagic and de-mersal fisheries. At present they have a 12m² working prototype steerable trawl door that is be-ing used by large (> 40 m) vessels in the pelagic sprat and the demersal sandeel industrial fisher-ies. In order to realise the full potential of the MLD steerable trawl door technology it is necessary to develop a much smaller size steerable solution for the whitefish and flatfish fisheries. The present 12m² working prototype is too large for the typical vessel in these fisheries. The devel-opment of a 2m² steerable trawl door will open up a much larger market and allow the economic and environmental benefits of the MLD steerable trawl door technology to be exploited on a much greater scale.

Hence, the aims of this project are to

- develop 2m² steerable trawl doors suitable for the demersal whitefish and flatfish fisheries.
- assess and quantify the economic and environmental performance of the 2m² MLD steerable trawl doors in the demersal whitefish and flatfish fishery

The doors will be evaluated during experimental trials at seas. The experiments will demonstrate to the fishing industry the benefits of the MLD steerable trawl doors, and highlight in particular the reduced fuel usage per kilo of fish caught, the increased manoeuvrability, the reduced seabed impacts and the decrease of greenhouse gas emissions during conditions they normally operate under. The trials will be fully instrumented, carried out under controlled conditions and provide a detailed and precise understanding of the environmental and economic performance of the MLD steerable trawl doors. Such information will be particularly useful to fisheries managers in assessing which fishing gears and practices should be permitted in protected and sensitive areas.

7.5.3.9 Project: Fast Track II

Project Full Title: Fast-Track II – Sustainable, cost effective and flexible gear solutions under a landing obligation

Project Timeframe: 2018-2022

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact person: Jordan Feekings, jpfe@aqua.dtu.dk

Link(s): www.fast-track.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project is a continuation of the Fast-Track project, which has already been running since 2015. The project aims to continue the collaboration with stakeholders (fishers, net makers, pro-ducer organisations, managers and scientists) pertaining to the development of ideas and tech-nical solutions originating from the industry. Furthermore, effort is being devoted toward creat-ing regional and international networks that ensure the knowledge about selective devices in specific fisheries is shared, and that there is a broad acceptance of the results obtained. In addi-tion, fisheries and gear-specific workshops will be organized with the participation of interna-tional experts who provide knowledge of selective gears from comparable fisheries.

With the reform of the EU Common Fisheries Policy and the introduction of a Landing Obligation the ability of fishers to adjust the selectivity of their gears to suit the quotas which are available to them will be an important factor in determining the revenue and rentability in the fishery. As the combination of gear, fishing practice and quota shares will differ between vessels, changes to the selectivity of the gears will need to be implemented at the vessel level and based on the quotas which are available to the vessel at a given time. For this to be realised, simple and cost effective solutions which can be quickly coupled with existing gears will be in demand. These solutions will need to be implemented quickly in order for them to solve the issues at hand without losing substantial income. Furthermore, these solutions will need to be scientifically tested to document their effect before being considered for implementation into the legislation.

7.5.3.10 Project: MatRedEx

Project Full Title: Innovative MATerials to REDuce fuel emission and increase cod EXits

(MatRedEx)

Project Timeframe: June 2020 – July 2023

Institution(s): DTU Aqua (coordinator), Euronete Scandinavia A/S, Strandby Net A/S, DFPO. The project is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact person: Junita D. Karlsen, jka@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The focus of the project is to accommodate two main challenges currently faced by the mixed trawl fishery targeting Norway lobster, which is to comply with increased management require-ments to reduce 1) catches of cod in all Danish waters and 2) CO2-emissions. One of the main aims is to reduce fuel consumption considerably by developing a trawl gear design that drasti-cally reduce towing resistance while taking existing knowledge on Norway lobster behaviour in trawls into consideration. Another main aim is to increase selectivity of larger cod through the open front part of the trawl, and in addition for all sizes of cod in the codend by developing low-flow zones, using innovative and new netting materials, and influencing fish behaviour. Data will be collected both during sea trials and laboratory experiments.

7.5.3.11 Project: COPE2

Project Full Title: Caught and released: An overview of fishes´sensitivity to being discarded as a tool to aid Pursuing Ecosystem-based management 2 (COPE2)

Project Timeframe: June 2020 – June 2023

Institution(s): DTU Aqua (coordinator), DFPO. The project is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact persons: Esther Savina, esav@aqua.dtu.dk ; Junita Karlsen, jka@aqua.dtu.dk

Link(s): https://orbit.dtu.dk/en/projects/caught-and-released-an-overview-of-fishes-sensitivity-to-being-di-2

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project aims at estimating discard survival for undersized plaice in the Baltic Sea (ICES areas 24 and 25) for the otter bottom trawl fleet, following ICES guidelines so that the discard estimate may be used to document a high survival exemption. We will sample undersized plaice in commercial conditions and observe their mortality in captivity (up to 21 days until the mortality levels off). Experimental conditions will include the two legal codends (mesh size of at least 120 mm constructed from T90, or at least 105 mm fitted with a BACOMA exit window of 120 mm), as well as key environmental conditions known to affect discard survival. Characteristic of the Bal-tic Sea is fluctuations in oxygen levels and size of hypoxic areas. An overlap index will be devel-oped between the fisheries (VMS data) and oxygen conditions at the seabed (oxygen data from previous research cruises and collected at the time of capture by the commercial fishers). Fur-thermore, pre-capture oxygen and feeding environment of trawl-caught plaice, and effects of hypoxia on recovery after capture will be studied from stomach samples and simulated trawl impact in the laboratory, respectively.

Work in this project is closely related to the OECD project, see below.

7.5.3.12 Project: OECD Co-operative fellowship

Project Full Title: Predicting and improving catch welfare in wild-capture fisheries

Project Timeframe: 04 2022 – 06 2022

Institution(s): Vrije Universiteit Brussel, DTU Aqua, ILVO

Contact person: Sven Sebastian Uhlmann, sven.uhlmann@gmx.net

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The high survival exemption rule of the European Landing Obligation policy generated a demand for assessments of discard survival and welfare of unwanted fish. The goal of this project is to facilitate the prediction of survival potential in the absence of available resources to empirically study it and to facilitate a reduction of gear impacts on captured fish by evaluating the utility of a dummy, sensor-equipped fish to measure prevailing forces inside a codend. The objectives of this project were to i) improve predictions of discard survival using vitality indicators, and ii) evaluate the utility of sensor-equipped silicone fish to measure prevailing forces (acceleration, flow velocity, rotation, pressure, shear) inside a conventional codend (at scale). As part of this fellowship, two harmonized datasets of bottom-trawled-and-discarded plaice observations from Denmark and Belgium were combined and analysed to optimise predictions of discard survival. A method paper is currently being written about it and is close to submission. To measure the forces inside a codend at scale (inside the flume tank in Hirtshals) an experiment was done to manipulate amplitude and frequency of a pulsating codend. A sensor fish was used to measure the forces inside the codend during a flume tank trial in Hirtshals.

7.5.3.13 Project: Biodegradable gillnet (BIOGARN)

Project Full Title: Biodegradable gillnet

Project Timeframe: June 2019 – 2023

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact person: Esther Savina, esav@aqua.dtu.dk

Link(s): https://orbit.dtu.dk/en/projects/biodegradable-gillnet-biogarn-39690

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: The project aims at testing whether biodegradable netting could be used in some of the Danish gillnet fisheries prone to gear loss and potentially ghost fishing and marine litter. The project will focus on (1) comparing catch efficiency between biodegradable and conventional netting, (2) quantifying the effect of use and wear and biodegradation on the physical properties of the net-ting, and (3) better understanding what causes potential differences in catch efficiency. Two commercial case studies will be used, to test for a wide range of technical and operational condi-tions: the wreck fishery for cod and the plaice fishery in Skagerrak.

7.5.3.14 Project: Nordic Council Bio Nets

Project Full Title: Nordic research and innovation for biodegradable netting in fisheries and aquaculture

Project Timeframe: 2023

Institution(s): The project is coordinated by DTU Aqua with participation of SINTEF Ocean in Norway, the Marine and Freshwater Research Institute (MFRI) in Iceland, and FAO. The project is funded by the Nordic Council of Ministers.

Contact person: Esther Savina, esav@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: Biodegradable netting has the potential to fundamentally change the green profile of the fishing and aquaculture industries by reducing ghost fishing and marine litter. Creating a strong set of competences for the development of new netting materials will strengthen the internationally leading role in research and innovation of the Nordic countries. The project will contribute to share feedbacks about ongoing research projects on the use of biodegradable netting and coordi-nate the research efforts put into this relative new area across research institutes in the Nordic countries. The project will primarily involve Denmark, Norway and Iceland, but support from the FAO will guarantee further relevance to other countries of the Nordic region and internation-ally.

7.5.3.15 Project: Sustainable lobster fishery in the Limfjorden (HUM-MER)

Project Full Title: Sustainable lobster fishery in the Limfjorden

Project Timeframe: November 2019 – May 2022

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.

Contact person: Jordan Feekings, jpfe@aqua.dtu.dk

Link(s): https://orbit.dtu.dk/en/projects/sustainable-lobster-fishery-in-limfjorden-hummer-39692

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project aims to develop an economically and biologically sustainable European lobster fish-ery in the Limfjorden. The European lobster is a high value product with the Limfjorden account-ing for ca. 71% of all Danish landings since 2010. However, both the status of European lobster populations and fishing pressure in the Limfjorden are currently not kown. Thus, the European lobster population of the Limfjorden is not either properly exploited or managed for optimum long-term sustainable commercial and recreational fishing. The aim of the project is to create a knowledge base on fishing pressure, lobster stock structure and distribution, an evaluation of fishing gear efficiency and impact, together with the assessment of current and potential man-agement plans which will contribute to the implementation of sustainable management practices.

7.5.3.16 Project: Reducing bycatch in the Crangon fishery

Project Full Title: Bycatch reduction in the North Sea brown shrimp beam trawl fishery

Project Timeframe: June 2019 – July 2023

Institution(s): DTU Aqua

Contact person: Tiago Veiga Malta, timat@aqua.dtu.dk

Link(s): https://orbit.dtu.dk/en/projects/bycatch-reduction-in-the-north-sea-brown-shrimp-beam-trawl-fisher

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project aims at: 1. Developing and establishing a well-functioning and well-documented bycatch monitoring program in the fishery that can properly estimate the total annual bycatch of quoted fish species. 2. Identifying what bycatch species are problematic regarding the de mini-mis exemption. 3. Developing bycatch reduction devices (BRDs) that effectively reduce the by-catch of juveniles of fish species in the North Sea brown shrimp fishery, with focus on the species identified as most problematic.

Overall, the project aims at providing scientific and technological knowledge that will ensure the fishery does not exceed the de minimis exemption obtained under the Landing Obligation and the (Marine Stewardship Council) MSC certification.

7.5.3.17 Project: UnCod

Project Full Title: UnCod: an easier and faster evaluation of gear designs to avoid cod catches in mixed species fisheries.

Project Timeframe: June 2020 – October 2023

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact person: Valentina Melli, vmel@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project UnCod aims at developing an easier and faster framework to compare gear designs that can be used to reduce unwanted catches, and in particular cod, in mixed species trawl fish-eries. By combining gear selectivity data, stock assessment data and newly developed statistical approaches, the predictive framework will identify the most effective gear designs, balancing ecological objectives (such as the required reduction in cod catches) and economical objectives (such as the retention of other valuable species). The predictive framework will allow scientists, fishermen and fisheries managers to rank the performance of different gear designs, in terms of cod catches and in terms of multispecies catch profile. Moreover, the project UnCod aims at transforming how the selectivity of fishing gears is described and presented to the stakeholders by applying data visualization approaches (i.e. visual summary of complex information). These approaches will enable users to explore the results of the predictive framework according to their specific needs, for example exploring the performance of different gear designs in relation to specific catch goals.

7.5.3.18 Project: Using hydroacoustic to observe and quantify fish behaviour in relation to active fishing gears

Project Full Title: Using hydroacoustic to observe and quantify fish behaviour in relation to active fishing gears

Project Timeframe: May 2022 – June 2025

Institution(s): The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and National Fisheries Agency.

Contact person: Laura Diernæs, ldie@aqua.dtu.dk

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Animal behaviour is decisive for the efficiency and selectivity of commercial fishing gears and so has consequences for the ecological impact of fishing gears. Behaviour of marine organisms is typically studied using various types of underwater cameras attached to the fishing gear. This technology has, however, given limitations in the operational conditions (e.g., at depth, at night, in turbid waters) during which observations can be obtained and thus in the understanding of the behavioural mechanisms involved when animals' respond to fishing gears. This project will take advantage of recent developments in high frequency acoustics to (i) develop methods for optimal observation of single targets and (ii) detailed observation of animal behaviour during the capture process with active fishing gear.

7.5.3.19 Project: Reducing the effect of seals on the fishery

Project Full Title: Reducing the effect of seals on the fishery

Project Timeframe: June 2019 – December 2022

Institution(s): DTU Aqua, Aarhus University

Contact person: Finn Larsen, fl@aqua.dtu.dk

Link(s): -

Summary: The aim of the project was to provide a more detailed assessment of the impacts of seals on the Danish coastal static gear fishery, to develop and test different solutions for reducing these im-pacts, and to contribute to a more precise estimate of the bycatch of marine mammals in Danish gillnet fisheries. This happen through a number of work packages including: 1) Testing an au-tonomous prototype seal scarer to reduce grey seal depredation on longline fisheries; 2) Testing stop grids in pound nets to keep seals from raiding the nets; 3) Estimate hidden loss rates inflict-ed by grey seals on cod in gillnets; 4) Estimate total grey seal consumption of cod in the Baltic; and 5) Estimate the drop-out rate for marine mammals bycaught in gillnets, i.e. the fraction of animals that are bycaught but drop out of the nets before coming to the surface and being availa-ble for observation.

The research has been conducted and a final report will be available within the first half year of 2023.

7.5.3.20 Project: IMBAF

Project Full Title: Interactions between protected species and fisheries

Project Timeframe: June 2020 – June 2023

Institution(s): DTU Aqua, Association for low-impact coastal fishing (Foreningen for Skånsomt Kystfiskeri)

Contact person: Finn Larsen, fl@aqua.dtu.dk

Link(s): -

Summary: Overall aim of the project is to reduce conflicts between protected species and coastal fishing, more specifically to reduce bycatch of marine mammals and seabirds in net fishing, and to re-duce the impact of seals on fishing through the development and optimization of seal-safe fish-ing gear. The project consists of six work packages:

1. LED light: will be tested in gillnets aiming to prevent bycatch of seabirds
2. Looming eyes: will be tested to scare birds away from fishing gear and eventually to prevent bycatch of seabirds
3. Thin twine gillnets: will be assessed with regard to bycatch prevention of harbour porpoise
4. Bait: trials will be carried to determine the best baits for cod pots depending on re-gion and season
5. Fishers´ ideas: for seal-safe gears will be identified and evaluated
6. Reflective gillnets will be assessed in relation to prevention of harbor porpoise by-catch and catch efficiency of target species

The trials are still ongoing.

7.5.4 Future projects and Ideas

Fishing-friendly offshore wind farms (or wind-farm friendly fishing gears): ongoing review paper for ICES special issue – contact esav@aqua.dtu.dk

7.6 France

7.6.1 Contact person

- Robin Faillettaz, Ifremer, robin.faillettaz@ifremer.fr

7.6.2 Summary

Several projects related to fishing technology and fishing behavior have been or are currently conducted in France, mostly within Ifremer at the Laboratoire de Technologie et Biologie Halieutique (Laboratory of Fishing Technology and Biology), in collaboration with professionals.

7.6.3 Projects

7.6.3.1 Project: INDIGO - Fish and Click

Project Full Title: INovative fIshing Gear for Ocean

Project Timeframe: Sept 2019 – June 2023

Institution(s): Ifremer – Fishing Gear Technology and Biology lab - Lorient

Contact person: Marie Morfin (marie.morfin@ifremer.fr); Dorothée Kopp (dorothee.kopp@ifremer.fr); Sonia Méhault (sonia.mehault@ifremer.fr)

Link(s): https://fishandclick.ifremer.fr/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: Plastic pollution caused by fishing gears lost at sea is a major environmental problem since they remain for several hundred years in seawater, trapping and killing marine life. Fishing gears are targeted by the recent European Directive on the reduction of the impact of some plastic products on the environment. In that context, a website and a mobile application have been developed under the participatory project "Fish and Click" to report all fishing gears losses both at sea or on the coast. It is led under the INDIGO France (Channel) England Interreg program. Citizen science tools are dedicated to a wide public including divers, fishermen, boaters, onboard observers, naturalist associations, walkers, etc. Several data such as date, location and gear type are re-quested, as well as a picture of the gear (Figure 7.18).

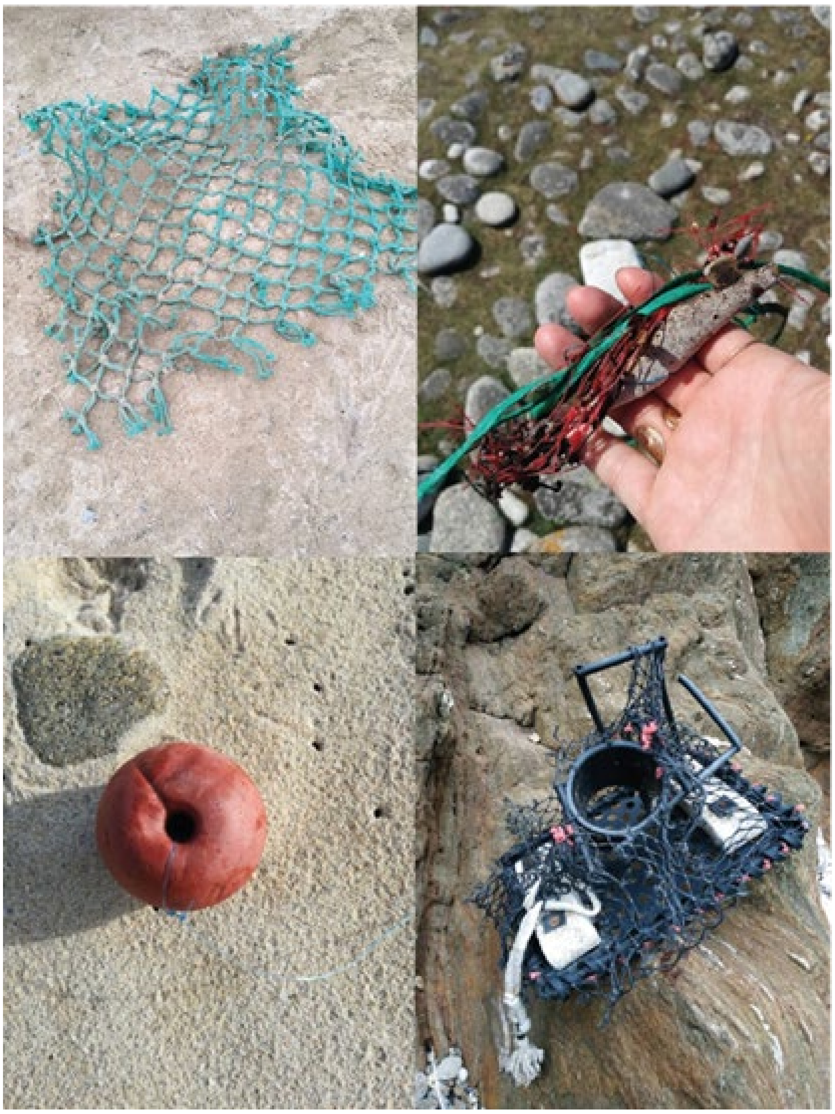


Figure 7.18: Examples of fishing gear reported by citizens

The database collected allow to inventory and map lost fishing gear by category. So far, around 550 participants reported more than 28,000 fishing gear or pieces of lost fishing gear in ICES subareas 7.d,e,h and 8.a and on its French coastline. The main gear fragments found everywhere are small ropes, that come mainly from trawl net mending. Then, the other main kind of material found: large ropes, lines, nets, and traps, are more location- (at sea or onshore) and region-dependent.

Results from this project will help to guide research on biodegradable fishing gear and to propose solutions for the management of lost gear.

7.6.3.2 Project: Selectivity indicators (InseR)

Project Full Title: INdicateurs de SElectivité en Routine

Estimated Project Timeframe: December 2022 – December 2023

Institution(s): Aglia, Ifremer DECOD - Lorient

Contact person: Sonia Méhault (smehault@ifremer.fr), Marie Morfin (mmorfin@ifremer.fr)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The development of gear selective devices is increasingly proposed within participative bottom-up projects with professional fishers to improve the acceptability and transfer. In 2022, the APASE project has developed a numerical open-source application to register selectivity data measured at sea. The next step is proposed in the InseR project to develop an R package for calcu-lating a set of selectivity indicators synthetized in a document generated via Rmarkdown, and to evaluate the performance of the devices tested. This package will offer great flexibility in terms of preliminary data analysis and can easily be combined with more in-depth analyses. This tool contributes to improve the responsiveness of feedback to fishers the end of experimental trips on the performance of the devices tested and to standardize the results of selectivity analysis.

7.6.3.3 Project: Planning human activity over the Grande Vasière (PACMAN)

Project Full Title: oPtimisation des Activités anthropiques pour une exploitation durable des éCosystèmes Marins de la grANde vasière

Project Timeframe: November 2020 – October 2022

Institution(s): Ifremer, MNHN, CNPMEM

Contact person: Marie Morfin (marie.morfin@ifremer.fr); Dorothée Kopp (dorothee.kopp@ifremer.fr)

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Spatial planning is becoming more and more essential because sharing space is now necessary between traditional and emerging activities. On one hand, with contemporary stakes of global warming and the necessity of energy self-sufficiency, renewable energy is expected to skyrocket in the coming decades. On the other hand, climate change, overexploitation and destruction of vulnerable habitats are putting tremendous pressure on the natural environment, leading to an urgent need for protection. While the restriction of activities even inside strict MPAs is still debat-ed and a subject of conflict, historical stakeholders must prepare for future restrictions, especially in coastal seas. These two rising stakes are gradually adding to the already complex maritime space management. Although many efforts are deployed to minimize the impacts of emerging activities on fishing and on biodiversity, the plurality of human, political, biological, and envi-ronmental stakes render the complexity of decision-making unprecedented.

We proposed an inclusive, equitable and flexible framework for prioritizing offshore windfarms and marine protected areas. The first step consisted in defining and mapping a set of indicators related to human activities, ecosystem services (ES) and biodiversity in consultation with main stakeholders. We then used these numerous spatial layers with a systematic conservation prioritization Decision Support Tool with multiple types of zones to both account for incompatibilities between activities and their varying impacts on the ecosystem. Finally, we developed a Shiny app to visualize, study and discuss results associated with multiple varying targets. This framework was applied to the extensive case study of the Grande Vasière, a major socioecosys-tem for spawning grounds and nurseries of several commercial species, biodiversity, ES, fisher-ies stakes, and marine renewable energy development (MRED) in the Bay of Biscay.

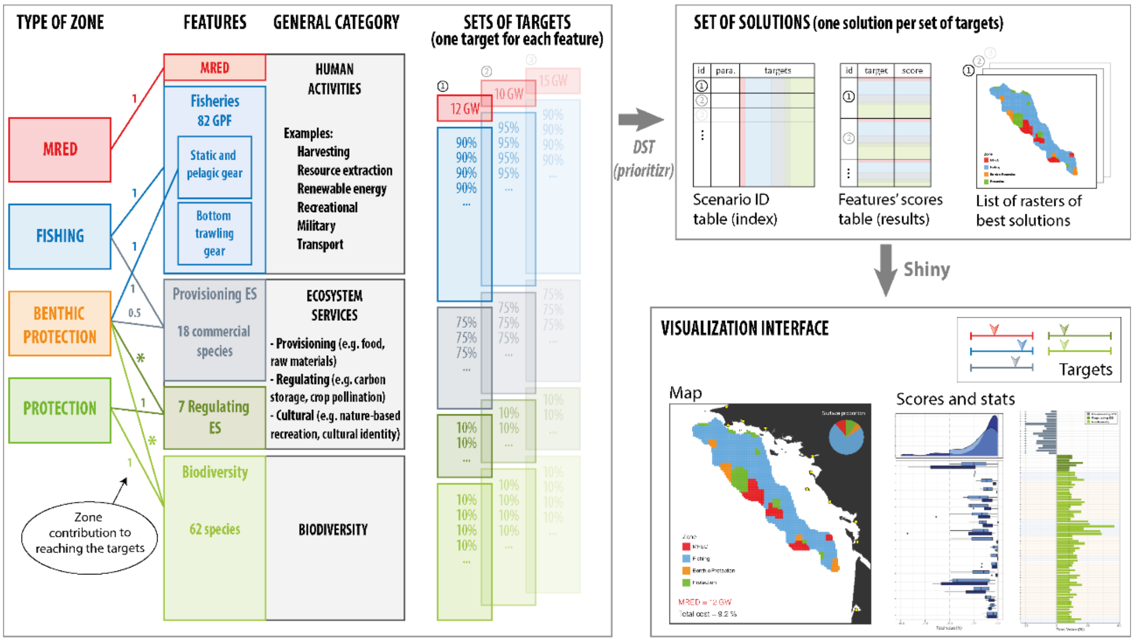


Figure 7.19: Overview of the prioritization framework. After defining the different types of zones and spatial layers constituting the features, sets of targets are chosen and used as input in prioritizr to obtain a set of solutions. This set of solutions, constituted of an index table, a results table and a list of rasters containing the best solution for each set of targets, is then used in a Shiny app to modify on-demand the sliders corresponding to targets and visualize the results (map and associated scores and statistics). Stars indicate that the zone contributions to reaching the targets are variable depending on the feature.

7.6.3.4 Project: Machine learning application to fish behavior (LEARN)

Project Full Title: Exploration of fine-scale ethology as a lever to improve fishing gear

Estimated Project Timeframe: October 2021 – October 2024

Institution(s): Ifremer DECOD - Lorient

Contact person: Robin Failletaz (robin.faillettaz@ifremer.fr); Dorothée Kopp (dorothee.kopp@ifremer.fr)

Collaboration welcome? Yes

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: As part of the PhD of Alexa Abangan, a review article will be published on the applications of artificial intelligence to fish behavior and how these may help improve fishing gear selectivity. Indeed, existing reviews discuss the potential of Artificial Intelligence (AI) methods in a broad sense in marine science. There are some reviews tackling how to apply these novel methods in the context of aquaculture and stock assessment for food production and animal welfare. In commercial fishery, there are reviews synthesizing fish behavior during capture process with numerical modeling but not as metrics integrated with AI models. There is still, however, no review presenting how AI methods may now help in improving fishing gear selectivity through automatization of fish behavior analysis; our review aims at filling this gap. Current knowledge on fish behavior for fishing selectivity is reviewed prior to presenting state-of-the-art AI applica-tions and datasets available for fish behavior studies. Advances in these two separate fields are used as the basis to discuss how they can be integrated into the study of fish-fishing gear interac-tions, and how automated tools can unplug data processing bottlenecks and laborious analysis. The strength and weakness of automated methods are also discussed in the context of gear selec-tivity. We believe that the democratization of these new approaches may provide finer selectivity assessment at larger scale, and eventually aid to reach more sustainable, less impactful fishing techniques. https://www.frontiersin.org/articles/10.3389/fmars.2023.1010761/abstract

Laboratory experiments on seabass response to light stimuli will also start in February in Brest. Infrared, red, green, blue and white light will be tested.

7.6.3.5 Project: Game of Trawls (GoT)

Project Full Title: GAME OF TRAWLS S2 – Giving Artificial intEligence tO Fishing TRAWLS Season 2

Project Timeframe: 01/2022 – 06/2023

Institution(s): IFREMER

Contact person: Julien Simon (julien.simon@ifremer.fr); Robin Faillettaz (robin.failletaz@ifremer.fr)

Link(s): https://gameoftrawls.ifremer.fr/en/home/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The GAME OF TRAWLS S2 project is a direct continuation of the GAME OF TRAWLS project. The project now aims to 1) consolidate technological developments to reach a sufficient level of maturity of the technology to become transferable to fishing professionals (improvement of neu-ral networks, learning of new species, better ergonomics and miniaturization of the complete system, etc.) and 2) extend ethological knowledge, in particular to evaluate the potential of stimu-li to trigger systematic responses in species in order to actively guide them in selective devices and to determine the extent to which the use of artificial light would modify swimming behavior and catch rates in commercial fishing conditions.

One of the most innovative aspects of the project is the ability of the system to detect in real time the species entering the trawl, send information to the skipper through an acoustic link and to automatically control the trawl. This is particularly suitable for reducing catches of non-target species. The imaging, signal processing and control systems for real-time active selective devices developed in the GAME OF TRAWLS project can be adapted to any species. Their transferability potential to new areas and species of interest has already been demonstrated for the assessment of the sea cucumber stock in the territorial waters of St. Pierre and Miquelon in April 2021 and 2022.

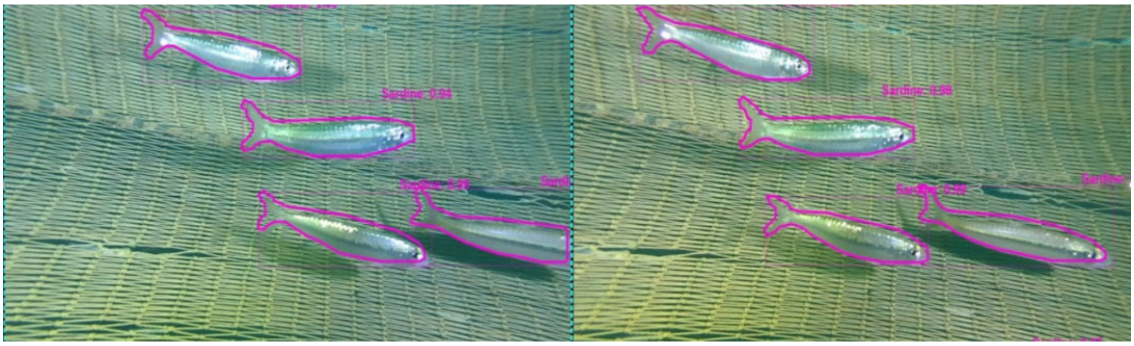


Figure 7.20: Stereo detections of sardines using maskRCNN neural network.

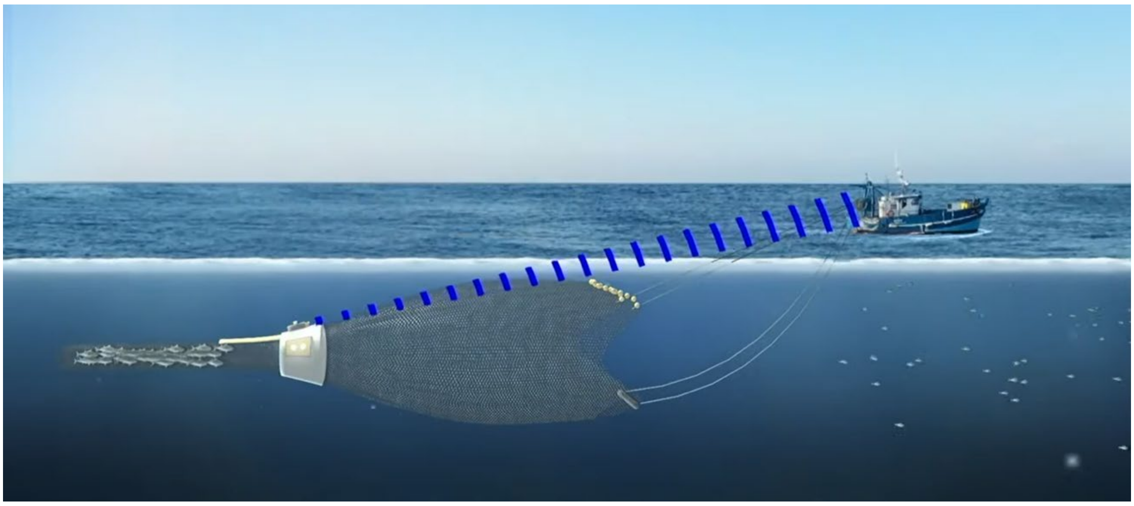


Figure 7.21: Overview of the intelligent trawl equipped with the video system, underwater AI, active selection device and acoustic communication.

7.6.3.6 Project: ESCAPE

Project Full Title: undErStanding and modelling esCapement behAviour of fish sPeciEs in fishing gearS

Project Timeframe: OCTOBER 2022– OCTOBER 2027

Institution(s):

Academic : Ifremer, Museum National d'Histoire Naturelle, Université Libre de Bruxelles

Stakeholders : PO Les Pecheurs de Bretagne, Aglia association

Contact person: Robert Marianne, marianne.robert@ifremer.fr

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Knowledge on animal behaviour is a key element to understand the capture processes by fishing gears. This knowledge would benefit the design of fishing gears and selective devices in both active and passive gears to avoid unwanted catches. Combining fishing gear technology, artifi-cial intelligence, behavioural concepts and traits-based ecology, the ESCAPE project aims to quantify, understand and model the different stages of capture and escapement processes of fish in fishing gears. The first objective is to identify underlying behavioural rules and their mor-pho-logical and functional determinisms at both individual and species levels. Then, behavioural rules will be mathematically formalised and tested in a coupled animal/gear modelling frame-work. The results will help in predicting both intra and inter selectivity properties of fishing gears, a stepping-stone towards the development of innovative and highly selective fishing gears for a more sustainable exploitation of marine resources.

7.6.3.7 Project: Toward environmentally friendly fishing gear through material science

Project Full Title: PhD Thesis on More environmentally friendly fishing gear through material science

Project Timeframe: End of 2021 to end of 2024

Institution(s): Ifremer

Contact person: B. Vincent, benoit.vincent@ifremer.fr , P. Davies, Peter.Davies@ifremer.fr

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: There is increasing pressure to develop more environmentally friendly fishing gear, both to im-prove catch conditions (better catch efficiency and selectivity, reduced fuel consump-tion…) and with respect to end-of-life or when nets are lost or damaged (risk of phantom fishing, long term degradation of net polymers, plastic pollution). In order to improve this situation two aspects must be investigated. The first step is to obtain a better understanding of the loads to which net elements are subjected during the phases of deployment, fishing, and retrieval. Both test data and modelling are needed, as without this information it will be impossible to optimize netting pa-rameters. The second aspect concerns the polymer fibres which form the net. These are currently petrochemical-based but alternative fibres, both biosourced and natural, may offer better envi-ronmental potential provided their short and long term properties can be shown to satisfy the design loads. Tests are therefore needed in order to evaluate these new polymer fibres and to establish their performance in seawater. This study will investigate both loading condi-tions and material improvements.

7.6.3.8 Project: CONTRAST

Project Full Title: Characterization of bottom trawls designs and practices

Project Timeframe: 2021 to end of 2022 (24 months)

Institution(s): Ifremer, AGLIA (project leader), professional structures.

Contact person: B. Vincent, benoit.vincent@ifremer.fr

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Article L.414-4 of the French Environmental Code requires that professional maritime fishing activities be subject to an analysis of the risk of harming the conservation objectives of

Natura 2000 sites. This risk analysis, carried out in partnership with professional structures, is based on the method proposed by the Ministry of Ecological Transition and Solidarity in 2019.

In a classic principle, the risk analysis methodology proceeds by crossing the sensitivity of habitats with the pressure generated by fishing gear. These two major objects are characterised in terms of their different dimensions, based on existing knowledge. The methodology is carried out in two stages, one defining a risk of degradation, then a second considering the local characteris-tics of the ecological issues and the fishing activities taking place on the site, which allows us to conclude that there is a risk of damaging the conservation objectives of the site and thus meet the obligations of Article L.414-4 of the Environmental Code.

With regard to the characterisation of fishing gear, the technical characteristics of the rigs make it possible to distinguish between two types of bottom trawl: heavy and light rigs. Although neces-sary to implement the analyses, this distinction is difficult to make for fishing activities within Natura 2000 sites, and more detailed knowledge of the fishing gear and its rigging is needed to support this classification and adapt it if necessary. Another element that seems to be lacking also emerges from the field, namely the characterisation of the influence of practices (in the sense of the way in which fishing gear is used, which is different from its technical characteristics) on the risk of habitat degradation.

The second level of analysis of the method considers local specificities to conclude on the risk of damaging the conservation objectives of the site. Thus, the characterisation of the effect of practices also seems useful for the implementation of risk analyses.

This observation forms the basis of the two lines of investigation that this project proposes to pursue: characterisation of rigging and bottom trawling practices. The final objective is to propose courses of action in these two areas to limit the risk of harm to the conservation objectives of the habitats.

7.6.3.9 Project: PECHDAUPHIR

Project Full Title: Interactions between common dolphin and fishing activity in the Marine Natural Park Iroise and the Bay of Audierne

Project Timeframe: 2021 to end of 2023 (36 months)

Institution(s): Ifremer, professional structures: CDPM29, project leader

Contact person: B. Vincent, benoit.vincent@ifremer.fr

Link(s):

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: For several years now, sea users and professional fishermen have been observing a more abun-dant presence of common dolphins (*Delphinus delphis*) within the perimeter of the Marine Natural Park and in Audierne Bay. Moreover, for the last 3 years, strandings of common dolphins on the beaches of Finistère have increased significantly and the majority of these stranded animals bear traces of accidental capture. In South Finistère, Audierne Bay and Douarnenez Bay, the gill-netters and the seine nets users are the professions that observe the most interaction between common dolphins and their fishing gear. The objective of this project work-package is therefore to better understand the behaviour of the net during the different phases of the fishing operation. To this end, sensors (pressure, temperature) will be integrated into several gears for which accidental captures have been recorded (sole trammel nets, hake nets, monkfish trammel nets, etc.). The data collected will be used to feed a model that will be developed by

Ifremer's Technologies and Fisheries Biology Laboratory in Lorient. Modelling the movements of the net underwater could provide new information on the conditions or types of gear likely to cause accidental catches.

7.6.3.10 Project: DELMOGES

Project Full Title: DELphinus MOuvements GEStion

Project Timeframe: 2022 to 2025 (36 months)

Institution(s): Ifremer, Pelagis, OFB, professional structures: CNPMEM

Contact person: R. Faillettaz, robin.faillettaz@ifremer.fr

Link(s): https://delmoges.recherche.univ-lr.fr/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Since the 1990s, France has regularly experienced episodes of significant dolphin mortalities in winter, leading to peaks in strandings on the Atlantic coast. Since 2016, strandings of small cetaceans in the Bay of Biscay showing signs of capture, have reached unprecedented levels. If the current scientific data allow us to assess the overall risk induced by these accidental captures for the conservation of the common dolphin population, they are however too incomplete to under-stand the ecosystemic and fisheries determinants at the origin of these captures. The DELMOGES project aims to fill these gaps by collecting new data on dolphin habitats, on their trophic interac-tions in the ecosystem and on their interactions with fisheries. In particular, fine-scale interactions are not known although observations of depredations are very frequent around the world. This is due to the difficulty to follow the movements of dolphins underwater with sufficient accuracy, as they are usually only observed at the surface.

This scientific campaign aims to observe for the first time the behavior of dolphins between the surface and the bottom, and in interaction with vessels and fishing gear, by deploying a new technology for tracking dolphins, based on a silent and large-scale drone carrying a network of hydrophones synchronized to the nanosecond in order to triangulate the position of dolphin clicks received. By coupling this monitoring with the activity of professional fishermen, the campaign will allow to classify different interactions and behaviors of dolphins around fishing gears, focusing on gillnetters.

7.7 Germany

7.7.1 Contact person

Daniel Stepputtis, Thünen Institute of Baltic Sea Fisheries, daniel.stepputtis@thuenen.de

7.7.2 Summary

In Germany, research related to fishing gears was mainly conducted by the Thünen Institute of Baltic Sea Fisheries (see report from university of Rostock below). The focus of the research in 2022 was

- Understanding and improving of trawl selectivity, incl.
  - investigations on the effect of mesh geometry variability on codend se-lectivity
  - Species-selection devices in beam trawl shrimp fishery
- By-catch reduction of marine mammals and birds in gill nets, incl.
  - modification of gillnets
  - improvement and test of alternative fishing gears pots and traps

7.7.3 Projects

7.7.3.1 Fundamental investigations on the effect of mesh geometry variability on codend selectivity

Project Full Title: NA

Project Timeframe: 2021-2023

Institution(s): Thünen Institute of Baltic Sea Fisheries, DTU-Aqua (Hirtshals, Denmark)

Contact person: Juan Santos juan.santos@thuenen.de

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Despite the huge efforts devoted in the last decades on trawl selectivity research, there are still open questions regarding how fish is selected by size. To better understand such selec-tion process, a collaborative project between researchers from the Thünen Institute and DTU-Aqua i aims at identifying factors affecting the degree of definition of the selectivity curve deliv-ered by the codend. Research conducted during the first year of the project (2021) aimed at quan-tifying the effect of variations in the mesh geometry on codend size selection, and more specifi-cally how much the variation in the geometry of the meshes impacts on the steepness of the se-lection curves from traditional diamond-mesh codends (parametrized as Selection Range). To this end, a novel experiment was conducted on a research cruise in the south-central Baltic Sea in September 2021, comparing the selectivity of a traditional diamond-meshed codend with the selectivity of an experimental codend with the mesh geometry set at ~30°. Results obtained from such experiment revealed that the variation in mesh geometry associated to standard dia-mond-mesh codends negatively impacts on the sharpness of the selectivity curve for cod (*Gadus morhua*), leading to 45% significant wider selection range (SR) than the SR estimated for a codend with the same netting but with fixed-mesh geometry (Bak-Jensen et al. 2022). The research on the topic resumed in 2022 with a more ambitious experimental program, where the variability in size selection delivered by traditional diamond-mesh and square-mesh codends were com-pared to the size selection obtained by experimental codends with mesh opening angle fixed at 30° (data from 2021), 60° and 90° (square-mesh shape). In comparing the selectivity properties of these four codends, the main interest of the research was to identify which codend, diamond or square mesh, provided the least variability in size selection with a fixed or flexible mesh opening. Preliminary results show that the strategy of turning the mesh geometry in traditional codends into a square-mesh shape is not as effective as it is often assumed, revealing at the same time the potential of codends with fixed-mesh opening towards achieving a better defined size selection in trawl gears.

Figure 7.22: Experimental codend with fixed meshes inside the cover codend.

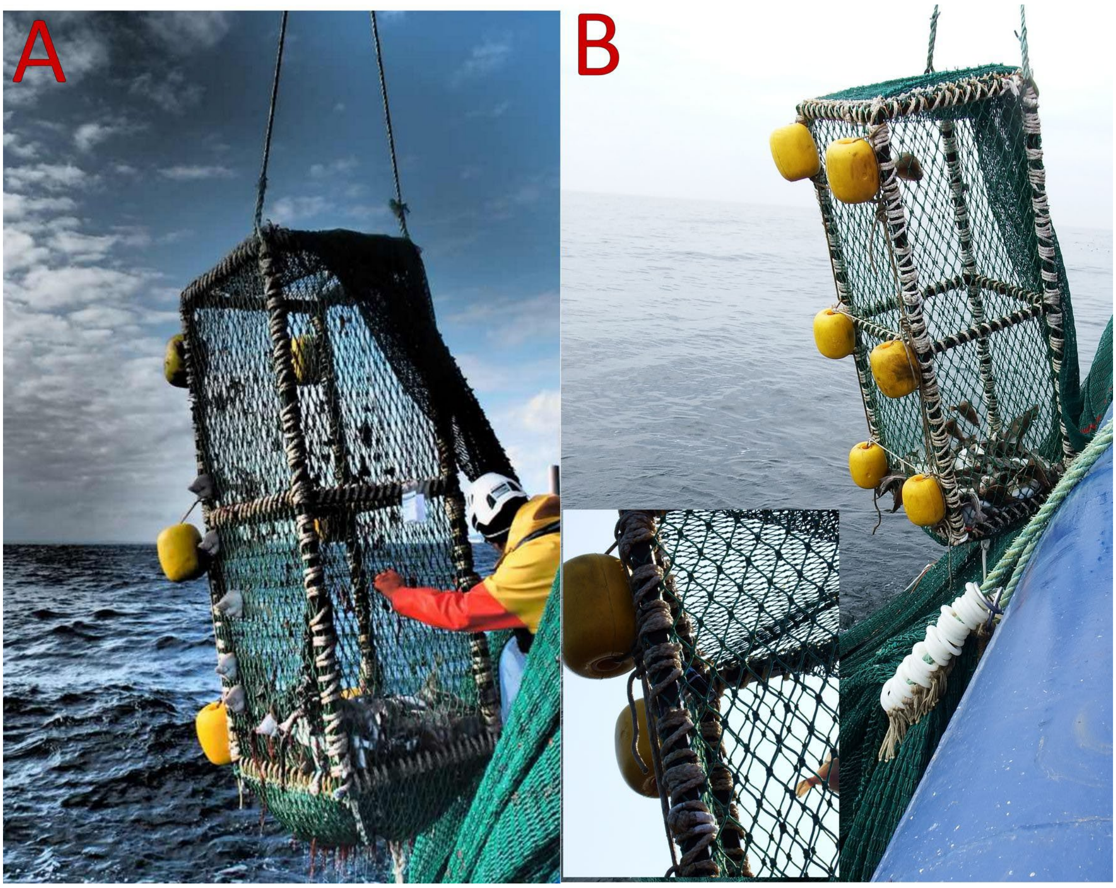


Figure 7.23: Onboard handling of the 2021 fixed-mesh codend (opening angle ~30°) and one of the codends tested in 2022 (open-ing angle ~30°)

7.7.3.2 By-catch reduction technologies in the North-Sea brown shrimp fishery

Project Full Title: "Making better use of ideas from the crab fishery", Schleswig-Holstein Inno-vation Programme

Project Timeframe: 2022-2023

Institution(s): Thünen Institute of Baltic Sea Fisheries, Shrimp Fisheries Advisory Board Schles-wig-Holstein

Contact person: Juan Santos juan.santos@thuenen.de

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The brown shrimp (Crangon crangon) beam-trawl fishery is the most important coastal fishery in Germany, with a fleet composed by ~180 vessels (20-24 m LOA segment) . One recur-rent issue in the fishery is the bycatch of unwanted fish species, as consequence of the small-mesh codends that are used to efficiently capture the targeted shrimp. This issue has been exten-sively addressed in the past, especially during the DISCRAN project (EU-Study 98/012). Those efforts led to the development of bycatch reduction devices (BRD) aiming at providing escape possibilities to fish species before entering the codend. As a result, fishers are obliged to mount either sieve-nets or sorting grids in their nets. However, while sieve nets and sorting grids can effectively reduce the bycatch of medium and large fish, none of them deliver an optimal species separation. Moreover, the performance of these devices can be largely affected by spatio-temporal variations of fishing grounds conditions, e.g. benthos material entering the trawl and clogging their selection surface, thus impairing their effectiveness. This phenomenon is of increasing con-cern in the German fishery, specially during the summer season, when the presence of high den-sities of suspended seaweed and other benthos material in estuarine fishing grounds are encoun-tered by the trawls. Under such conditions, commercially sustainable fishing operations are highly compromised. Therefore, it has been identified the need for investing further research efforts on developing effective Bycatch-reduction technologies to address today's fisheries chal-lenges. The Thünen Institute initiated in 2022 a project in collaboration with stakeholders to ad-dress the need for BRD alternatives in the German fishery. The first experimental fishing trials related to the project took place in German fishing grounds onboard the RV/ Solea (September 2022). The aim was to test the catch efficiency of the mandatory sieve-net and housed-elliptic sorting grid devices, and two device concepts as alternatives i) a simplified, rectangular grid design, and the letterbox device developed in the Dutch fishery. Results obtained from a paired-gear experiment conducted in German fishing grounds revealed that ~95% of the marketable shrimps (total length ≥ 50 mm) available for the trawl ended in the codend when the sieve net was used. Fishing with the traditional housed-elliptic sorting grid was impractical due to clog-ging problems, leading to a catch efficiency for the target shrimp of less than ~50%. In contrast, the simplified rectangular grid and the letterbox did not suffer clogging-related issues, delivering a catch efficiency for marketable shrimp of ~75%. Altogether, using the rectangular grid resulted in the best bycatch-reduction performance with a catch efficiency below 50% for the quoted spe-cies plaice and whiting. The project will continue during the 2023 with two additional research cruises onboard RV/Solea and a potential transfer of newly developed technologies for testing in the commercial fishery.

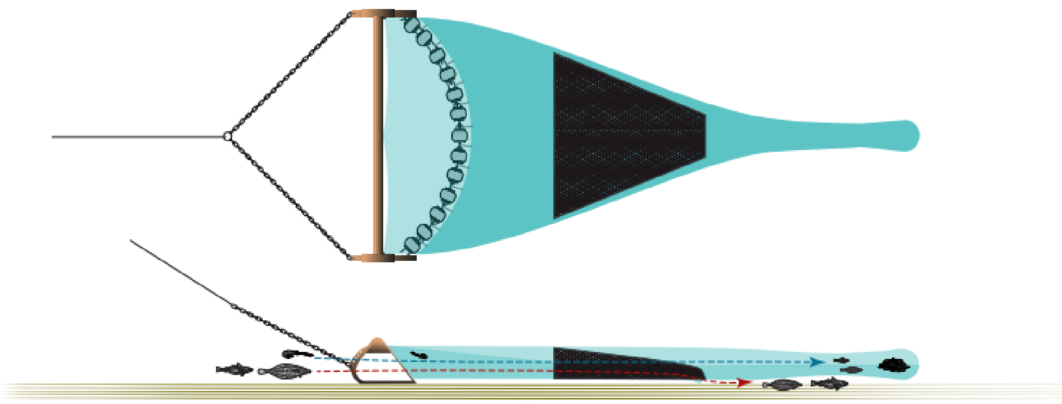


Figure 7.24: Top and lateral view of a beam trawl mounting the mandatory sieve-net

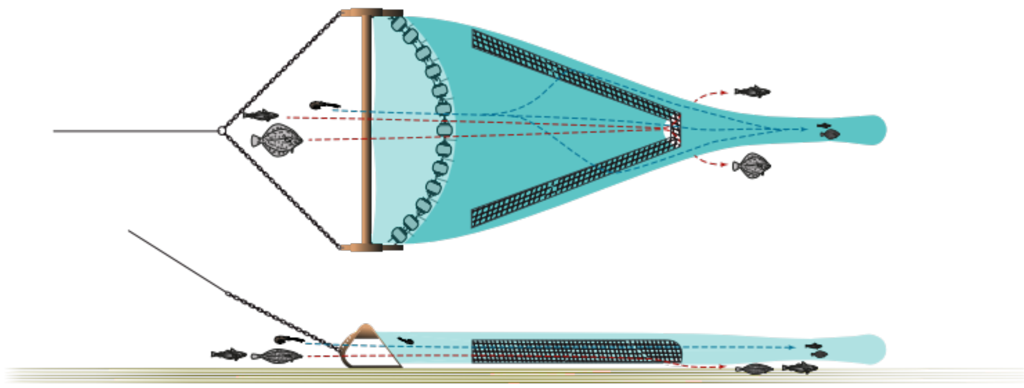


Figure 7.25: Top and lateral view of a beam trawl mounting the letterbox device

7.7.3.3 Project: Development of technical bycatch mitigation strategies for gillnet fisheries – STELLA2

Project Full Title: Development of technical mitigation approaches towards minimizing conflicts in gill net fisheries and conservation objectives and subjects of protection in the EEZ of the Baltic Sea

Project Timeframe: 01.11.2021 – 31.10.2024

Institution(s): Thünen Institute of Baltic Sea Fisheries, German Maritime Museum, NABU, DTU Aqua

Contact person: Daniel Stepputtis daniel.stepputtis@thuenen.de , Thomas Noack Thomas.noack@thuenen.de , Hannah Schartmann hannah.schartmann@thuenen.de , Sara Berzosa sara.berzosa@thuenen.de

Link: https://www.thuenen.de/en/institutes/baltic-sea-fisheries/projects/fisheries-and-survey-technology/stella2

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Within the previous project STELLA (https://www.thuenen.de/en/of/projects/fisheries-environment-baltic-sea/gill-net-fisheries-development-of-alternative-management-approaches-stella/) technical measures were developed to reduce bycatch of marine mammals (harbour por-poises) and diving seabirds. These technical measures include gillnet modifications as well as the development of alternative gears such as fish pots and pontoon traps. These devices are now to be tested on a larger scale under commercial settings.

a) Gillnet modifications

Gillnets equipped with acrylic glass spheres ("pearl nets") have a substantially higher echo than standard gillnets, making them more detectable for harbour porpoises. A first pilot trial in the Black Sea (STELLA) has shown promising results. To investigate if the pearls have an effect of the catches of target species, a catch comparison trial has been conducted in autumn 2022 using standard gillnets and pearlnets at the same time. First analyses of the data do not show significant differences between the catches of standard net, but in-depth analyses are still ongoing. The next step planned in the project is a large-scale mitigation trial, where several fishers will be equipped with gillnets with acrylic spheres to fish with them for a longer period. Lifting the magnitude of pearlnet tests this level aims at providing sufficient data for comparing bycatch rates between standard net and pearl net.

Remark: to carry out a large-scale trial it is necessary to a) build approximately 50 km of gillnets with acrylic glass spheres (still needs to be automated) and b) find areas with comparatively high bycatch numbers of harbour porpoises. **Any collaborations to develop the automation of "pearl net" production and suggestions about such areas are highly welcome.**

Figure 7.26: Gillnet with Acrylic-pearl (diameter: 8 mm)

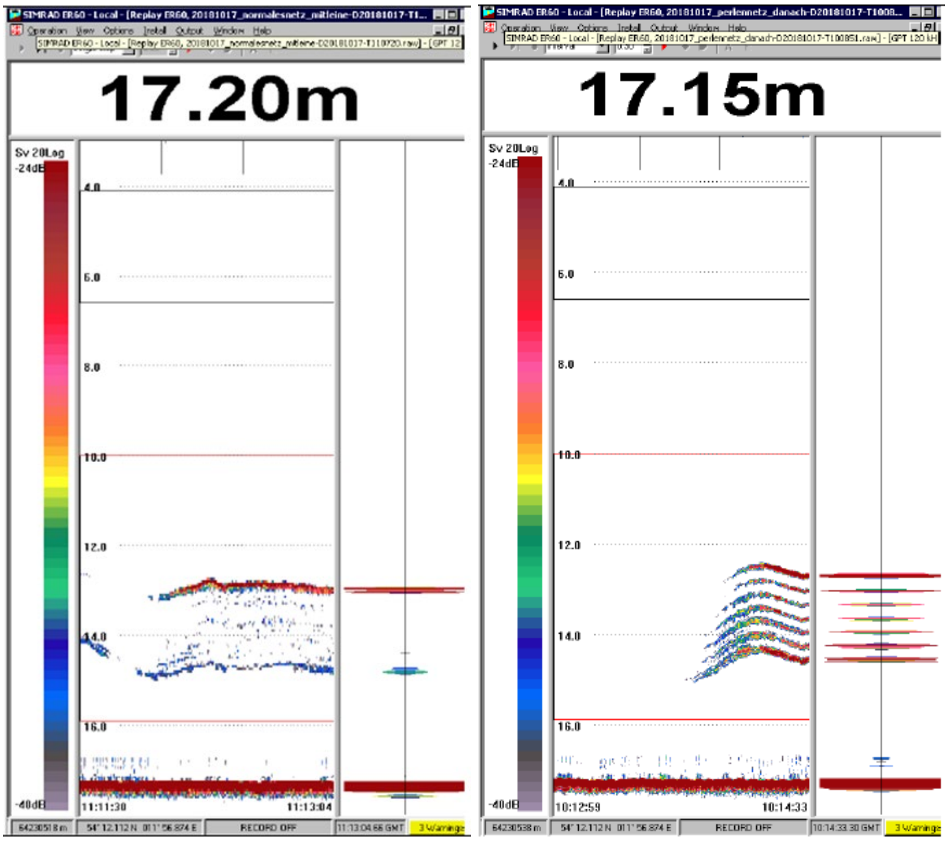


Figure 7.27: Echograms taken with the sonar (SIMRAD EK60, 120 kHz) of FRV "Clupea": Left: standard gill-net without pearls; Right: modified gillnet with pearls

b) Alternative Gears

Within STELLA an "ideal" entrance within a fish pot was developed for cod and other round-fish. Within STELLA2 the systematic studies to construct an "ideal" fish pot for other species such as flatfish will be continued. These trials started in autumn 2022 and will be conducted in spring 2023. Furthermore, STELLA showed that the attraction of fish to a pot highly influence its catchability. A bait experiment will determine ideal baits. Fish pots will be also used on a larger, commercial scale.

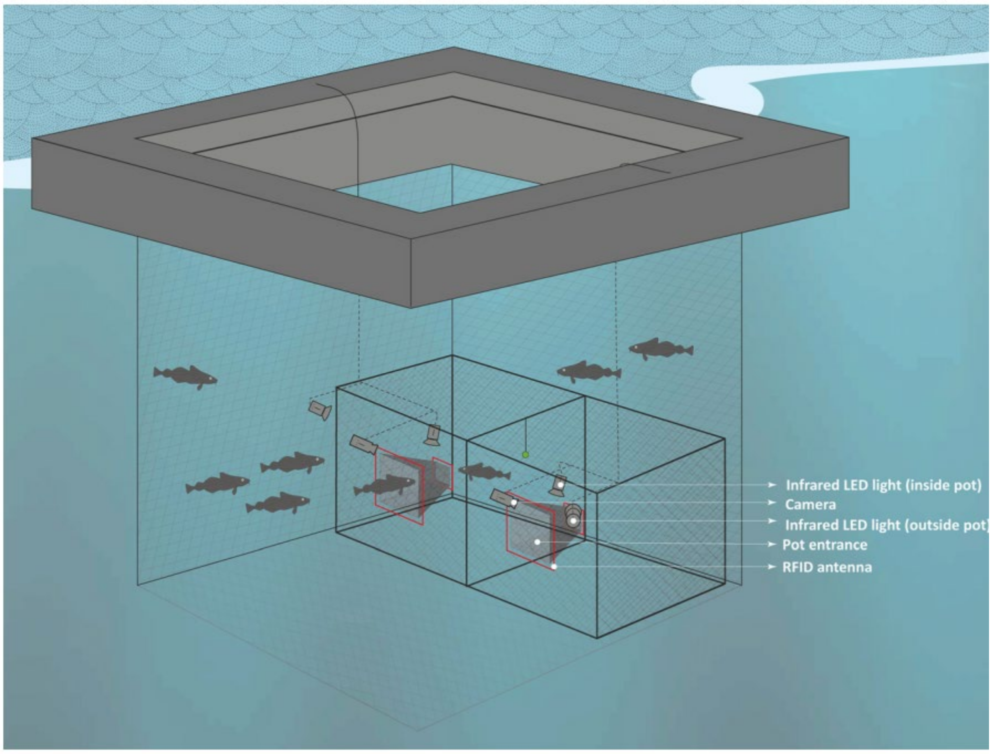


Figure 7.28: Schematic representation of the experimental setup to test different entrance designs. An experimental pot with two exchangeable entrances is lowered into a 3 × 3 × 3 m net pen. Cod inside the pot are free to swim from one entrance to the other. For observation, an IR-camera system (one camera and one IR light before the entrance, one IR light inside the pot above the inner opening of the funnel), and two RFID antennae are mounted at each entrance. Note: Owing to technical difficulties, RFID data could not be used in the data analysis.

Figure 7.29: Bait-experiments: experimental setup for automatic bait choice experiments. The inflow of bait water is realized by a number of pumps which are automatically computer-controlled. The behaviour of fish is automatically recorded using an IR-camera system

Figure 7.30: Bait-experiments: screenshot of video recording. The bait-water is dripping in from left and/or right.

The pontoon trap will also be developed further in STELLA2. This includes modifications to make it suitable for rougher environments as well as different target species (herring, garfish, cod, flatfish). A modular, easy to build-design is planned for 2023.

Figure 7.31: Pontoon trap in German waters (water depth at position of pontoon trap is approx. 3 m). Picture shows the original design. Several improvements were tested.

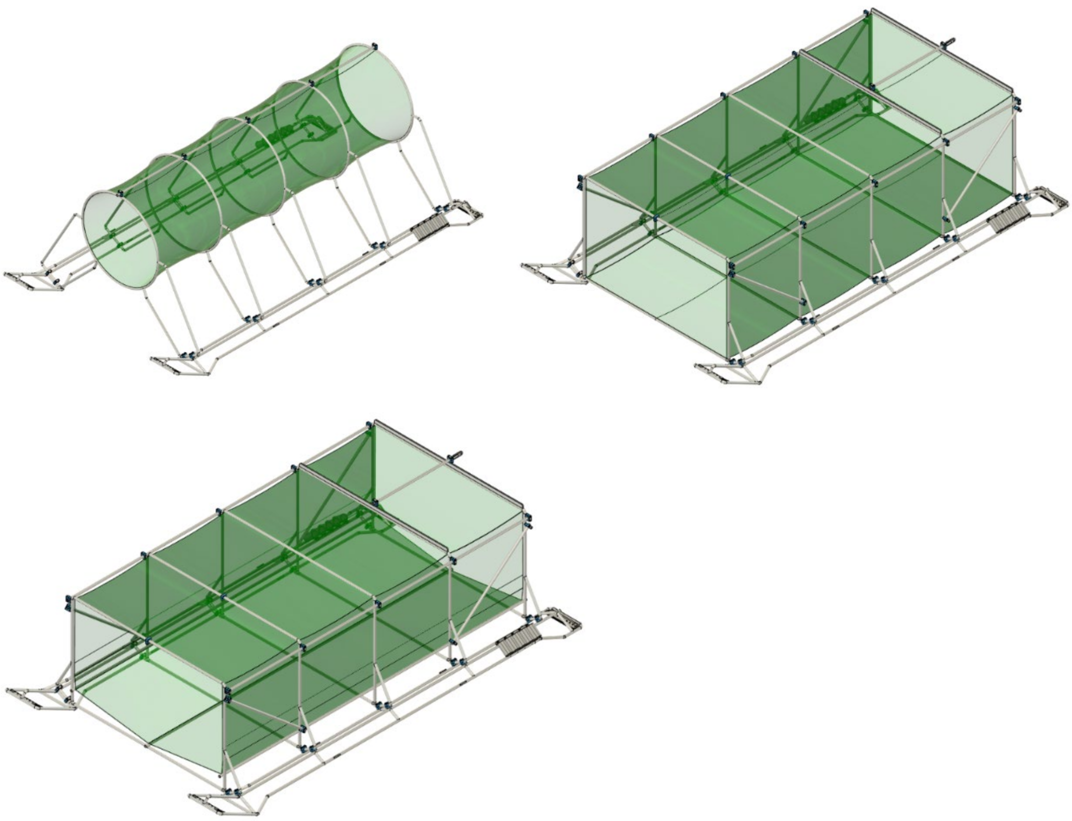


Figure 7.32: Different pontoon trap designs; top: original design tested in 2018; middle: re-designed for testing in 2019; bottom: pontoon trap design with modified floor section tested in 2020

References:

Isabella Maria Friederike Kratzer, Daniel Stepputtis, Juan Santos, Frauke Lütkefedder, Arne Stoltenberg, Lea Hartkens, Matthias Schaber, Lotte Kindt-Larsen, Finn Larsen (2022) Angle-dependent acoustic reflectivity of gillnets and their modifications to reduce bycatch of odontocetes using sonar imaging. Fisheries Research 250. 14 pp. https://doi.org/10.1016/j.fishres.2022.106278

Isabella Maria Friederike Kratzer, Mollie Elizabeth Brooks, Sabri Bilgin, Süleyman Özdemir, Lotte Kindt-Larsen, Finn Larsen, Daniel Stepputtis (2021) Using acoustically visible gillnets to reduce bycatch of a small cetacean: first pilot trials in a commercial fishery. Fisheries Research 243, 10688. https://doi.org/10.1016/j.fishres.2021.106088

Jérôme Chladek, Daniel Stepputtis, Andreas Hermann, Isablle M.F. Kratzer, Peter Ljungberg, Paco Rodriguez-Tress, Juan Santos, Jon Christian Svendsen (2021) Using an innovative net-pen-based observation method to assess and compare fish pot-entrance catch efficiency for Atlantic cod (Gadus morhua). Fisheries Research 236. 27 pp., https://doi.org/10.1016/j.fishres.2020.105851

Jérôme Chladek, Daniel Stepputtis, Andreas Hermann, Peter Ljungberg, Paco Rodriguez-Tress, Juan Santos, Jon Christian Svendsen (2020) Development and testing of fish-retention devices for pots: transparent triggers significantly increase catch efficiency for Atlantic cod (Gadus morhua). ICES Journal of Marine Science 78(1): 199-219, https://doi.org/10.1093/icesjms/fsaa214

Isabella M. F. Kratzer, Ingo Schäfer, Arne Stoltenberg, Jérôme C. Chladek, Lotte Kindt-Larsen, Finn Larsen, Daniel Stepputtis (2020) Determination of Optimal Acoustic Passive Reflectors to Reduce Bycatch of Odontocetes in Gillnets. Frontiers in Marine Science 7: Article 539, https://doi.org/10.3389/fmars.2020.00539

7.7.3.4 Project: Mini seine in the Baltic fishery

Project Full Title: MiniSeine - a small Danish seine for German coastal fisheries

Project Timeframe: 01.01.2022 – 31.12.2023

Institution(s): Thünen Institute of Baltic Sea Fisheries, DTU Aqua

Contact person: Thomas Noack Thomas.noack@thuenen.de , Daniel Stepputtis, daniel.stepputtis@thuenen.de

Link(s): https://www.thuenen.de/en/institutes/baltic-sea-fisheries/projects/fisheries-and-survey-technology/miniseine-eine-kleine-snurrewade-fuer-die-deutsche-kuestenfischerei

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The mini seine system (Danish seine reduced in size in order to be operable from a gillnetter) has been tested, evaluated, modified and improved by DTU-Aqua (Denmark) since 2018. As results showed that the gear is capable of reaching catches comparable to gillnets and additionally chances of catch loss due to raiding seals are much more unlikely, it can be considered a potential gillnet alternative. Additional ecological advantages of the gear over set gillnets are the expected reduced catches of species protected under the EU Habitats Directive (Directive 92/43/EEC) and the Bird Directive (Council Directive 2009/147/EC) such as harbour porpoise (Phocoena phocoena) and different sea-birds, and the reduced risk of ghost nets in the area.

In order to evaluate the gear in other areas than the waters around Bornholm, initial tests of the gear have been carried out in collaboration with a commercial gillnetter in German waters in summer 2022. Although setting up required some deck rearrangement, catches with the gear seemed promising and handling with two people was no problem. The overall opinion of the involved fisherman was very positive and he considers the gear to be potentially used in the future.

Figure 7.33: Mini seine system installed onboard the Danish fishing vessel being involved in previous work with it.

7.7.3.5 Project: SimuNet

Project Full Title: SimuNet – A tool for fishing gear optimisation

Project Timeframe: April 2020 – June 2023

Institution(s): University of Rostock and Thuenen Institute of Baltic Sea Fisheries

Contact person:

Karsten Breddermann, University of Rostock, karsten.breddermann@uni-rostock.de

Uwe Lichtenstein, Thuenen Institute of Baltic Sea Fisheries, uwe.lichtenstein@thuenen.de

Daniel Stepputtis, Thuenen-Institute of Baltic Sea Fisheries, daniel.stepputtis@thuenen.de

Link(s): https://www.lmt.uni-rostock.de/en/simunet/ ; www.thuenen.de/en/of/projects/fisher-ies-and-survey-technology/simunet-a-tool-for-fishing-gear-optimisation/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: In a joint effort, the University of Rostock and the Thuenen-Institute of Baltic Sea Fisheries, in close collaboration with Dr. Daniel Priour (Ifremer - Laboratoire Comportement des structures en Mer), developed a design tool that serves to calculate the hydrodynamics and the deformation of fishing gear. This design tool shall aid the development of innovative and eco-logically sustaina-ble fishing gear Figure 7.34.

From an engineering point of view, a fishing net is a system of rigid bodies connected by a cloth-like, permeable structure that is assumed to be ideally flexible. The shape of the net is the result of the flow loads acting on the bodies and the cloth-like structure. The flow loads, in turn, are the result of the arrangement and orientation of the bodies and the cloth-like structure in relation to each other, i.e. the result of the shape of the net. This mutual influence is called fluid-structure interaction (FSI). If questions about drag resistance, flow through or inflow to components (such as sorting grids) are to be answered, this interaction must not be neglected.

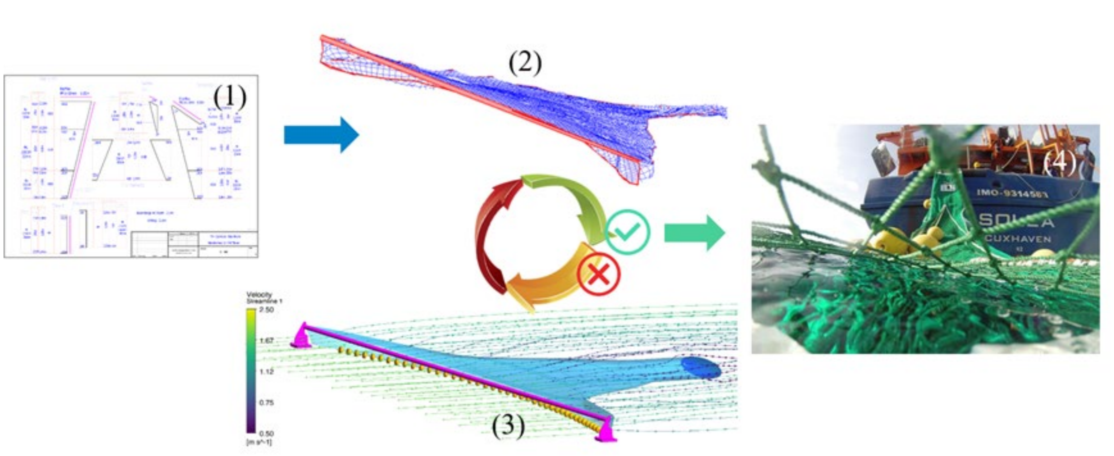


Figure 7.34: Process chart: Based on the information given in the net plan (1) the shape of the trawl (2) is calculat-ed and the geometry information is passed to the fluid dynamics software. The flow field is predict-ed/calculated (4) and the information is passed back as new input for the shape calculation. Once the shape finds an equilibrium the iteration process is stopped and the results can be discussed. When the design meets the requirements, the net can be built and tested (4).

For the calculation of the shape of the fishing gear, the software FEMNET was chosen (written by Daniel Priour). For the prediction of the flow field, the open source toolbox OpenFOAM was adapted. The modelling of a trawl and its components is computationally very expensive. Therefore trawl doors, ground gear and netting are represented by placeholders which reflect the hydrodynamic properties of these. This requires beforehand individual investigations of the components to identify drag and lift information.

Results (Figure 7.35) of the simulation include the solidity of the meshes, the velocity as well as the pressure field inside and outside the trawl, drag forces, and tensions in rig and netting. Knowledge of trawl's drag and tension may allow for a more precise choice of netting and rigging materials and thus avoid over-designed components which cause unnecessary high fuel consumption. The information of the solidity may allow to judge if a sufficient mesh opening will be achieved in the trawl sections. The velocity and pressure field information may be utilized to assess if a sorting grid is prone to clogging. A further application of the velocity and pressure field information may be the development of stimulus-based bycatch reduction devices.

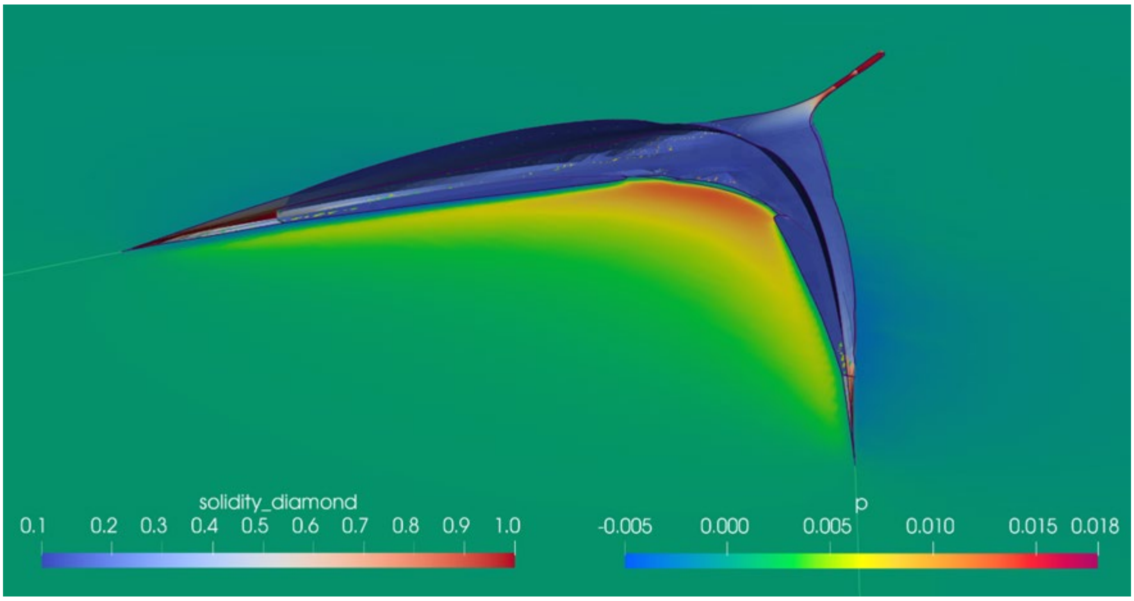


Figure 7.35: Simulation results of a bottom trawl used in the Baltic Sea. On the nets surface the solidity of the netting is given, on the bottom the kinematic pressure is depicted.

Validation of the software is taking place by conducting experiments with net panels and trawl models in a flume tank. With successful validation the software will be a helpful tool to analyse and assess existing trawls. Furthermore, it will path the way to stimulus-based bycatch reduction devices.

7.7.4 Future projects and Ideas

7.7.4.1 Project: "Fishing vessel of the Future"

Project Full Title: Development of a new concept for a fishing vessel for coastal fisheries.

Estimated Project Timeframe: 2023-2026

Institution(s): Thünen Institute of Baltic Sea Fisheries

Contact person: Daniel Stepputtis, Daniel.stepputtis@thuenen.de

Link(s): NA

Collaboration welcome? Y

Funding secured? N

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Summary:

- Conceptual design of a fish cutter of the future
- Future viability should not only concern the ship's propulsion (CO2 neutrality), but many other (urgently needed) aspects, e.g.
    - Flexible propulsion concept (climate-neutral, emission-free, modular)
    - Flexible/modular deployment/use concept, for diversification of the business model
    - Ship safety and occupational safety
    - Animal welfare and food quality

If you work (or plan to work) on this topic, please contact us.

7.8 Iceland

7.8.1 Contact person

- Haraldur A. Einarsson, Marine and Freshwater Research Institute (MFRI). haraldur.arnar.einarsson@hafogvatn.is

7.8.2 Summary

- FishScanner
- Fishing gear as a contributor to the problem of marine plastics

7.8.3 Projects

7.8.3.1 Project: FishScanner

Project Full Title: NA

Project Timeframe: December 2018 – December 2023

Institution(s): Marine and Freshwater Research Institute, StarOddi, and Hampiðjan

Contact person: Haraldur A. Einarsson, haraldur.arnar.einarsson@hafogvatn.is

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project started in 2018 in cooperation between the Marine and Freshwater Research Insti-tute, StarOddi, and Hampiðjan. The project aims to develop a lightweight and user-friendly de-vice that provides real-time information on the catch composition. The device is called FishScan-ner. A circular frame in front of the codend contains stereo cameras and light. It scans all fish before it enters the codend, and in real-time process in a computer on board the vessel using arti-ficial intelligence. The cable from the vessel to the device can be either a coax type or fiber optic cable for more data quality. This device is a significant improvement for science work and the commercial fishery with towed fishing gear. The prototypes of the FishScanner have been tested at sea, both in a research vessel and a commercial trawler.

The project has developed a version of the FishScanner suiting better for the commercial fishery. The FishScanner gives fishermen real-time information about catch composition for species and size distribution. Further tests on the commercial version will be conducted in spring 2023, possibly followed by commercial use within the fishery company Brim.

The research version is scheduled to take a reliability test in the fall of 2023.

The group is interested in developing FishScanner further and possibly in the direction of remoted selectivity. However, a grant possibility is needed.

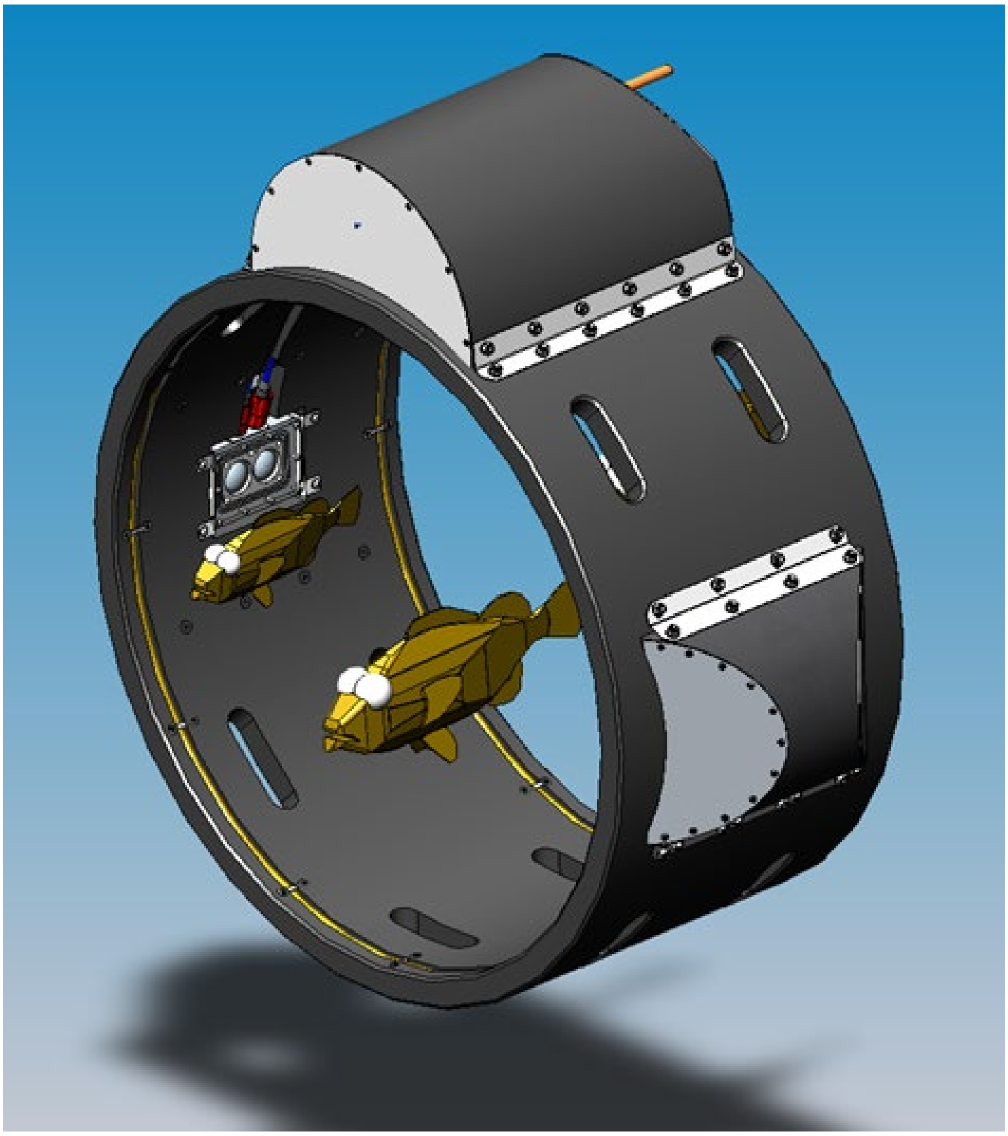


Figure 7.36: Sketch of FishScanner (CAD)

7.8.3.2 Project: Fishing gear as a contributor to the problem of marine plastics

Project Full Title: NA

Project Timeframe: March 2018 – Present

Institution(s): Marine and Freshwater Research Institute

Contact person: Haraldur A. Einarsson, haraldur.arnar.einarsson@hafogvatn.is

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: After establishing a classification scheme and implementing a registration protocol, the MFRi started in 2019 to register all marine debris found during its surveys. There are three main clas-ses: fishing gear, marine industry and waste. In the fishing gear class, waste can be registered by gear type or part of the gear such as trawl-net, longline or floatation. The data will be continuous-ly collected over the coming years, and the distribution of waste in the Icelandic EEZ will be monitored and analyzed.

As a side work to this, Haraldur is chair of a small working group funded by AG-Fish focusing on the Circular Economy of fishing gear in the northern countries (Greenland, Iceland, Faroe Islands, and Norway). And another similar activity is cooperating in the project named PAME (https://www.pame.is/), focusing on the arctic marine litter.

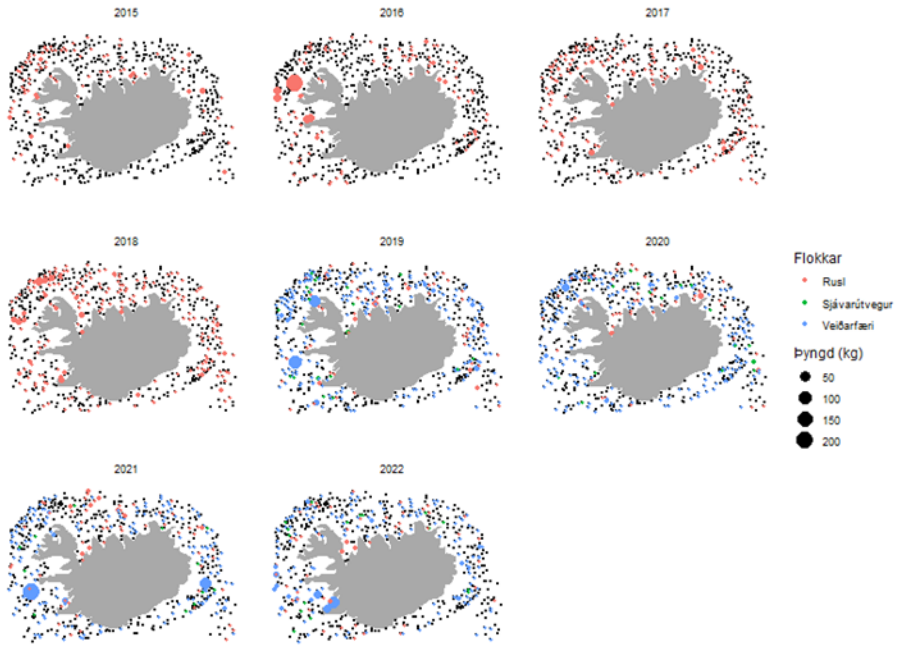


Figure 7.37: Results from the first years of monitoring trash found in annually March survey trawl catch (all other surveys are moni-tored as well). Black dots are with no trach of any kind registered. First four year anything registered was cat-egorised as "trach" (Rusl), red dots. From 2019 and present a three main classes are used, with subclasses (not shown here), the three classes are Rusl (trach) red, Sjávarútvegur (based from fishery industry) green, and Veiðarfæri (Fishing gear) Blue. Sizes of dots represent the magnitude in kg (see the legend).

7.9 Ireland

7.9.1 Contact person

- Dr Ronan Cosgrove, BIM, ronan.cosgrove@bim.ie

7.9.2 Summary

- Irish research relevant to FTFB focused on bycatch of unwanted species in response to the landing obligation, and energy efficiency in response to the energy crisis and longer-term transition away from fossil fuels.
- Future research will include work on mitigating seabed impacts given the variety of EU regulations which will need to be addressed by the fishing industry. These include the Marine Strategy Framework Directive, Biodiversity Strategy and Nature Restoration proposal.

7.9.3 Projects

7.9.3.1 Project: New guide on Fisheries Conservation solutions

Project Full Title: New guide on Fisheries Conservation solutions to reduce unwanted catches

Project Timeframe: 2022

Institution(s): BIM, ATU Galway

Contact person: Matthew Mchugh, MatthewMchugh@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: An updated guide on fisheries conservation solutions to reduce unwanted catches in Irish fisheries was issued in early 2022 (Figure 5.1). The useful guide contains one-page summaries of 22 gear modifications, survival exemptions and technical tools, all devel-oped in close collaboration with the Irish Fishing Industry. These solutions help address landing obligation requirements, boost fisheries' sustainability and marine biodiversity by decreasing catches of juvenile, over-quota and non-target species.

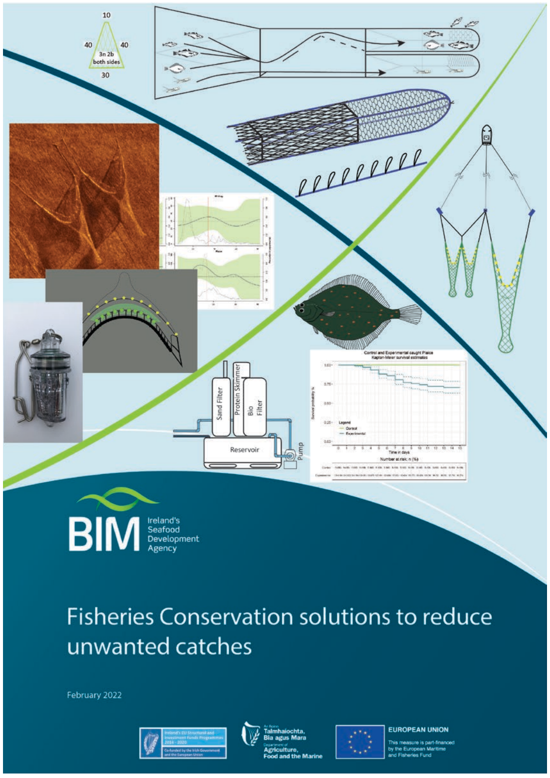


Figure 7.38: Cover of new BIM guide

7.9.3.2 Project: Energy efficiency Nephrops trawl

Project Full Title: Preliminary assessment of the energy efficiency of a four-panel Nephrops trawl

Project Timeframe: 2022

Institution(s): BIM, ATU Galway

Contact person: Matthew Mchugh, Matthew.Mchugh@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Building on previous BIM work, this trial assessed the energy efficiency of the box trawl in the Irish Nephrops fishery. The four-panel trawl comprised extensive sections of large mesh in the top sheet and upper wings, and a SELTRA four-panel codend both of which facilitate escape of unwanted fish catches. The greatest operational difference between the box trawl and standard gears was a 10% increase in wing-end spread resulting in a greater swept area and increased Nephrops catches in the four-panel trawl. No increase in fuel or carbon emissions occurred thanks to improved hydrodynamics in the box trawl.

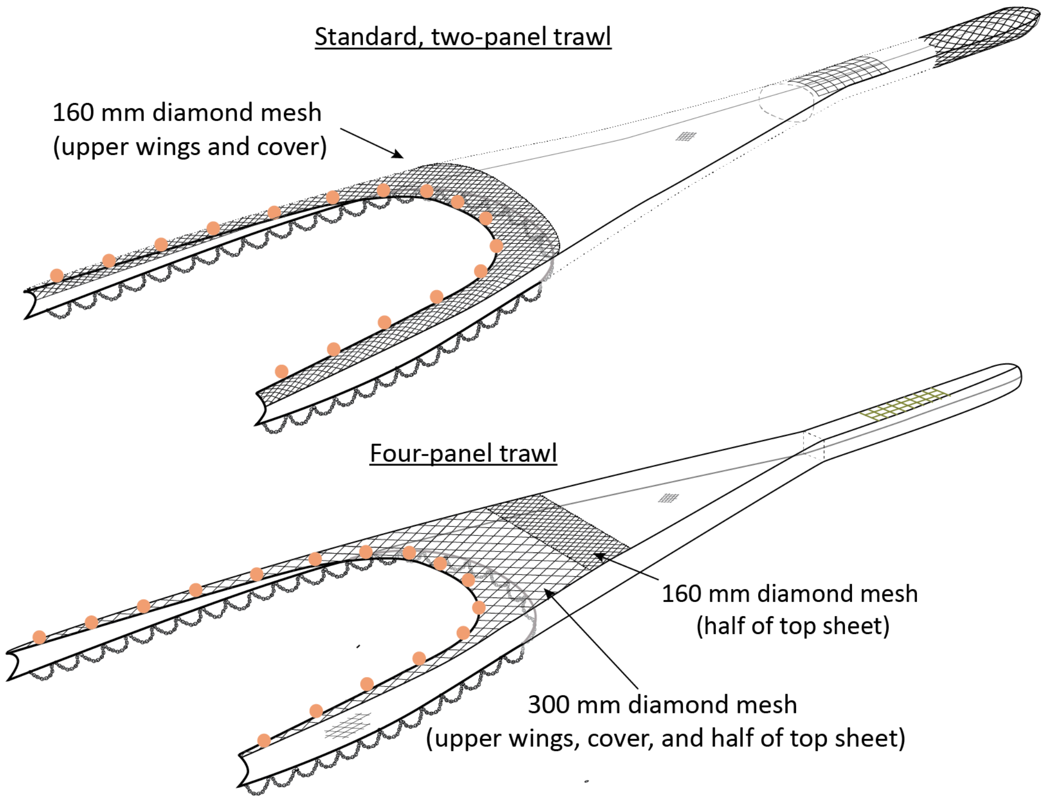


Figure 7.39: Standard and four-panel 'box' trawl tested in the Irish Nephrops fishery.

7.9.3.3 Project: Artificial light on raised fishing line

Project Full Title: Artificial light on the raised-fishing line in a Celtic Sea mixed-demersal fishery trawl

Project Timeframe: 2022

Institution(s): BIM, ATU Galway

Contact person: Martin oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The raised fishing-line is an effective gear option for reducing catches of low-quota cod and vulnerable skate and rays for vessels targeting demersal fish species in the Celtic Sea. A full-scale assessment of lights mounted on and off the raised-fishing line demon-strated a 65% reduction in low-quota cod. In the context of major increases in fuel prices, accompanied reduc-tions in target species suggested that lights were not a commercially viable option at the time of the trial.

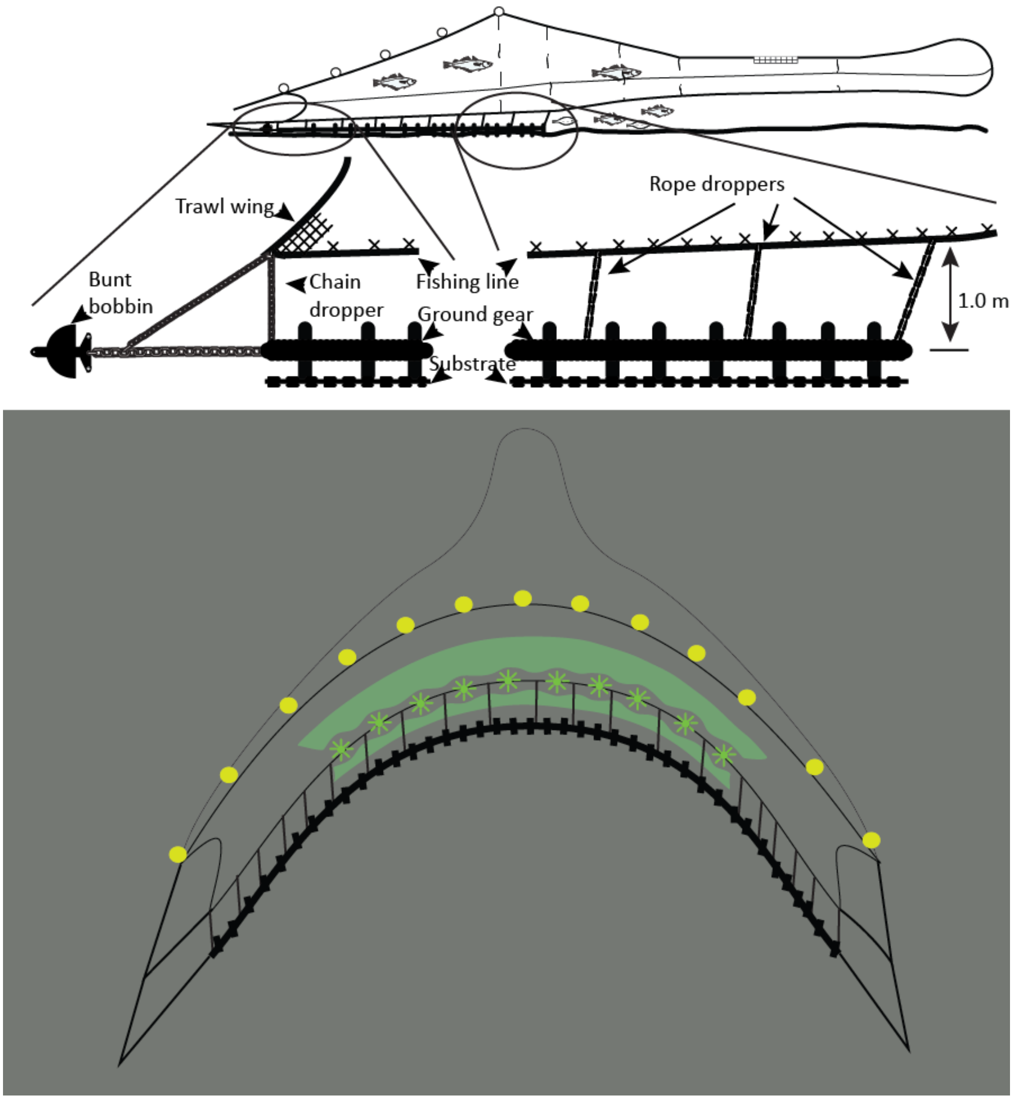


Figure 7.40: RFL with artificial light on the fishing line

7.9.3.4 Project: Modified rigging in Nephrops fishery

Project Full Title: Testing of modified rigging towards reduction of unwanted catches in the Nephrops fishery

Project Timeframe: 2022

Institution(s): BIM, ATU Galway

Contact person: Daragh Browne, daragh.browne@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Testing of modified rigging and an escape gap between Nephrops trawls demonstrated reductions in catches of large fish such as skates and rays and dogfish and an increase in Nephrops catches possibly due to improved bottom contact associated with the new rigging. The skippers of the trial vessel and another vessel operating in the Irish Sea have continued to use the new rigging thanks to the positive results. Further assessment of bycatch and energy reduction benefits is planned in 2023.

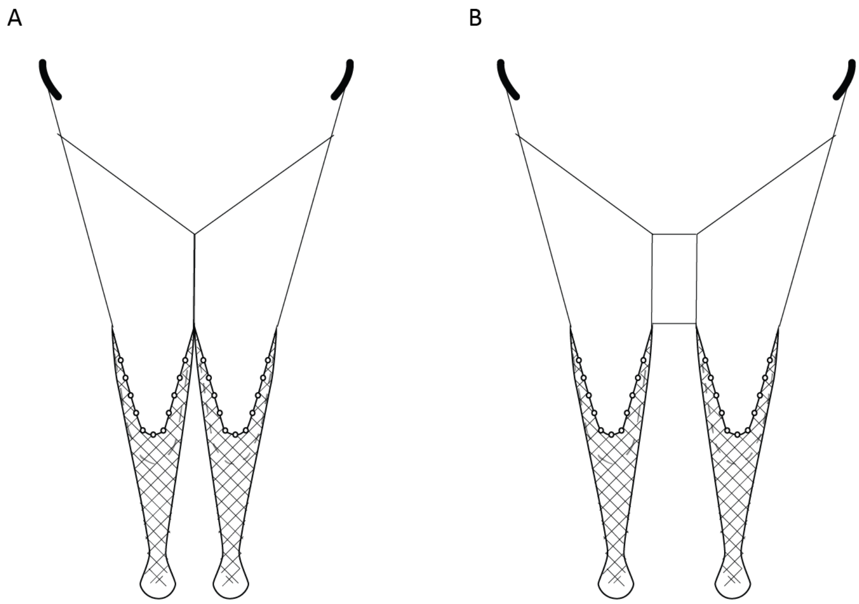


Figure 7.41: Illustration of modified rigging

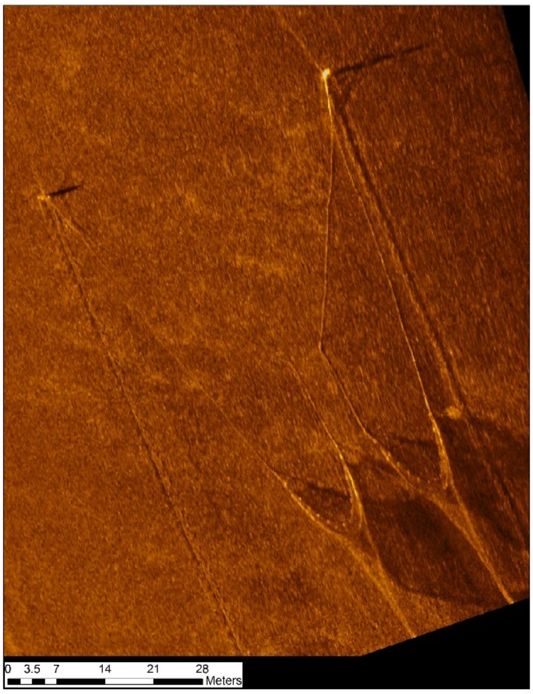


Figure 7.42: Side-scan sonar image of the modified rigging

7.9.3.5 Project: Assessment of pari fishing for demersal species

Project Full Title: Assessment of pair fishing towards more efficient targeting of demersal fish species

Project Timeframe: 2022

Institution(s): BIM

Contact person: Matthew Mchugh, Matthew.mchugh@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This trial primarily aimed to improve energy efficiency with supporting biological in-formation collected to assess any potential impacts on unwanted catches. The pair ves-sels reduced their fuel use by 40% during fishing. Catch rates were 29% greater due to in-creases in swept area and fish herding. Resulting reductions in variable costs and in-creases in revenue provided an estimated 32% increase in profitability at trip level. The method was found to have minimal impact on unwanted catches and has major poten-tial for scale-up in Ireland's whitefish sector.

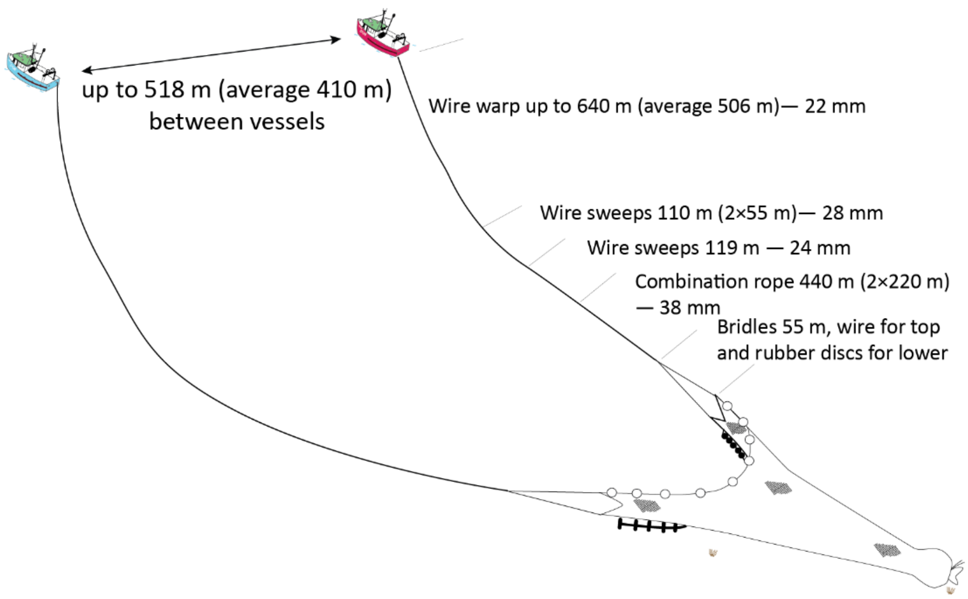


Figure 7.43: Pair-trawl configuration

7.9.3.6 Project: Cod survival in seine-net fishery

Project Full Title: Assessment of cod survival in the Irish seine-net fishery using pop-up satellite archival tags

Project Timeframe: 2022

Institution(s): BIM, ATU Galway

Contact person: Martin oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Assessment of cod survival in the Irish seine-net fishery using pop-up satel-lite ar-chival tags. 10 cod caught under normal fishing conditions were tagged and re-leased on board an Irish seine-net vessel. Tag deployment periods ranged from 2 to 21 days with an average survival period of 10 days. Generally, a minimum survival proba-bility of 50 % after 15 days or longer is needed before a case can be made towards a sur-vival exemption and overall survival results fell well short of that level. Caused by haul-ing of the net from depth, barotrauma was likely the main reason behind cod mortalities. Measures to mitigate barotrauma are currently commercially unviable in the Irish seine net fishery. The study delivered an innovative new survival assessment technique with potential applications to other fish species.

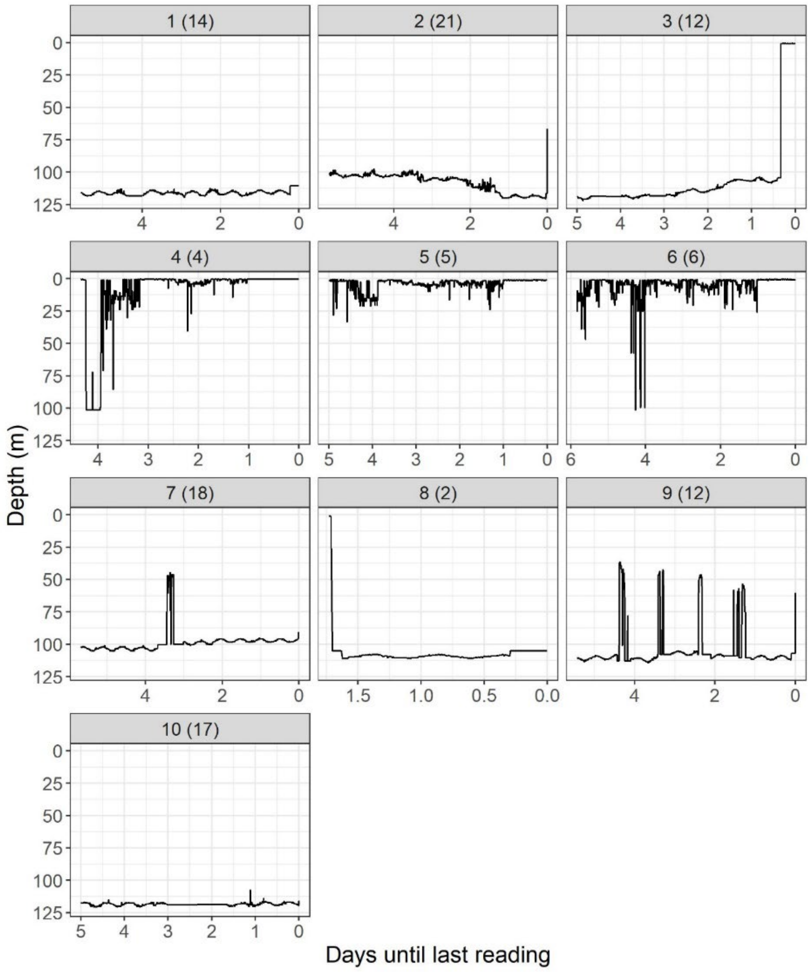


Figure 7.44: Vertical behaviour for tagged cod up to six days prior to tag pop off. Figure headings consist of fish ID number with total deployment period in brackets.

7.10 Italy

7.10.1 Contact person

- Antonello Sala, National Research Council (CNR), antonello.sala@cnr.it

7.10.2 Summary

The 2023 WGFTFB national report from Italy describes the CNR-IRBIM's research activities. Projects – relevant for the WGFTFB topict - are conducted within the framework of research, development and innovation projects, both national and international, under regionally directed funding programs (POR FEAMPA – Regional Operational Program of the European Maritime Affairs Fund Fisheries and Aquaculture (EMFAF) and ROP ERDF – Regional Operational Program of the European Regional Development Fund) or ministerial (PRIN – Projects of significant national interest, PNRA – National Antarctic Research Program, European Territorial Cooperation programs (Interreg), direct funding programs of the European Commission (Horizon2020 and Horizon Europe, Life, JPI – Joint Programming Initiatives, ERA-NET Cofund). Thematic collaboration initiatives run by international organizations such as FAO, and GFCM (General Fisheries Commission for the Mediterranean). The Institute also develops funded projects in the context of collaborations with private companies in the sectors of the blue economy as well as technology transfer and research results. Research projects, mainly of a collaborative nature, are developed through a wide network of partners that include major Italian and foreign research institutions and universities.

7.10.3 Projects

7.10.3.1 Project: Life DELFI

Project Full Title: Dolphin Experience: Lowering Fishing Interactions (LIFE18 NAT/IT/000942)

Project Timeframe: January 2020 – December 2024

Institution(s): National Research Council (CNR)

Contact person: Alessandro Lucchetti, alessandro.lucchetti@cnr.it

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/delfi/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Life DELFI aims at reducing interactions between dolphins and fishing activities through technical, management and socio-economic measures. Conservation activities will mainly focus on the bottlenose dolphin (*Tursiops truncatus*), although the transversal actions of the project will also extend to other species of cetaceans facing threats caused by fishing activities. The project will last 5 years, and is co-financed by the European Union as part of the Life Program for the conservation of endangered species and habitats. DELFI covers many localities along the Italian and Croatian waters and involves 8 partners, including Universities, NGOs, MPAs and research institutes. The specific objectives of the Life DELFI Project are:

- To reduce interactions between dolphins by 1) encouraging the use of pots as dolphin-safe and alternative gears to the passive nets 2) testing deterrent devices, including interactive pingers (DiD-01 by STM) and visual deterrents (LEDs), both in set nets and trawl fisheries.

- To promote citizen science and dissemination activities aimed at increasing public awareness on dolphins' conservation.
- To engage fishers through specific training courses on more sustainable economic alternatives, such as dolphin watching, and on how to deal with entanglement and bycatch events.
- To investigate interactions through passive acoustic and visual (e.g. photo-identification) monitoring

Figure 7.45: Project DELFI; Dolphin deterrent device

7.10.3.2 Project: ECOSCOPE

Project Full Title: Ecocentric management for sustainable fisheries and healthy marine ecosystems

Project Timeframe: September 1, 2021 - August 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Giuseppe Scarcella

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/ecoscope/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: EcoScope aims to promote an effective ecosystem-based approach to fisheries management in European seas. EcoScope will develop an interoperable platform, a tool (toolbox) to facilitate decision-making, a series of online courses, and a mobile application. These tools will be made available through a single public portal to promote an efficient, ecosystem-based approach to fisheries management. The four-year project addresses the degradation of marine ecosystems and the anthropogenic impact caused by unsustainable exploitation of fisheries in several European seas to promote more efficient, holistic, sustainable and "ecocentric" fisheries management that can restore the sustainability of fisheries and ensure greater balance between food, safety and healthy seas. The EcoScope platform will organize and homogenize climate, oceanographic, biogeochemical, biological, and fisheries datasets for European seas according to a common standard type and format that will be available to users through interactive mapping layers. This information will be presented to users through user-friendly interactive mapping layers. The international consortium will develop the EcoScope Toolbox, a scoring system linked to the platform, which will house ecosystem models, socio-economic indicators, fisheries and ecosystem assessment tools that will be used to examine and develop fisheries management and marine policy scenarios, as well as maritime spatial planning simulations. EcoScope will also apply new assessment methods for data-poor fisheries, including non-commercial species, as well as for biodiversity and conservation status of protected megafauna. This will include an assessment of the status of all ecosystem components in European seas and will test new technologies to assess environmental, anthropogenic and climate impacts on ecosystems and fisheries. Finally, tools such as online courses, films, documentaries, webinars and games will be available through the EcoScope Academy. The project consists of a partnership of 24 partners (universities, research institutions, NGOs, individuals) from Greece, Bulgaria, Germany, Canada, Israel, the Philippines, Spain, France, Belgium, United Kingdom, Portugal, Italy, Netherlands, Malta, Norway, Switzerland, and Cyprus, coordinated by the Aristotle University of Thessaloniki. CNR's participation in the project is coordinated by IRBIM CNR and includes the participation of the Institute ISTI CNR.

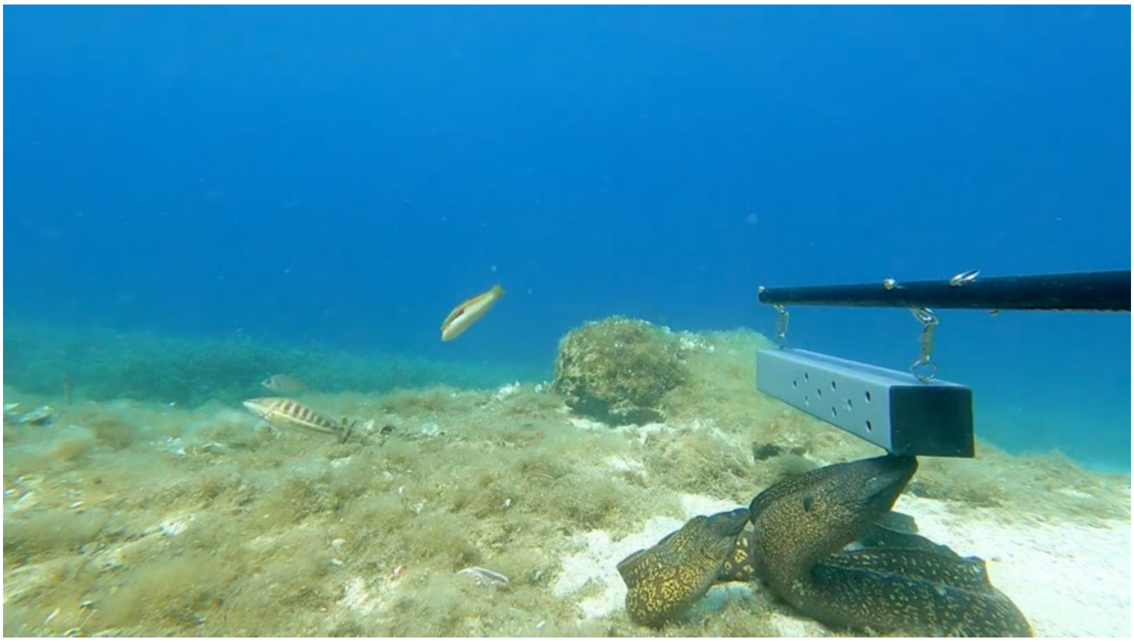


Figure 7.46: Baited video systems are part of a wider effort within the EcoScope project to develop new ways to collect data in order to fill in existing data gaps in marine research.

7.10.3.3 Project: LIFE ELIFE

Project Full Title: Elasmobranchs Low-Impact Fishing Experience

Project Timeframe: September 1, 2021 - August 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Alessandro Lucchetti and Sara Bonanomi

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/elife/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The ELIFE project aims to improve the conservation of elasmobranch species (sharks and rays) by promoting best conservation practices in European professional fisheries in the Mediterranean Sea by carrying out pilot and demonstration actions in Italian and Greek ports. Specific objectives of the project are:

- reduction in bycatch of many threatened elasmobranchs, critically endangered, endangered and vulnerable species, during professional fishing activities;
- reduction in mortality of threatened elasmobranchs during professional fishing activities;
- elimination of catches for the endangered shark Carcharhinus plumbeus caused by trawling in Lampione Island waters;
- reduction of incidental catch and collisions and anthropogenic disturbance on the endangered basking shark, Cetorhinus maximus, in the North Sardinian Sea;
- implementation of appropriate conservation measures with ecosystem approach to fisheries through the preparation and adoption of specific local management plans;
- support management authorities for shark conservation and management policies in IT and CY by providing more recent and in-depth data for environmental status assessment and implementing activities consistent with a management plan for this species.

7.10.3.4 Project: PNRDA

Project Full Title: National program for the collection and management of biological, environmental, technical and socio-economic data for fisheries management

Project Timeframe: March 1, 2013 - July 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Enrico Arneri

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/pnrda-national-program-for-fishery-data-collection/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: CNR IRBIM coordinates the National Program for Fishery Data Collection (PNRDA), conducted through a national partnership of research organizations, universities and private entities. Researchers belonging to the Institutes CNR IAS and CNR IREAalso participate in this Program. The PNRDA is formulated under the European Regulations establishing a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice relating to the Common Fisheries Policy (Data Collection Framework – Regulation (EU) 2017/1004). The basic purpose of this Program is to provide national and European administrations, as well as regional-level fisheries management bodies such as the General Fisheries Commission for the Mediterranean (GFCM) and the International Commission for the Conservation of Atlantic Tuna (ICCAT), biological, environmental, technical and socio-economic data and appropriate tools to undertake planning interventions and adopt management measures in line with the Common Fisheries Policy (CFP).

7.10.3.5 Project: Co4SSF

Project Full Title: Co-developing Data Collection, Analysis and Decision Support System for Small Scale Fisheries

Project Timeframe: May 1, 2022 - October 31, 2023

Institution(s): National Research Council (CNR)

Contact person: Anna Nora Tassetti

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/co4ssf/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The Co4SSF project aims to introduce new systematic approaches to fisheries management to advance knowledge needed to support the integrated management of the coastal zone and maritime compartments where protected habitats fall, with particular reference to the Small-Scale Fisheries sector that to date lacks a solid information layer. An innovative data collection, analysis and management support system for Small Scale Fisheries will be developed under the project. Data collection activities and systematic characterization of Small-Scale Fisheries activities will be developed through the involvement of fishery operators and stakeholders and complemented by ecological knowledge, through tools for analysis and shared spatial planning of sea uses that will take into account impacts on the environment and potential conflicts with other uses. This approach will encourage the design of integrated management protocols among Small Scale Fisheries operators with a view to sustainable management of the resources of the marine environment. The project is carried out in partnership with the Coldiretti National Confederation (which plays the role of Lead Partner).

7.10.3.6 Project: SISTEMA

Project Full Title: Environmental care as a lever of sustainable development

Project Timeframe: September 1, 2021 - August 31, 2024

Institution(s): National Research Council (CNR)

Contact person: Luca Bolognini

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/sistema/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: SISTEMA is a territorial project, coordinated by the Municipality of Ancona, dedicated to the protection, promotion and enhancement of land-sea ecosystems in the area of the city of Ancona and the Conero Park, understood as a flywheel for the growth of sustainable, inclusive and innovative economies and communities that make environmental care a lever for local productions capable of contributing to the achievement of the SDGs 11, 14 and 15 of the 2030 Agenda. The project will act within an ecosystem largely protected by a Nature Park and Natura 2000 sites established under the Habitats Directive, where production activities and urban settlements act within natural terrestrial and marine contexts subject to increasingly intense anthropization. Public administrations, Third Sector entities, associations, producers, economic activities and Research Centers participate in the project with the aim of redefining production, consumption, communication and relationship strategies with terrestrial and coastal environments in a sustainable way according to multiple and complementary activity directions: from land to sea; from sea to land; from man to man; from environment to man; from urban center to protected areas; from protected areas to the city. Along these lines, the project will organize its actions, which will cover the following areas: ecological conversion of production systems (organic farming and Small-Scale Fishery) and strengthening their aggregative and distributional capacity; tourism enhancement; environmental education and animation; and communication and information to citizens. The ambition is to support the growth of sustainable, responsible and aware communities through actions promoted by multi-actor partnerships, capable of guaranteeing measurable impacts and proposing innovative and scalable solutions both in the tools and methodologies adopted, keeping at the center of the project strategy, as the polar star of the SISTEMA, the ancestral relationship between land and sea on which the history and economy of this territory has been built. This generative approach will transcend the temporal boundaries of the project itself, thanks to an intense strategic as well as economic commitment on the part of the City of Ancona, giving rise to new systems of organization, production, fruition and enhancement that can continue and multiply in time and space the results obtained, providing opportunities for work, exchange and growth for the community as a whole. IRBIM CNR is contributing to the Project through research dedicated to the Small-Scale Fishery sector, encouraging the adoption of fishing practices and gears that have less impact on the environment, supported by scientific evidence and through the expertise available to the partnership. At the same time, it is planned to operate an awareness campaign and direct involvement of Small-Scale Fisheries operators with the aim of fostering the penetration of the proposed practices and techniques, up to the persuasion of operators about the advantages of their use.

7.10.4 Future projects and Ideas

7.10.4.1 Project: Managing fishing health and safety (SAFETRAWL)

Project Full Title: Managing fishing health and safety by reducing risks of snagging in fishing vessels

Estimated Project Timeframe: 2023 – 2025

Institution(s): CNR, fishers (trawlers)

Contact person: Antonello Sala, antonello.sala@cnr.it

Link(s): -

Collaboration welcome? Yes

Funding secured? Yes

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes, indirectly by reducing snagging and the risk of losing fishing gears during towing operations

Summary: Trawling is a method of catching fish in a large volume where fish nets are pulled through water using one or two boats. Bottom trawling is where the nets are pulled over on the seabed. The bottom trawling gear would impact snags and/or the exposed subsea pipelines on the seabed. This study will assess the risks of trawling activities and reduce risks of snagging by installing an electronic system onboard for the real-time measurement of towing forces.

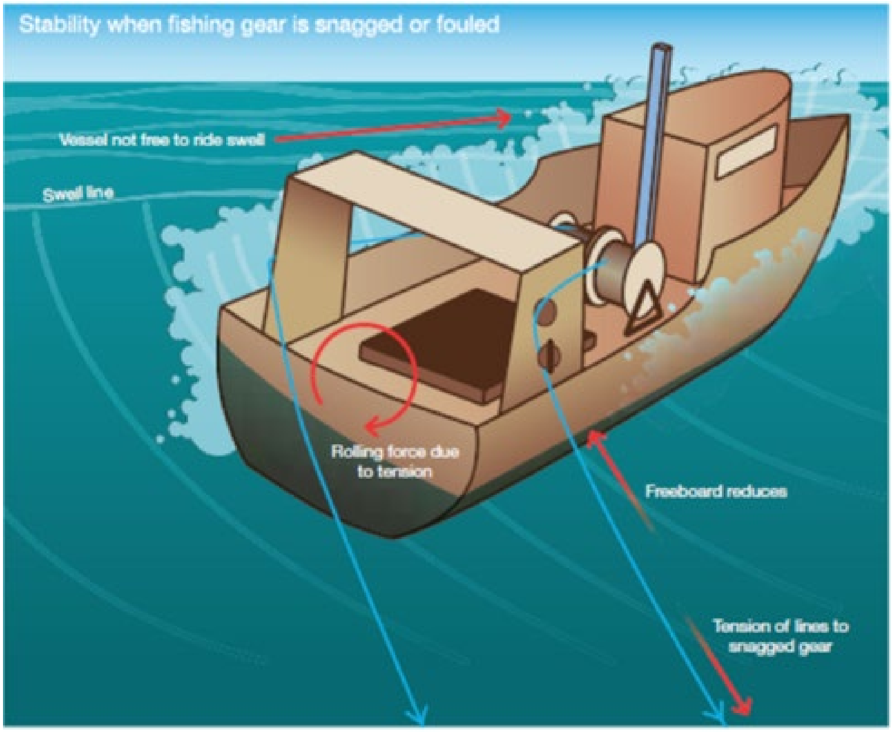


Figure 7.47: Fouling or snagging of fishing gear

7.11 Japan

7.11.1 Contact person

- Yoshiki Matsushita, Nagasaki University, yoshiki@nagasaki-u.ac.jp

7.11.2 Summary

- Information on five studies was received from Hokkaido University, Tokyo University of Marine Science and Technology, and Nagasaki University. Fishing technology research is also being conducted at the Japan Fisheries Research and Education Agency, Nihon University, Kinki Uni-versity, National Fisheries University, and Kagoshima University, but no information was re-ceived at this time.

7.11.3 Projects

7.11.3.1 Project: Camera observation in shrimp pot fishery (COSPF)

Project Full Title: Underwater camera observation of entry and escape behavior of Coon-stripe Shrimp (*Pandalus hypsinotus*) in a shrimp pot fishery

Project Timeframe: September 2019 – October 2020

Institution(s): Faculty of Fisheries Sciences Hokkaido University, Hokkaido Research Organization Central Fisheries Research Institute

Contact person: Makoto Tomiyasu, tomiyasu@fish.hokudai.ac.jp ; Yasuzumi Fujimori, fujimori@fish.hokudai.ac.jp

Link(s): https://researchmap.jp/tomiyasu/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Coonstripe shrimp in Funka-Bay, Hokkaido is one of the important fishery resources which are caught mainly by shrimp pot fishery. Understanding the capture process of fishing is important for the sustainable use of the resources, however, there are few examples of observing that behaviour in the shrimp pot fisheries at deep depths. In this study, we attached an underwater camera and red LED light to the shrimp pot in Funka Bay and observed the entering and escaping processes of corn strive shrimp, *Pandalus hypsinotus*. A total of 32 shrimps were observed in eight surveys, with a longest of 11.1 hours of video recording. The shrimp appeared concentratedly in a specific time zone, which may have been influenced by the behavioural activity rhythm of the shrimp and the diffusion of the attractive effect of bait. 12 of 32 shrimps escaped at the funnel, and 8 individuals escaped through the funnel after making contact with the bait. The remaining 12 individuals fell to the bottom of the pot and 2 of them escaped through the funnel after falling. No shrimps escaped through the mesh of the pot. The mean duration of contact with the bait was short, 41 minutes, indicating that the shrimp's time allocation for activity in the pot was mainly occupied by moving and remaining in the pot. Therefore, it is suggested that the main escape behaviour is escaping from the funnel, and if the pot is installed with escape gaps, escaping may occur while moving in the pot.

7.11.3.2 Project: Behaviour of aquaculture basket for oyster (BABO)

Project Full Title: Behaviour of aquaculture baskets affecting oysters' growth and valve movement.

Project Timeframe: September 2020 – October 2022

Institution(s): Faculty of Fisheries Sciences, Hokkaido University

Contact person: Makoto Tomiyasu, tomiyasu@fish.hokudai.ac.jp ; Yasuzumi Fujimori, fujimori@fish.hokudai.ac.jp

Link(s): https://researchmap.jp/tomiyasu/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The shape of the oyster is an important factor in assessing its quality of the oyster. Generally, the most valuable oysters are those with a broad shell shape and a deep cup. Traditionally, oysters have been grown at high densities on culture ropes. On the other hand, for the production of high-value individuals, 'single-seed cultivation', in which the oysters are grown while rolling them freely in a basket, has been practiced. However, it has been suggested that conditions such as the type of basket and farming density affect the shape of the shell of the oysters, and it is necessary to understand the relationship between basket behaviour, individual growth, and valve movement in order to efficiently produce high-quality individuals. This study conducted an experiment at a single-seed aquaculture facility in Akkeshi, Hokkaido, Japan, using three types of baskets to grow Oysters. In the experiment, the amount of shell growth of the oysters was measured, and the characteristics of behaviour of the aquaculture basket and valve movement such as the opening and closing of individual shells were investigated using acceleration and magnetic hole sensors.

7.11.3.3 Project: Monitoring of seal invading a salmon set-net

Project Full Title: Monitoring of Kuril harbour seal invading a salmon set-net with rope grid to reduce fish damage from seals.

Project Timeframe: September 2020 – October 2022

Institution(s): Faculty of Fisheries Sciences Hokkaido University, the Ministry of the Environment

Contact person: Yasuzumi Fujimori, fujimori@fish.hokudai.ac.jp ; Kazuma Kuroda

Link(s): https:// https://www.researchgate.net/profile/Yasuzumi-Fujimori

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study has been ongoing since 2014 under the promotion of the Ministry of the Environment, Japan. Since then, a monitoring has continued with underwater camera installed in the bag-net of a salmon set-net. The use of rope grid made of Dyneema attached with the entrance of bag-net began in 2016. At the first year, the number of seal occurrences measured by camera was about 200 times in a week, but since 2017 to 2021 it had decreased to 20% - 40% of that number. From the result of individual identification using camera images, the number of individuals appearing over multiple years has also decreased. This suggests that the use of rope grids to keep seals out of the bag-net has reduced their obsession to the salmon set-net.

7.11.3.4 Project: Tracking technology for fish near FADs

Project Full Title: Construction of tracking technology for highly migratory fish near the fish aggregating device

Project Timeframe: April 2018 – March 2021

Institution(s): Tokyo University of Marine Science and Technology

Ajinomoto Co., Ltd.

Contact person: Yoshinori Miyamoto, miyamoto@kaiyodai.ac.jp

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The purpose was to develop technology to elucidate the behavior and ecology of high-ly migratory fish near the fish aggregating devices (FADs), especially skipjack tuna. There are two methods for observing behavior and ecology: a bio-logging method using a small re-corder and an ultrasonic biotelemetry method using a small ultrasonic transmitter. We worked on de-vising ways to develop methods and solve problems. We organized issues and previous studies on the use and challenges of existing methods. Then, these problems were clarified, and a new system was developed. In the new development, a small fishing boat operating near FADs was equipped with a receiver for an ultrasonic biotelemetry system, and the data was sent to re-searchers by e-mail using a mobile phone network. The effectiveness is confirmed by evaluating the reception status depending on the operation status of the fishing boat. In addition, by com-bining the method of installing the existing ultrasonic biotelemetry system on FADs and the newly developed fishing boat-mounted receiving system, we conducted an ecological survey of highly migratory fish (skipjack tuna and yellowfin tuna) in the vicinity of FADs. As a result, we gained new insights into the behavior and ecology of two tuna species.

7.11.3.5 Project: Development of Fishing USV

Project Full Title: Development of USV (Unmanned Surface Vehicle) for fishing operations

Project Timeframe: Aug. 2021 – Mar. 2024

Institution(s): Nagasaki University

Contact person: Yoshiki Matsushita, yoshiki@nagasaki-u.ac.jp

Link(s): https://www.nagasaki-u.ac.jp/en/research/research64.html

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: USVs (Unmanned Surface Vehicle) have advantages over flying drones in that they can carry heavier and larger equipment, and have easier position control and communication than underwater drones, but the use of USVs in fisheries is limited. We have developed the USV that can be equipped with fisheries and research equipment, while exploring the needs of fish-eries industries. Trials are underway for fish attraction in a light fishing (light mounted) and monitoring fish schools in a trap-net fishery (U/W camera and echosounder mounted).

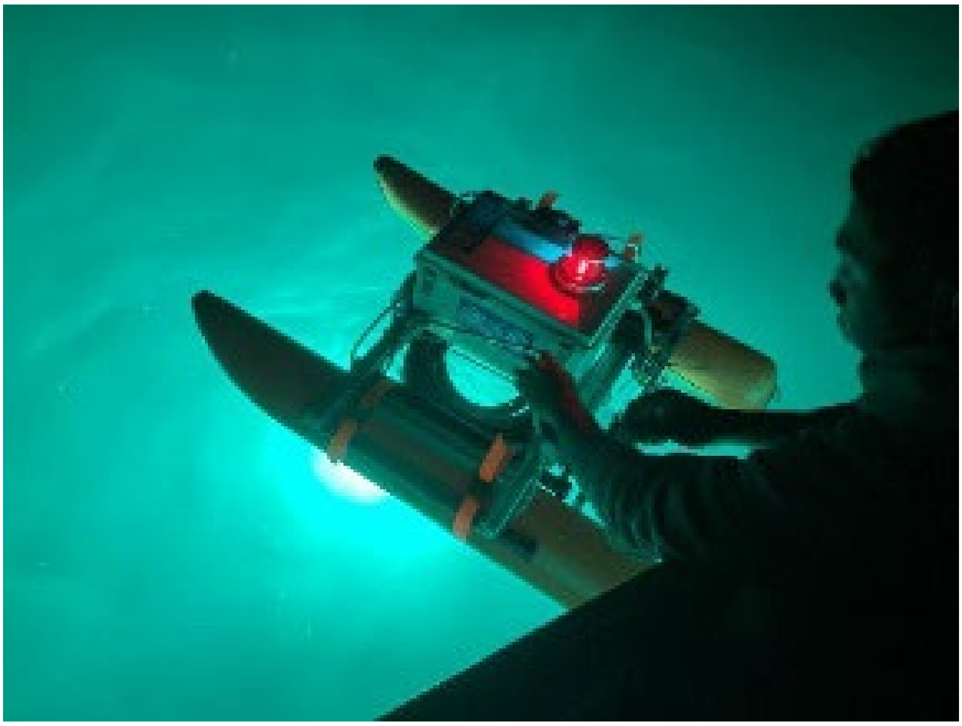


Figure 7.48: Fishing USV

7.12 The Netherlands

7.12.1 Contact person

- Pieke Molenaar, Wageningen Marine Research, pieke.molenaar@wur.nl

7.12.2 Summary

- The helix ticklers project is developing a new type of tickler for the stimulating flatfish to leave the seabed.
- The SepCran project develops innovations for increased selectivity, reduced bottom impact and fuel consumption the Dutch brown shrimp beam trawl fishery
- SimTech aims to develop an ecological and economic alternative fishing technique for flatfish fisheries.
- Gear innovation Sole fisheries further develops the water spray method and rubber strands as tickler method for sole and place fisheries.
- The 'improving discard quantification on commercial fishing vessels' project aims for providing multiple technical solutions for highly accurate measurements of total catch and discard quantities onboard commercial fishing vessels.
- 'Stunning Fish at Sea' aims for developing safe and effective methods to stun fish at sea prior to slaughtering
- The GoPro Downrigger project developed an easy and cost effective tool to identify species after a school is detected on a pelagic trawler.
- MASENRO 2.0 aims to develop methods for automatic species recognition, individual counts and length detection of (flat)fish on the seabed and inside flyshoot trawls.
- OSW 2.2: Norway Lobster develops a novel catch and discard monitoring program for Norway lobster fisheries.
- The Selectivity and Survival project aims to develop and test several gear innovations aimed at reducing fisheries mortality among undersized fish by either avoid that they are caught (increased selectivity) or increasing their survival probability when discarded.
- With Bridging knowledge gaps for sharks and rays in the North Sea discard survival of 2 ray species was assessed, and the population and migration patterns are investigated.
- FDF aims at the development of an electronic monitoring (EM) system that enables the implementation of fully documented fisheries FDF for the Dutch beam trawl fishery (BT2 segment).
- Development passive brown shrimp fisheries is a project idea that aims to investigates with field trials or two passive methods could be an alternative for the Wadden sea shrimp beam trawling

7.12.3 Projects

7.12.3.1 Project: Helix Ticklers

Project Full Title: New innovation for Dutch beam trawlers: Helix Ticklers

Project Timeframe: January 2022 – December 2023

Institution(s): Wageningen Marine Research, Post Engineering

Contact person: Allard van Mens, allard.vanmens@wur.nl

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In order to reduce fuel consumption and subsequent CO2 emissions for Dutch beam trawlers the helix tickler was developed. The theory behind the innovation is that the metal helixes (Figure 7.49) turn into the soil by the forward movement of the ship, displacing less soil and requiring lower fishing speeds resulting in lower fuel consumption compared to their tickler chain beam trawl counterparts. The lower fishing speed might also offer new opportunities for selective nets.

The Helixes have been tested in a tow tank and are scheduled for sea trials beginning of 2023.

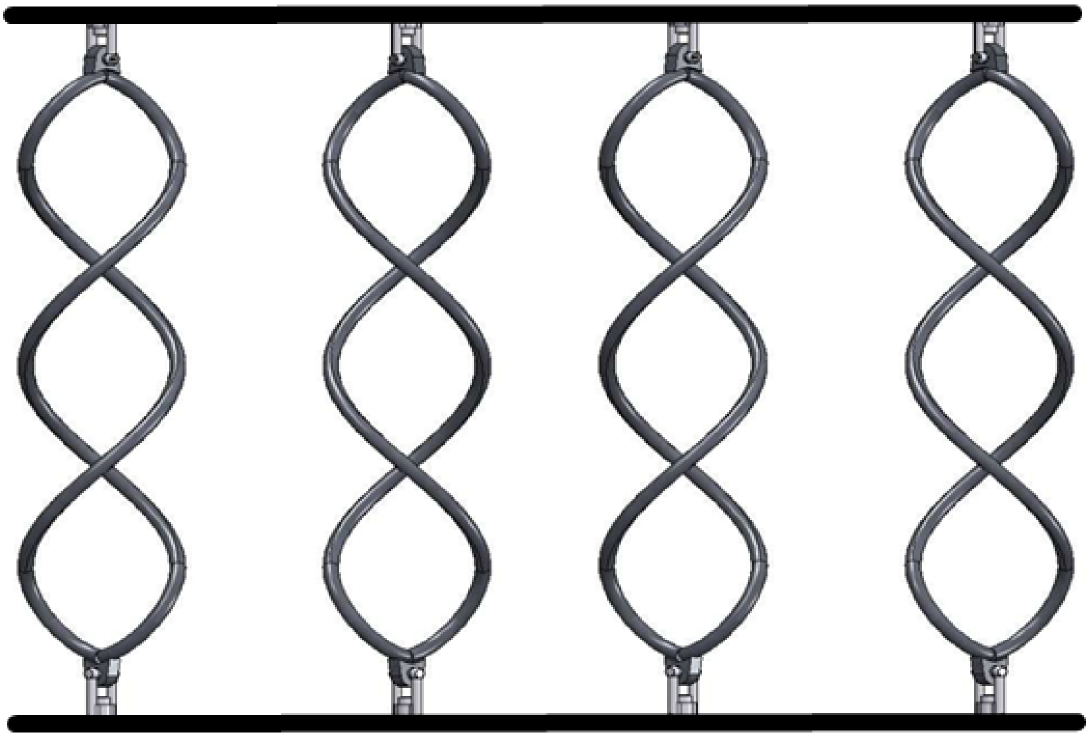


Figure 7.49: Schematic representation of innovate helix ticklers

7.12.3.2 Project: SepCran

Project Full Title: Innovation project selective shrimp fisheries Wadden sea

Project Timeframe: 2019 – 2023

Institution(s): Wageningen Marine Research, Visned, De Nederlandse Vissersbond

Contact person: Pieke Molenaar pieke.molenaar@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The SepCran project develops gear innovations in the Dutch brown shrimp beam trawl fishery, those innovations aiming for increased selectivity, reduced bottom impact and fuel consump-tion. The effectivity of several innovations has been tested on beard of commercial shrimp ves-sels.

Sieve Mat: The sieve mat is a declining separation panel that is placed in full entrance of the trawl. It starts at the head rope behind the beam and is connected to the ground rope. Only organisms smaller than the mesh size of the sieve mat can pass the trawl, all other catch is directed to pass under the trawl. The advantage of this panel appears when the conventional sieve net is clogged with macro algae, the sieve mat will be cleaned without a labour-intensive manual cleaning process. Trials have been in with and without the presence of macro algae with better performance for the sieve mat with the abundant macro algae.

Small shrimp grid vertical bars: An inclined grid with vertical 6 mm spaced bars to reduce catches of small shrimp have been tested on a commercial vessel. During the trial the grid was combined with a sieve-net to reduce catches of large unwanted bycatch that potentially clog the grid. The combination of both re-duced the waterflow in the aft part of the trawl and resulted in catch losses through the escape hole of the sieve-net.

Straight rolling bobbins in U-shaped bobbin rope: A new bobbin based on an older concept has been developed and tested. The bobbins in the U-shaped rope are all aligned with the towing direction of the vessel. Due to the reduced drag and digging of the bobbins, cleaner catches were achieved with minor losses of marketable shrimp. Mainly catches of debris reduced.

Wing bobbins with plate ground rope: Why using a bobbin rope to catch shrimp? A Dutch fisher developed steel wing bobbins as an alternative for conventional bobbins. Due to downward pressure of their spoiler shape of the wing bobbins they pushed against the seabed. Initial design was tested in a tow-tank, followed by a 1-day sea trail combined with a plate ground rope. The results showed increased caches of both shrimp and debris. The additional catches of debris were problematic; therefore, no follow-up tails have been performed.

Horizontal V-shaped grid: A double horizontal positioned grid with 6mm bar spacing was positioned in a V-shape in the aft section of a commercial shrimp trawl. This innovation was aiming to reduce catches of un-dersized shrimp and flatfish. The sea trail on a commercial vessel showed reduced catches of undersized shrimp while maintaining all marketable shrimp catches. The fisher (and developer) was very positive about the grid performance and is aiming for further development.

Bump separation panel: This novel design aiming for cleaner shrimp catches included a from the top panel descending separation panel, combined with 'bumps' of netting with floatation on top that were connected to the lower panel. The idea was that those bumps would let shrimp jump through the separa-tion panel while all other by-catch was guided to an escape hole at the end of the separation pan-el. Unfortunately, this design did not result in the desired separation and severe catch losses were reported.

7.12.3.3 Project: StimTech

Project Full Title: New Stimulation Techniques for flatfish trawling

Project Timeframe: 2022 - 2025

Institution(s): Wageningen University, TU Delft, Wageningen Marine Research

Contact person: Johan van Leeuwen johan.vanleeuwen@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Common sole (*Solea solea*) and European plaice (*Pleuronectes platessa*) are two commercially exploited flatfish species targeted by beam trawl fisheries in the North Sea. Currently the best available tickler methods are electrical pulse fishing and mechanical stimulation by tickler chains or chain matrices. SimTech aims to develop an ecological and economic alternative fish-ing technique for flatfish fisheries. The technique should modify flatfish behaviour through the use of a combination of stimuli that prevent burrowing and encourage escape behaviour towards the net thereby improving the capture efficiency. This will be achieved in three steps: 1) Deter-mine the speed and distance swam during a startle response, the burrowing behaviour and achievable burrowing depth. 3) Expose the flatfish to various stimuli (physical, visual, auditory, and thermal) to determine the most optimal combination for altering swimming behaviour. 3) Develop a prototype of the new gear for tow tank experiments with fish.

7.12.3.4 Project: Gear innovation Sole fisheries

Project Full Title: Development of water spray gear for sole fisheries

Project Timeframe: 2022 – 2023

Institution(s): Wageningen Marine Research, Jaczon, De Nederlandse Vissersbond

Contact person: Pieke Molenaar pieke.molenaar@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: With the European ban on electrified (pulse) beam trawls there has been an increased effort to find environmental and economical alternatives for pulse and tickler chain beam trawling in the North Sea sole (*Solea solea*) fisheries. One of those, the innovative water spray gear, applies water jets to stimulate flatfish to leave the seabed and enter the trawl. The previous water spray project managed to catch 70% and 66% for sole and plaice compared to the pulse trawl gear. The current project continued the optimization of the water spray gear on several types of fishing grounds. Both square and round water spray application ground rope were developed. The gear was able to catch sufficient sole on the soft sediment fishing grounds but did not manage to catch suffi-cient on hard sandy bottom types. The fishing grounds where the gear was effective were mainly in British waters, however the British government did not allow experiments with this gear in their waters. As a large share of the Sole quota are captures in British water, the industry decided to stop the development of the water spray gear as it could only be used on a limited area (EU) area of their fishing grounds. To fish economically year-round there is a need for a gear that is accepted in both EU and British water. The current project will focus on alternative tickler meth-ods that are allowed in both waters. Trials in 2023 mainly will focus on the optimization of catch efficiency and fuel use of rubber strand and 'twister' tickler gears.

7.12.3.5 Project: Improving discard quantification on commercial fishing vessels

Project Full Title: Improving discard quantification on commercial fishing vessels: Discard valves, load cells and old-fashioned estimations.

Project Timeframe: January 2022 – December 2022

Institution(s): Wageningen Marine Research

Contact person: Allard van Mens, allard.vanmens@wur.nl

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: We want measurements, not estimates! The aim of this project was to provide multiple technical solutions for highly accurate measurements of total catch and discard quantities onboard com-mercial beam trawl fishing vessels that are participating in gear technology innovation trials and discards monitoring programs in the Dutch North Sea. For these programs, amounts of discards are usually calculated by subtracting landings (i.e. marketable fish) from the total catch (i.e. all fish caught in the net). The total catch is usually inferred through an estimation of the haul weight by skipper/researchers (i.e. optical estimations). The composition of discards is rendered by taking a discard subsample, weighing it and sorting it to species level. These species are then individually measured for length and weighed collectively. This way, with a ratio of estimated discards weight to the discard subsample weight, the composition of all discards is estimated. This method has been criticized by fishermen and scientists alike for being imprecise due to the visual estimation of the total catch.

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

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

7.12.3.6 Project: Stunning Fish at Sea

Project Full Title: Operationalize stunning of captured fish at sea: make provisions to ensure improved welfare

Project Timeframe: March 2021 – December 2024

Institution(s): Wageningen Livestock Research, Wageningen Marine Research, Good Fish, Fish Management Systems Ltd, Wageningen Economic Research, MDV-beheer B.V. and Stichting Prosea Marine Education.

Management team: MDV-beheer B.V., Wageningen Livestock Research and Good Fish

Contact person: Hans van de Vis PhD, hans.vandevis@wur.nl

Link(s): Stunning captured wild sea fish for better animal welfare - WUR

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Due to societal developments, there is a need for the fishing industry to become more sustainable with regard to technologies used on-board to process captured fish. Animal welfare is one of the themes of sustainability. Discomfort caused by processing of live fish on-board can be mini-mized by stunning fish prior to killing them. Stunning is rendering fish unconscious and insen-sible without avoidable discomfort. Insensibility is required to avoid that unconscious fish can be aroused. Contrary to publications in various media in the Netherlands, electrical stunning of captured sea fish, such as plaice, it not ready for use on board of a fishing vessel.

An inventory study in 2018 among Dutch consumers suggests that 72% of the respondents be-lieve that the welfare of fish should be safeguarded in the same vein as other food animals. The inventory study also showed a possible willingness to pay 20% more as a premium price for such a fish product.

Given the fact that demersal fish are the major target species the Netherlands fishing cutters, we decided to focus our research on this type of fisheries. Plaice (*Pleuronectes platessa*) and turbot (*Scophthalmus maximus*) are economically important species and, therefore, these species have been selected for our proposed project. To improve welfare of these fish species at slaughter on board we aim to: 1) operationalize stunning of captured plaice and turbot prior to killing them; 2) to ensure that the product originates from a vessel that has put stunning of the fish species into practice by assurance of the supply chain; 3) assist consumers to make an informed choice with regard to fish that was stunned prior to killing on board and a regular sea fish product by the use of for instance the *VISwijzer* (Fish Guide) App on a mobile phone; 4) perform an inventory study to assess possibilities to valorise sea fish products that originate from a fishing vessel that stuns fish on board prior to killing them; and 5) contribute to support by stakeholders regarding fish welfare at slaughter and to disseminate our results for use in education and utilization on board. We envisage that our contribution to support by stakeholders together with the activities for dis-semination are needed to make our project a blueprint for fishing companies that are not part of our consortium.

7.12.3.7 Project: GoPro Downrigger

Project Full Title: GoPro Downrigger for Species identification pelagic schooling fish

Project Timeframe: 2022 – 2023

Institution(s): Wageningen Marine Research, PFA

Contact person: Pieke Molenaar pieke.molenaar@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Commercial pelagic fisheries locate pelagic schooling fish with sophisticated echo sounding techniques. Those may locate fish school in a range up to 3 kilometre around the vessel. However, when a school is detected in some cases it cannot be determined what species are pre-sent. The skipper of a pelagic trawler may decide to perform an experimental short haul to assess species and composition, leading to substantial unwanted catches is case it appeared to be the wrong species. We developed a cost-efficient quick tool that can be deployed and towed through pelagic schools up to 200 meters depth. Within several minutes the skipper knows the species and is able to avoid unwanted catches. The tool has been successfully implemented on trawlers resulting in reduced unwanted catches with some by-catch of interesting underwater recordings.

7.12.3.8 Project: MASENRO 2.0

Project Full Title: Under water (flat)fish detection and species recognition

Project Timeframe: 2022 – 2025

Institution(s): Wageningen Marine Research, Visserij Innovatiecentrum Zuid West Nederland, Wageningen University, Vissersvereniging Zuid west Nederland

Contact person: Pieke Molenaar pieke.molenaar@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project aims to develop methods for automatic species recognition, individual counts and length detection of (flat)fish on the seabed and inside trawls. First steps for fish tracking and species recognition are performed with existing underwater footage with a wide range of species from North Sea and English Channel flyshoot fisheries. If species recognition is successful, the project investigates the possibilities for under water species selection and release. Future devel-opments will include video observations of several flatfish species (sole, plaice, turbot) in a tank environment to train automatic detection software and application on seabed video collected from commercial trawls.

7.12.3.9 Project: OSW 2.2: Norway Lobster

Project Full Title: Doorontwikkeling van een state-of-the-art monitoring programma Noorse kreeft (OSW 2.2)

Project Timeframe: 2018 – 2023

Institution(s): Wageningen Marine Research, Nederlandse Vissersbond, VisNed

Contact person: Lobke Jurrius lobke.jurrius@wur.nl

Link(s): https://www.wur.nl/nl/onderzoek-resultaten/onderzoeksinstituten/marine-research/themas/visserij-in-transitie/onderzoekssamenwerking-met-vissers/noorse-kreeft-langoustine.htm

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project "*Doorontwikkeling van een state-of-the-art monitoring programma Noorse kreeft (OSW 2.2)*" (translates to: Further development of a state-of-the-art monitoring program Norway lobster) aims to develop an internationally accepted sampling program for the Norway lobster trawl fishery. The aim is to improve (through independently validated self-sampling by fishermen and calibrated sea state compensated load cells to measure catch quantities) the data base and stock assessment for the data-poor stocks of Norway lobster in the North Sea by ICES.

The so-called Fully-Catch-Monitored (FCM) system was developed and tested as a 'pilot' in an earlier EFMZV project Research Collaboration 2.0 (OSW 2.0). After testing with international scientists within ICES, it emerged that various adjustments were still necessary regarding the development of the FCM system. Within OSW 2.2, a better spatial distribution of catch data is being created by expanding the FCM reference fleet of fishermen. Alternative monitoring methods are being developed to obtain randomization in sampling to allow more fishermen to participate in data collection. Active feedback to fishermen will improve their own understanding of catch composition, directly benefiting their operations. At the same time, they contribute to stock management by collaborating to provide better data for stock estimates.

OSW 2.2 is a collaboration between Wageningen Marine Research, the Dutch Fishermen's Union and VisNed, and active fishermen affiliated with them. The use of an innovative monitoring program and active feedback to participating Dutch Norwegian lobster fishermen contributes to improving the data base and stock assessment and also sustainable management of Norwegian lobster stocks in the North Sea.

7.12.3.10 Project: Selectivity & survival

Project Full Title: Research collaboration on reducing under sized by-catch mortality

Project Timeframe: 2019 – September 2023

Institution(s): Wageningen Marine Research, VisNed, Nederlandse Vissersbond

Contact person: Edward Schram Edward.schram@wur.nl

Link(s): https://www.wur.nl/web/nl/project/flyshoot-in-beeld.htm

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project aims to develop and test gear innovations aimed at reducing fisheries mortality among undersized fish by either avoid that they are caught (increased selectivity) or increasing their survival probability when discarded. Main focus of this project is on bycatches of plaice in beam trawling for sole and quad-rig otter trawls for Norwegian lobsters and by-catches of whit-ing in flyshoot fisheries. The main gear innovations tested are summarized in Table 7.1.

Table 7.1: Summary of gear innovations

Name	Aim	Mechanism	Status	Results	Future
Speed-bump panel	Reduce bycatch of undersized plaice in beam trawl fisheries BT2 targeting sole	Separation of plaice and sole by a horizontal panel equipped with waterflow modifying bumps and es-cape holes, separation based on differences in es-cape behaviour.	Ongoing	Proof of principle established in lab trails	Testing in full scale in beam trawl fishery
MHS	Increase discards survival probability of undersized plaice in beam trawl fishery BT2 targeting sole	The MHS is basically a 'bag of water' cod-end. In the section before the actual cod-end, a graded water flow inside is achieved with strategically posi-tioned and sized escape-ment ports along the length of the cod-end to allow water and undersize	Ongoing	Two trails at sea with beam trawlers with 4m and 12m wide gears showed much improved condition of dis-cards (proxy for higher survival) while landings	Further opera-tional refine-ment. Discards sur-vival measure-ments MHS vs. conventional

		catch to escape. The actual cod-end is a closed bag which allows the lifting of the fish on board while in water, minimizing the physical strain on the fish.		equalled the conventional gear.	beam trawl BT2 gear.
Rubber strands	Selective and low impact stimulation of sole for beam trawl BT2 fisheries, resulting in increased discards survival probabilities for mainly plaice and reduced bycatches of undersized plaice.	Reduced mechanical impact should result in higher discards survival.	Completed	Landings were lower or comparable to the conventional BT2 gear depending on the type of seafloor / fishing ground. Fuel consumption required to tow the gear was reduced with the lower towing speed. Condition of discards caught with rubber strands was slightly better, indicating a slightly higher discards survival probability.	Discontinued
Swedish grid	Reduce bycatch of undersized flatfish in Norwegian lobster fisheries while retaining the marketable fish bycatch.	Sorting grid separating lobsters from fish, leading fish to a second, larger meshed cod-end.	Completed	Among others: 70% reduction of by-catch of undersized plaice but also some loss in lobster landings.	Legalization
Flyshoot	Gain insight in species specific behaviour as knowledge base for developing escape routes	Utilize differences in fish behaviour related to the different stages and speeds of the flyshoot fishing technique	Ongoing	Under water footage collected	Develop selectivity measures

7.12.3.11 Project: Sharks & Rays

Project Full Title: Bridging knowledge gaps for sharks and rays in the North Sea.

Project Timeframe: January 2021 – January 2023

Institution(s): Wageningen Marine Research, Nederlandse Vissersbond, Cooperatie Kottervisserij Nederland (VisNed), Visserij-innovatie Centrum Zuidwest Nederland, Wageningen University.

Contact person: Edward Schram Edward.schram@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project addresses the following research questions:

- What are the survival chances of rays that are released into the sea after being caught by the Dutch demersal beam trawl and flyshoot fisheries?
- What is the life cycle of demersal sharks and rays in the North Sea and what are the roles of the North Sea and the Dutch coastal zone in these life cycles and what factors influence their spatial dynamics and distribution?

To address the first research question, discards survival will be measured by captive observation of rays collected from commercial demersal fisheries, 4 trips were done on a large tickler chain beam trawler, and 4 trips were performed at a flyshoot trawler. Survival probabilities were estimated for thornback and spotted rays during 3 weeks captive observation experiments.

To address the second research question the following research is performed:

- Use of tags to map the individual migration patterns of rays. These individual migration patterns shed light on the distribution at the population level.
- At population level, an attempt is be made to map the distribution of the ray pop-ulations and the possible genetic subpopulations in the North Sea.
- A more detailed analysis of catch data from surveys and commercial vessels, by modelling CPUE data to map abundance hotspots or by processing fishery-dependent data as input for stock assessments.

7.12.3.12 Project: FDF

Project Full Title: Fully Documented Fisheries

Project Timeframe: January 2019 – October 2023

Institution(s): Wageningen Marine Research, Cooperatie Kottervisserij Nederland (VisNed), Wa-geningen Plant Research, Wageningen University.

Contact person: Jurgen Batsleer, jurgen.batsleer@wur.nl

Link(s): -

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project aims at the development of an electronic monitoring (EM) system that enables the implementation of fully documented fisheries FDF for the Dutch beam trawl fishery (BT2 segment). The two main goals within the research are:

- Improving and adapting the current EM set-up, both technical and process-related, so that the total catch per type of a fishing trip in the BT2 segment can be fully registered.
- Automation of the EM data review process using of automatic image recognition ("computer vision" technology).

Commercial vessels are equipped with EM systems and the performance is continuously assessed in an iterative process. Results of different video analysis protocols are compared to 'ground truths' obtained by observer trips. New computer vision technologies are being developed and tested on board.

7.12.4 Future projects and Ideas

7.12.4.1 Project: Development passive brown shrimp fisheries

Project Full Title: Development of passive brown shrimp fishery in the Dutch Wadden sea

Estimated Project Timeframe: September 2023 – September 2025

Institution(s): Wageningen Marine Research

Contact person: Pieke Molenaar; pieke.molenaar@wur.nl

Link(s): -

Collaboration welcome? Yes

Funding secured? No

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Brown shrimp (*Crangon crangon*) beam trawl fisheries in Dutch coastal waters are facing econom-ic and ecological sustainability issues. Government, NGO's and society are demanding more sustainable brown shrimp fisheries for the future, and should aim for lower carbon emissions, minor unwanted bycatches and decreased bottom impact. This requires innovative fishery prac-tices, may be achieved with the transition from active gear to passive fishing gears. Two possible options for passive brown shrimp fishing gears are stow net and pots. Both methods have been used in the area in the past but not to catch brown shrimps. This project investigates whether those methods offer an economically and environmentally alternative, and focusses on a year-round field trial and optimalisation for both methods. Those trials will give insight in the catch efficiency, fuel consumption and economic viability. The results feed into an economic model that calculates or, and on what scale both methods can offer an acceptable economic alternative for the current brown shrimp beam trawl fishery.

7.13 Norway

7.13.1 Contact person

- Roger B Larsen, UiT the Arctic University of Norway, roger.larsen@uit.no
- Svein Løkkeborg, Institute of Marine Research, svein.lokkeborg@hi.no

7.13.2 Summary

- SFI Dsolve (2020-2028)
- SFI HARVEST (2020-2028)
- AFO-JIGG – Service design thinking to improve welfare and product quality in the Norwegian small-scale fishing fleet (2021-2024).
- FUTURES4Fish – Adaptive socio-technological solutions for Norwegian fisheries and aquaculture (2022-2026)
- NOR-LANKA BLUE (2019-2023), a research and education network in fisheries, aquaculture and aquatic sciences.
- Alternative materials to replace plastics used in seine ropes and dolly-ropes (Alternative materialer til plast som er brukt til snurrevadtau og trålmatter) (2021-2023).
- Selectivity in pelagic and industrial trawls (Utvikling av effektive seleksjonssystem i pelagisk- og industritrål) (2021-2023).
- EthiCatch Fish welfare, ethics, quality and added value in coastal fisheries (Fiskevelferd, etikk, kvalitet og økt verdi i kystfiskeriene) (2020-2022).
- Catch limitation in the blue whiting pelagic trawl fishery (2019-2025)
- Selection in the demersal seine haddock fishery (2021-2025)
- Catch and live storage of flatfish by the use of species selective demersal seine (2022-2024)
- Snowcrab fishing gear technology (2017-2023)
- By-catch of seabirds in coastal purse seine fisheries – magnitude and mitigation measures (2022-2024)
- Identification and testing methods to reduce interactions between fisheries and whales (2021-2023)
- WP3 ground truthing methods for acoustic data in the CRIMAC center for research-based innovation (2020-2028)
- Development of selectivity systems for gadoid trawls (2020-2023)
- Sustainable catch and live storage of bluefin tuna in Norway

7.13.3 Projects

7.13.3.1 Project: SFI Dsolve

Project Full Title: Centre for Research-based Innovation – Biodegradable plastics for marine applications (Dsolve).

Project Timeframe: November 2020 – November 2028

Institution(s): UiT The Arctic University of Norway, NORNER Research AS, SINTEF Industry AS, SINTEF Ocean AS, NORSUS AS, DTU Aqua, Thünnen Instituite of Baltic Sea Fisheries, University of Croatia, LG Chem, S-Enpol, NOFI Tromsø AS, Mørenot Fishery AS, Løvold AS, Mustad Autoline, Øra AS, Tystern AS, Legøy Rederi AS, Martin Solhaug AS, Opilio AS, Loran AS, Kvarøy Fiskeroppdrett AS.

Contact person: Roger Larsen, roger.larsen@uit.no ; Eduardo Grimaldo, eduardo.grimaldo@sintef.no ; Hanne Risan Johnsen, hanne.r.johnsen@uit.no

Link(s): https://uit.no/research/dsolve-en

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: The SFI DSolve addresses the problems associated with marine plastic litter (macro/microplastics and ghost fishing) caused by the fishery and aquaculture sectors. The negative environmental- and socio-economic impacts can be significantly reduced if traditional plastics in these sectors are replaced with new biodegradable materials. The goal of this SFI is to develop technologies and new products, improve the governance framework, and foster innovations that enable the plastic value chains to become more circular and resource-efficient in order to reduce their carbon and greenhouse gas footprints so that they are in line with climate, energy, and sustainable development goals (UN SDG 9, 12, 14). A highly qualified interdisciplinary consortium has been assembled to meet the SFI objectives. The consortium represents different disciplines and consists of a leading Norwegian university, research institutions, fishing and aquaculture companies, gear suppliers, industrial organiza-tions, public management authorities, and NGOs. The SFI will be supported by key R&D institutions from the EU and a leading global polymer producer from South Korea (Part 3, Section 8). This international support will help maximize dissemination and exploitation of the project results and expand the market potential for new innovations. Results of this SFI will directly strengthen scientific knowledge, build up research capacity, and secure good management processes and sustainable value creation based on marine resources through innovation projects for the industrial sector.

7.13.3.2 Project: SFI HARVEST

Project Full Title: Centre for Research-Based Innovation: Technologies for sustainable biomarine value creation (SFI HARVEST)

Project Timeframe: November 2020 – November 2028

Institution(s): SINTEF Ocean AS, SINTEF Digital AS, UiT The Arctic University of Norway, Norwegian University of Science and Technology, The Norwegian University of Life Sciences, NOFIMA, Aker Bi-omarin AS, Br. Birkeland AS, Skretting AS, Nordnes AS, Optimar AS, Konsberg Maritime Subsea AS.

Contact person: Ingunn Marie Holmen, Ingunn.Holmen@sintef.no ; Eduardo Grimaldo, eduardo.grimaldo@sintef.no ; Roger Larsen, roger.larsen@uit.no

Link(s): https://sfiharvest.no/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project is aimed at developing knowledge and technologies for responsible harvesting and processing of lower trophic marine resources, allowing sustainable growth of Norway's biomarine industries. SFI Harvest brings together pioneering shipowners, key technology providers, large producers of raw materials and feed for the aquaculture sector, stakeholders, SINTEF Ocean and other strong re-search groups, including AMOS (the Norwegian Centre of Excellence for Autonomous Marine Operations and Systems). The innovations will enable precise and efficient capture and processing of meso-pelagic species, zooplankton and phytoplankton. The project research areas (RA) are: RA1. Develop technology for autonomous vehicles and sensor systems to support mapping and monitoring of un-derexploited marine resources. RA2. Understand and predict ecosystem dynamics to provide information and knowledge needed for sustainable fisheries management and harvesting. RA3. Develop decision support systems combining ecosystem models and collected data on the marine resources, enabling energy efficient precision fishing. RA4. Develop cost-efficient and environmentally friendly harvesting and onboard processing technologies. RA5. Develop sustainable products through cost and energy efficient processes for on-land processing followed by market introduction. RA6. Design guide-lines for responsible management regimes and construct sustainable business models.

7.13.3.3 Project: AFO-JIGG.

Project Full Title: AFO-JIGG – Service design thinking to improve welfare and product quality in the Norwegian small-scale fishing fleet

Project Timeframe: 2021 –2024

Institution(s): UiT The Arctic University of Norway

Contact persons: Melania Borit, Melania.borit@uit.no , Jorge Santos, Jorge.santos@uit.no , Roger Larsen, roger.larsen@uit.no

Link(s): https://en.uit.no/project/afo-jigg

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The AFO-JIGG project uses the lenses of service design and futures thinking to look at multiple aspects of the Norwegian jigging fishery, from the sea and into the supply chain. Three PhD students and three internship students are attached to the programme.

In Norway, the number of fatalities among fishers in the small-scale fleet (SSF) is about five times larger than in the larger coastal vessels and nearly 20 times larger than in the deep sea fishing vessels. The main reason for fatalities involves drowning after vessel disasters, but man-overboard events and drowning in port are also relevant causes. Although there is a need to re-enforce the "safety culture" in this segment, there is a scope to utilize latest developments in Artificial Intelligence (AI) and service-design thinking with the ambition of creating a safer and healthier environment in the Norwegian jigging fleet, of lowering its ecological footprint, and improving the product quality and economic return to the fishery and coastal society. AFO-JIGG will explore this along two integrated lines of investigation. One line will perform a work (boat and human) and product (fish) flow analysis, to evaluate what operations can be optimized from a human and fish welfare perspective, and what operations can be autonomised or optimized to ensure delivery of a high quality product in a sustainable way. The other line of research will look at the competences of the present work force, skills required in the future and the acceptance by fishers and society at large of the new technology. Automatization of certain tasks, including navigation and fish handling, may raise legal and ethical issues that must be taken into consideration at early stages of development. AFO-JIGG integrates interdisciplinary insight from environmental, technological, social, and ethical perspectives. The emphasis on the SSF of northern Norway attempts to mitigate the general lack of R,D&I in this sector and builds on the consensual political support for this fleet. At a time when the maritime industry is facing a technological revolution with the introduction of autonomous vessels and services, there is a window of oppor-tunity to improve and modernize conditions in the jigging fleet.

7.13.3.4 Project: FUTURES4Fish

Project Full Title: FUTURES4Fish: Adaptive socio-technological solutions for Norwegian fisheries and aquaculture

Project Timeframe: 2022-2026

Institution(s): UiT The Arctic University of Norway,

Contact persons: Melania Borit, Melania.borit@uit.no , Jorge Santos, Jorge.santos@uit.no , Roger Larsen, roger.larsen@uit.no

Link(s): https://en.uit.no/project/f4f

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: With an expectable 'end of oil', fisheries and aquaculture (F&A) may soon become Norway's leading export industry with a green profile. However, the impact of trends such as high start-up cost, veganism, synthetic fish, use of next-generation technologies on the F&A industry, individ-uals, local communities, society, and the environment has not been assessed until now and no coping strategies have been designed for possible disruptive events (e.g. untreatable salmon dis-ease; confrontation or nuclear accident in the Barents Sea; market lockdown). We suggest that, right now, there is a window-of-opportunity for the development of socially & environmentally responsible next-generation technologies and associated practices of marine resource extraction, within the wider vision of possible, probable, and desirable futures. Right now it is the moment to empower the imagination of F&A stakeholders and enhance their ability to prepare, recover, and invent as changes occur in an industry that has to become better at dealing with the un-known and unpredictable, or the unlikely but possible. FUTURES4Fish will contribute to avoiding path dependence and socio-technical lock-in in a domain where technological development not seldom had negative consequences. To co-design and prototype effective and sustainable solutions, we will use an interdisciplinary methodology, latest developments in next-generation technology, and the most recent techniques in creative thinking and strategic foresight. Our vi-sion is to contribute to an adaptive F&A industry in Norway that is both successful and benign. The main output of the project is the CRAFT Toolbox of Knowledge Integration for Blue Futures, which provide stakeholders (fishers, aquaculture farmers, school students, scientists, policy makers etc.) with the competence to develop and practice the ability to imagine and prepare for change and disruptive events in fisheries and aquaculture.

7.13.3.5 Project: NOR-LANKA BLUE

Project Timeframe: 2019-2023

Institution(s): UiT The Arctic University of Norway

Contact persons: Melania Borit, Melania.borit@uit.no , Jorge Santos, Jorge.santos@uit.no , Roger Larsen, roger.larsen@uit.no

Link(s): https://blue2023.weebly.com/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: NOR-LANKA BLUE is an innovative research and education network in fisheries, aquaculture and aquatic sciences. The project was established by a team of researchers from

Norway and Sri Lanka. BLUE will foster research and educational exchange, as well as industry linkages, through both direct project involvement and policy mechanisms. The BLUE initiative formalizes nearly 40 years of educa-tion and research cooperation between the University of Tromsø (UiT) and Sri Lanka. The coordinating organization is the Faculty of Biosciences, fisheries and economics (BFE) of the UiT. The lead partner in Sri Lanka is the University of Ruhuna (UoR), which will coordinate with the University of Jaffna (UoJ) and the National Aquatic Research Agency (NARA), ensuring unprecedented national net-working.

7.13.3.6 Project: Selectivity in pelagic and industrial trawls (Utvikling av effek-tive seleksjonssystem i pelagisk- og industritrål) (2021-2023).

Project Full Title: Selectivity in pelagic and industrial trawls

Project Timeframe: February 2021 – December 2022

Institution(s): SINTEF Ocean AS, Institute of Marine Research (Norway), UiT The Arctic Universi-ty of Norway

Contact persons: Eduardo Grimaldo, eduardo.grimaldo@sintef.no ; Bent Herrmann, bent.herrmann@sintef.no ; Shale Rosen, shale.rosen@imr.no ; Manu Sistaga, manu.sistiaga@hi.no ; Olafur Ingolfsson, Olafur.imgolfsson@hi.no ; Terje Jørgensen, terje.jorgensen@hi.no ; Roger Larsen, roger.larsen@uit.no ; Jesse Brinkhof, jesse.brinkhof@uit.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901634/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The bycatch of demersal fish, tunas and various shark species is a growing problem in pelagic and industrial trawling. Most shark species are red-listed and should therefore be selected gently during towing. Lack of a technically well-functioning solution for species selectivity is missing. This project will develop knowledge and technology that can help reduce unwanted bycatch in pelagic and industrial trawls. This project will focus on solid and flexible selection systems, with a special focus on excluder devices.

7.13.3.7 Project: Alternative materials to replace plastics used in seine ropes and dolly-ropes (Alternative materialer til plast som er brukt til snurrevadtau og trålmatter) (2021-2023).

Project Full Title: Alternative materials to replace plastics used in seine ropes and dolly-ropes

Project Timeframe: February 2021 – December 2022

Institution(s): SINTEF Ocean AS, UiT The Arctic University of Norway, SALT Lofoten AS

Contact person: Eduardo Grimaldo, eduardo.grimaldo@sintef.no ; Heidi Moe Føre, heidi.moe.fore@sintef.no ; Bent Herrmann, bent.herrmann@sintef.no ; Jørgen Vollstad, Jorgen.vollstad@sintef.no ; Hilde Rødås Johnsen, hilde@salt.nu , Carl Højman, carl@salt.nu ; Roger Larsen, roger.larsen@uit.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901669/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: In 2020, the Norwegian Directorate of Fisheries estimated that approximately 200 tonnes of plas-tic fragments are produced annually and left at sea by the use and wear of fishing gears. Of all fishing gear related sources, seine ropes and dolly-ropes are estimated to be creating most of pollution, producing 100 and 40 tonnes of microplastics annually, respectively. The main goal of this project is to find alternative materials for replacing the plastics used in seine ropes and dol-ly-ropes. Sub-goals are to: conduct workshops with relevant actors for obtaining proposals / in-put for a solution regarding alternative materials; carry out material testing in controlled conditions; obtain estimates of wear from various plastic materials and other relevant materials; carry out small-scale and full-scale experiments on board fishing vessels; document operational properties of new alternative materials; study the life cycle and value chain of seine ropes and new alternative materials; and assess the cost and financial consequences of various measures and alternative materials (i.e., for current rope material and new alternative materials).

7.13.3.8 Project: EthiCatch Fish welfare, ethics, quality and added value in coastal fisheries (Fiskevelferd, etikk, kvalitet og økt verdi i kystfiskeri-ene) (2021-2024).

Project Full Title: EthiCatch Fish welfare, ethics, quality and enhanced value creation in coastal fisheries

Project Timeframe: January 2020 – December 2022

Institution(s): NOFIMA AS, UiT The Arctic University of Norway

Contact persons: Silje Kristoffersen, Silje.kristoffersen@nofima.no ; Geir Sogn-Grundvåg, geir.sogn-grundvag@nofima.no ; Jesse Brinkhof, jesse.brinkhof@uit.no

Link(s): https://nofima.com/projects/ethicatch

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: During this project, we will be identifying how the use of various types of commercial fishing gear affect the physiology and mortality of cod and thus their welfare and quality. We will also be investigating the links between ethical fishing, quality and price. This subject affects fisher-men, the fish processing industry, sales and producer organisations, the authorities and con-sumers. We will also be developing new knowledge about how fish react to the catch process based on their physiology and behaviour in controlled laboratory experiments. We will also investigate if there is a connection between the behaviour and quality of cod by monitoring the blood content in fillets, the properties of fillets, production yields and shelf-life. We will also investigate if it is possible to improve the welfare and quality of cod during catch and thus increase the opportunities which exist in processing for a higher share of valuable products. In this way it may be possible to gain several benefits in respect of sustainability: all fish which is caught is taken ashore and has a higher quality. The amount of food wasted would also be reduced. This would help to strengthen the white fish industry and improve the economic aspects of the entire value chain.

7.13.3.9 Project: Catch limitation in the blue whiting pelagic trawl fishery

Project Full Title: Catch limitation in the blue whiting pelagic trawl fishery

Project Timeframe: Jan 2019 – Jun 2025

Institution(s): IMR, Norwegian Directorate of Fisheries

Contact person: Ólafur A. Ingólfsson, olafur@hi.no

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In the pelagic fishery for blue whiting (*Micromesistius poutassou*), catches are usually measured in hundreds of tonnes. There have been frequent incidents of burstet codends and it is difficult to fill the vessels accurately. The main objectives in the project are thus to develop and implement a catch limitation device to set a maximum capacity for the codend. A device was tested, with large meshes in the bottom panel in front of the codend and smaller openings in top and bottom. A fish lock is mounted behind the large openings to avoid spillage of fish during haulback. The codend is choked to determine its maximum volume, and automatic releaser fittet to release the choking during ascent, adjusted to release at 100-150 m depths (Figure 7.50).

The solution proved to be successful, with negligible loss of fish before the codend was full. Two types of releasers were tested, one electronic and one mechanical. Both were fully functional but some issues with the prototypes need to be addressed to secure consistent release. The fish lock also needs some considerations.

Results are published in 2022 (https://www.frontiersin.org/articles/10.3389/fmars.2022.1011862/full).

Two cruises with commercial vessels will be conducted in 2023 and three are planned in 2024.

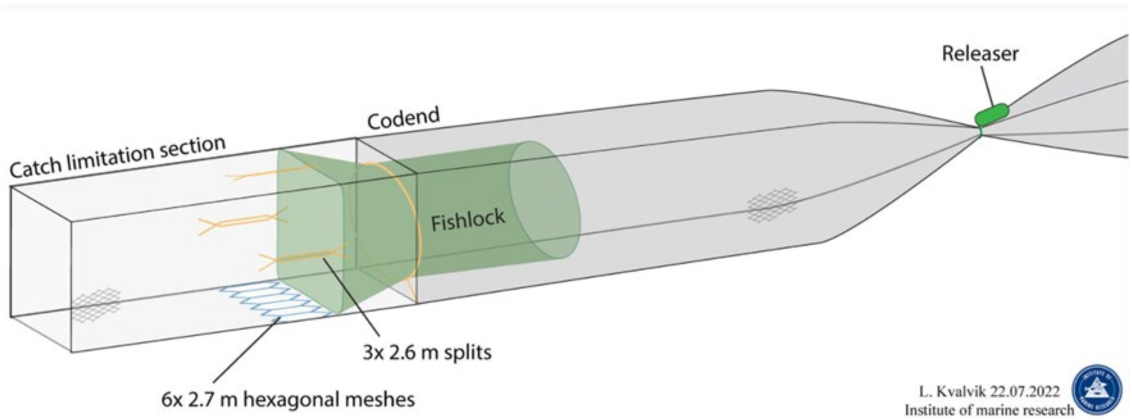


Figure 7.50: The catch release system illustrated. Catch limitation section with openings and fish lock. Codend releaser for choking the codend to set a maximum desired volume.

7.13.3.10 Project: Selection in the demersal seine haddock fishery

Project Full Title: Selection in the demersal seine haddock fishery

Project Timeframe: Jan 2021 – Jun 2025

Institution(s): IMR, Norwegian Directorate of Fisheries

Contact person: Ólafur A. Ingólfsson, olafur@hi.no

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In the Norwegian demersal seine fishery for haddock, size selection is considered unsatisfactory and great proportion of escaping juveniles do so at the surface. The project aim is mainly to doc-ument the situation and suggest technical solutions for selection to take place at the bottom.

The vessels usually use codend extensions in front of a square mesh codend, measured in tens of metres. The extensions are narrow and inhibit fish passage to the codend. Removing those exten-sions has resulted in increased selection at depth and considerably less catches of undersized haddock and cod. A drawback is that when catch rates are high, great proportion of haddock are pinned in the meshes (enmeshed). Using square mesh extensions instead of diamond mesh was then tested, with mesh diameters of 7.5 and 12 mm. Using the square mesh extensions shifts the (relative) selection curve a little to the left, compared to removing the extensions altogether, but is a significant improvement compared to diamond mesh extensions. For some reason, significant-ly less fish were pinned in the meshes when the square mesh extension was used. Constructing the square mesh extension and codend of 12 mm twine instead of 7,5 mm results in significantly "poorer" selection (greater retention of undersized fish).

The minimum legal size is set at 40 cm, and great proportion of the fishable stock has lengths of 40-50 cm. Minimizing retention of fish below 40 cm causes considerable catch losses if the diamond mesh extensions are banished.

Experiments will continue in 2023 and 2024 and aim at obtaining sharper selection (narrowing the selection range). As a part of the project, the effect of varying size selection pattern on stock development will be modelled.

7.13.3.11 Project: Catching efficiency and species selectivity in the demersal seine fishery for flatfish

Project Full Title: Catch and live storage of flatfish by the use of species selective demersal seine

Project Timeframe: Jan 2022 – Jun 2024

Institution(s): IMR, Nofima

Contact person: Ólafur A. Ingólfsson, olafur@hi.no

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: A demersal seine with low opening has been developed and tested for the flatfish fishery to avoid catches of cod and haddock. The herding effects of the seine ropes are known and utilized in the flatfish fisheries, but the seine wings and footrope are often of great lengths. We tested a low opening demersal seine, fishing alternatively with 50 and 10 m ground rope lengths by adding and removing 20 m wings to a 10 m wide seine.

Total catches with the longer wing length tended to be larger (by 13%) than the small wing length. This difference was, however, not statistically significant. Otherwise, the importance of wing length to catches for individual species varied. For the same total catch, lower amounts of European plaice, European flounder, lemon sole and thorny skate were caught with the longer wings. For the largest catches of each wing type, these differences amounted to 46, 7, 2.8 and 0.2 less individuals caught, respectively. These effects were either non-significant (thorny skate) or only marginally significant (European flounder and lemon sole). In the case of European plaice, a marginally significant interaction with total catch size was evident. With smaller catches, any

differences between wing types for these species became increasingly negligible. For Atlantic halibut, longer wings resulted in a significant mean increase of 1.2 individuals per haul.

7.13.3.12 Project: Snowcrab fishing gear technology

Project Full Title: Snowcrab fishing gear technology

Project Timeframe: January 2017- March 2023

Institution(s): Institute of Marine Research

Contact person: Odd-Børre Humborstad, oddb@hi.no , Svein Løkkeborg, sveinl@hi.no , Terje Jørgensen, terje.joergensen@hi.no , Neil Anders neil.anders@hi.no

Links: NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: "Snowcrab fishing gear technology" is an umbrella project in the Barents Sea snowcrab pot fish-ery, covering diverse aspects including the development of sampling gear, selectivity, survival of escapees/release, efficiency, bait research, ghost fishing and environmental impacts as the main focus areas. Experiments were conducted in the Barents Sea in June 2020-2022 to: evaluate the feasibility of reducing catches of undersized crab while maintaining commercial size catch rates through the use of rigid stadium shaped escape gaps and/or mesh size alteration; continue the development of a nonselective pot for stock assessment purposes, and; continue tests of "fishing gear finders" to be used on fishing grounds affected by fluctuating drift ice. In their current state, none of the efficiency/selectivity pot designs we tested optimized catches better than the currently used commercial design (*Anders et al, 2022*: https://doi.org/10.1016/j.fishres.2022.106517). Small-meshed sampling pots were equipped with closure mechanisms to ensure exact fishing times, regardless of soak time. Preliminary data suggests that large crab may escape small-meshed pots when catches increase, thus representing a conceptual problem as a sampling gear. Modification of fishing gear finders improved communication between vessel and gear unit, and a system called ICEcatcher is ready for commercial testing. Research on evaluating the feasibility of mounting biodegradable twines to prevent ghost-fishing in lost pots was initiated in 2020. Based on commercial sea trials in 2021 and 2022 testing different diameters of cotton thread, recom-mendations to the Directorate of Fisheries to introduce rot thread in the fishery were given. Rec-ommendations include not only braided biodegradable cotton thread diameter but also a maxi-mum weight in grams per 1000 meter, to compensate for how tight or loose the thread is braided https://www.hi.no/hi/nyheter/2022/desember/anbefaler-okning-i-snokrabbekvoten .

7.13.3.13 Project: By-catch of seabirds in purse seine fisheries

Project Full Title: By-catch of seabirds in coastal purse seine fisheries – magnitude and mitigation measures.

Project Timeframe: May 2022 – April 2024

Institution(s): Norwegian Institute for Nature Research (NINA) and Institute of Marine Research (IMR)

Contact person: Maria Tenningen, maria.tenningen@hi.no / Signe Christensen-Dalsgaard, Signe.Dalsgaard@nina.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901751/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project aims to get a better understanding of by-catch incidents of seabirds in the coastal purse seine fishery for Norwegian spring spawning herring. The aim is to estimate how often by-catch incidents occur, what the processes leading to by-catch are and to identify and test existing mitigations measures (e.g. light, sound, visual objects). The project started in May 2022 and we have now completed the first part of the planned field work (November 2022 – January 2023). The fisheries take place in the dark and there was a need to first test and develop monitoring methods. We used a combination of visual observations, light sensitive cameras and IR binocu-lars. In, addition we have collected data on bird-fishery interactions and registered by-catch inci-dents. In most of the observed purse seine catches there were large amounts of seagulls present and in a few of the catches birds were taken as by-catch. These incidents seemed to occur in the first days of the fishery. We are now in the process of analysing the data and will use the time until next winter and fishing season to refine the monitoring methods and decide on mitigation measures that will be tested.

7.13.3.14 Project: By-catch of whales in purse seine fisheries

Project Full Title: Identification and testing methods to reduce interactions between fisheries and whales.

Project Timeframe: July 2021 – June 2023

Institution(s): Institute of Marine Research, Arctic University of Norway and University of St. Andrews

Contact person: Maria Tenningen, maria.tenningen@hi.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901681/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: During winter a large part of the Norwegian spring spawning herring stock gather in the north-ern Norwegian fjords. The herring are targeted by the coastal purse seine fleet and attract large numbers of whales, mainly humpback and killer whales. The whales tend to aggregate around the fishing boats and feed on the herring escaping the nets. At times whales get entangled in the net, often leading to damaged nets that are costly and time consuming to repair and / or the whale may drown and die. This project aims to use sound to deter the whales from interacting with the fisheries. The aim is to test and develop sound that elicit the autonomous reflexes asso-ciated with the flight response. The first task was to tag killer and humpback whales and moni-tor their startle responses to different sound signals under controlled conditions. The second task was to expose whales to the species-specific sounds during commercial fishing. The preliminary results indicate that both killer and humpback whales show a startle response to the species-specific sounds. Killer whales also responded to the sound during commercial fishing, while we have not yet tested the sound system developed for humpback whales during commercial fish-ing. As part of the project, we also consider practical implementation of the sound systems to commercial fisheries.

7.13.3.15 Project: WP3 Ground truthing acoustic data (CRIMAC)

Project Full Title: WP3 ground truthing methods for acoustic data in the CRIMAC center for research-based innovation

Project Timeframe: November 2020 – November 2028 (depending on midway evaluation in 2024)

Institution(s): IMR, Kongsberg Maritime AS, Scantrol Deep Vision, Eros AS, Libas AS, university of Bergen

Contact person: Maria Tenningen, maria.tenningen@hi.no , Nils Olav Handegard, nilsolav@hi.no

Link(s): https://crimac.no/en/projects/crimac

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: CRIMAC is a center for research-based innovation that aims to improve and automate the inter-pretation of data and images from modern broadband acoustics in marine research and fisher-ies. The center has 6 work packages where WP3 "ground truthing methdos" aims to develop and implement techniques for identifying and measuring sources of broadband backscatter. The fo-cus is currently on further development of in-trawl camera systems including data processing and flow, implementation in routine fish stock surveys and development to commercial fisher-ies. We are also developing methods for monitoring mesopelagic species using combined acous-tic and optic tools. The work done is in close cooperation with the industry partners.

7.13.3.16 Project: Development of selectivity systems for gadoid trawls

Project Full Title: Development of selectivity systems for gadoid trawls

Project Timeframe: October 2020 – December 2023

Institution(s): Institute of Marine Research (IMR), Arctic University of Norway (UiT), SINTEF Ocean

Contact person: Manu Sistiaga, manu.sistiaga@hi.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901633/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project "Development of selectivity systems for gadoid trawls" aims at improving exploitation patterns of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) in the Norwegian Sea and Barents Sea bottom trawl fisheries. Between November 2021 and March 2021 three cruises were conducted on the commercial vessel M/Tr Hermes and the research vessel R/V Helmer Hanssen. These were carried out in the fishing grounds around Bear Island and around Sørøya, where in addition to cod and haddock, saithe can be abundant.

In the commercial cruise onboard M/Tr Hermes the size selectivity of a 55 mm sorting grid section (Sort-V type) was compared to that of an identical section with a bar spacing of 45 mm. The results showed that the size selectivity of the two sections is significantly different. The 45 mm grid retains in general significantly more fish over minimum legal size (MLS) but it may also retain more fish below MLS, which can become a challenging in areas with high juvenile densities. The data analysis evidenced the limitations of paired-gear analysis method.

In the first cruise onboard R/V Helmer Hanssen, a codend with 0, 15 and 30% shortened lastridge ropes was tested on cod, haddock, redfish and saithe. The results showed that while shortening the lastridge ropes by 15% can be beneficial for the size selectivity of these species, shortening them further to 30% can create issues regarding the fraction of fish that gets a chance to escape through the codend meshes. This issue is attributed to the potential folding in the codend netting panels created when lastridge ropes are excessively shortened.

During the second cruise onboard R/V Helmer Hanssen, the selectivity of saithe was evaluated using the FISHSELECT methodology, which determines if a fish can penetrate a certain mesh based on its morphology. In addition, trials conducted to determine the potential effect of red and white lights on size selectivity showed that lights, especially white lights, can have a significant negative effect on the size selectivity of haddock, redfish and saithe in sorting grids.

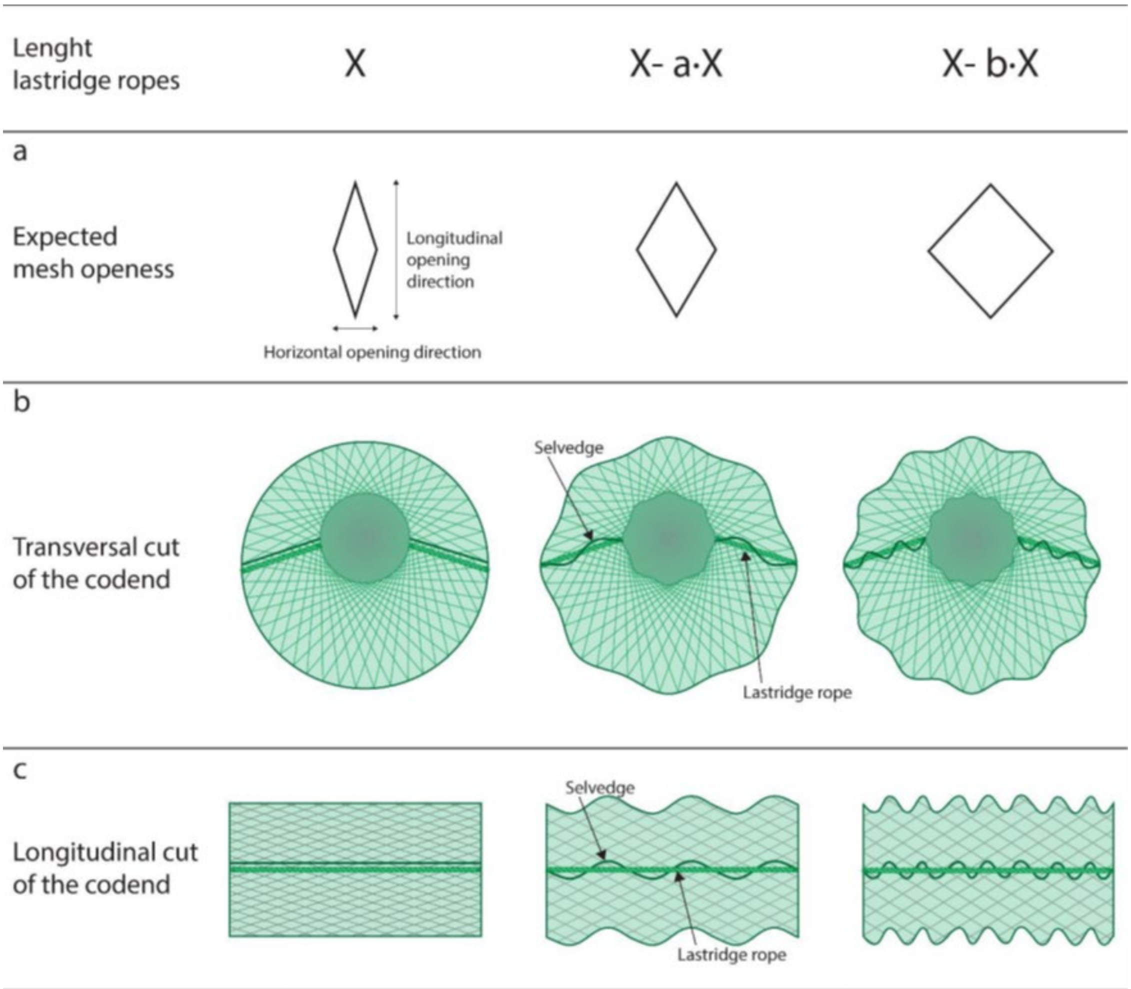


Figure 7.51: Illustration of the effect of shortening lastridge ropes by two different percentages, a and b, on the codend geometry.

7.13.3.17 Project: Sustainable catch and live storage of bluefin tuna in Norway

Project Timeframe: January 2022 – December 2023

Institution(s): Institute of Marine Research (IMR), NOFIMA, Polytechnical University of Valencia (UPV)

Contact person: Manu Sistiaga, manu.sistiaga@hi.no

Link(s): www.hi.no

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Despite the increasing presence of bluefin tuna in Norwegian waters and the initial interest shown by the industry to harvest BFT, low profitability in the fishery has led to that the quota assigned to the Norwegian fleet has not been fully harvested the last years. This low profitability is attributed to poor catch efficiency, lack of procedures and infrastructure to guarantee stand-ards of quality, and poor marketing. Live-storage of BFT is regarded as a potential solution, at least partially, to mitigate the low profitability in the fishery.

In 2020 Norwegian authorities and the Institute of Marine Research (IMR) started a project to develop live-storage of Atlantic BFT. The aim of the project is to implement live-storage of BFT in Norway and develop the different procedures necessary from catch and monitoring of fish to transfer and storage in coastal cages. The project has four main focus areas: BFT identification, harvest, catch control, and fish welfare and quality. This is the third report of a series that sums up the developments and the results from the sea trials in 2022.

The sea trials were carried out at the end of September along the west coast of Norway between Bergen and Stad. The weather during the cruise was in general bad, which limited the effective sea trial period to three days. Despite the high number of observations of BFT during the trial period, the fish moved very fast, with no clear pattern, and in large aggregations, which made it very difficult to catch. Thus, the difficulties to catch the fish combined with the short trial period lead to no catches of tuna, which substantially limited the work that initially was to be carried out. However, some of the equipment tests carried out and the experience gained during the trial period are of interest for future work.

The operation of the sonar used for early identification of fish provided a clear view of the gear and would most likely also be able to identify BFT, which was satisfactory. The operation of the small mesh netting tested in the seine to avoid entangling fish and the installation of the stereo camera applied for catch control during the transfer process were also satisfactory from the operational point of view. Also, the surface ROV constructed with catch control and fish welfare monitoring purposes during the capture process showed also to work as planned, although we could not determine to what extent one would be able to identify BFT in the seine. As the catches in the trial period were absent, there were no tuna samples to evaluate fish welfare and quality at the level planned in the trials.

The present trials brought up some of the challenges in the BFT purse seine fishery that limit catches in the fishery and consequently the development for live storage. Low profitability in the fishery together with the overlap with the mackerel fishery has lowered the participation of the fleet. This, added to the lack of infrastructure for fish delivery as well as the strict regulations and associated costs to enforce the right to fish, have contributed further to the low participation in the commercial fishery, which limit the possibility for R & D activities in the fishery.

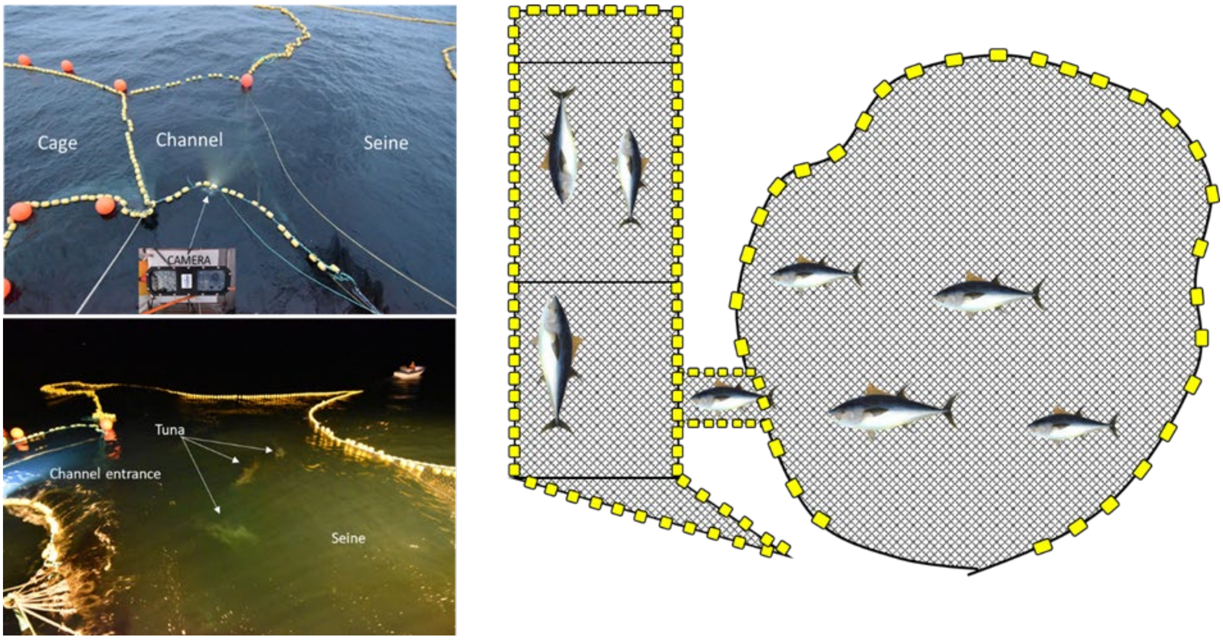


Figure 7.52: Illustration of gear arrangement including tuna transfer channel and cage for transfer of live fish from purse seine.

7.14 Portugal

7.14.1 Contact person

- Aida Campos, IPMA, Portuguese Institute for Sea and Atmosphere acampos@ipma.pt

7.14.2 Summary

- At the scope of the project TECPESCAS (Fisheries Technology and Selectivity), coordinated by IPMA, the activities under development include : (1)) Characterization of the fishing operations in métiers of the Portuguese coastal fleet ; (2) Exploring the information on daily sales and e-logbooks to improve knowledge on the fishing gear used at a trip level; (3) Improvement of the selectivity in trammel nets using a modified net - "aranha"; (4) Development of an integrated technological system for collecting real-time information on fishing operations.
-
- Within the project SARDINHA2020, coordinated by IPMA, two activities are being developed: (1) Interaction between small cetaceans and the Portuguese purse seine fishery; (2) Develop survivability studies on sardine (*Sardina pilchardus*) and chub mackerel (*Scomber colias*)

7.14.3 Projects

7.14.3.1 Project: TECPESCAS (MAR-01.04.02-FEAMP-0010)

Project Full Title:

Project Timeframe: January 2019 – March 2023

Institution(s): IPMA/CCMAR/ ESTM

Contact person: IPMA: Aida Campos, acampos@ipma.pt ; Monika Jadwiga Szynaka, mjszynaka@gmail.com ; Jorge Gonçalves jgoncal@ualg.pt

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary:

(1) Validating Métiers in the Portuguese multi-gear coastal fleet

Data from questionnaires/interviews carried out in port with skippers of the multi-gear coastal fleet operating off the south Portuguese coast were analysed, with focus on information on the fishing gear used and the operations, with the aim of validating proposed métiers for this fleet. This validation was continued through onboard sampling, with a view to collecting more detailed information on fishing gear and operations, including detailed georeferenced information on fishing activity; and catch composition, including target and by-catch species.

Figure 7.53: Validating Métiers with questionnaires in the Portuguese multi-gear coastal fleet (Photo by M.Szynaka)

(2) Exploring the information on daily sales and e-logbooks to improve knowledge on the fishing gear used at a trip level

The daily sales (2012-2016) of the Portuguese multi-gear coastal fleet, including around 500 vessels, were analysed to capture multiple associations between the species landed. These associations were assigned distinct gear types based on prior knowledge about the fisheries, with the aim of improving understanding of the dynamics of this fleet and the identification of métiers.

The information recorded in the e-logbooks (2012-2016), available for approximately 1/3 of the vessels from the multi-gear coastal fleet, was combined with the sales notes, available for all vessels, and analysed using machine learning classification techniques. Classifications were obtained for a total of six types of fishing gear and applied to the remaining trips.

(3) Improvement of the selectivity in trammel nets using a modified net - "aranha"

The selectivity experiments initiated in the multi-gear coastal fleet operating off the southern Portuguese coast were completed, testing trammel nets targeting cuttlefish (*Sepia officinalis*) and sole (*Solea solea*) equipped with a selective panel (greca). The results of the comparative tests demonstrated that this solution contributes to environmental sustainability, reducing the capture of sensitive species such as corals and sponges and the destruction of essential habitats, without significant loss of target species; and for economic competitiveness, reducing the costs associated with repairing or buying new networks to replace those that are destroyed in this type of funds. The costs associated with changing these nets are reduced, and the simplicity of this solution allows its direct application by fishers.

The extension of these experiments and eventually, the commercial introduction of this option to trammel net fisheries in other areas (west coast), will be carried out at the scope of the “Tram-Sel” project, at the scope of Schmidt Marine Fisheries Initiative 2022.

Figure 7.54: Coral Dendrophyllia ramea (left) and sponge Axinella polypoides (right) caught in small mesh gill-nets and trammel nets. (Photos by M.Szynaka)

(4) Development of an integrated system for collecting real time information on fishing operations

The development of a technological system for the automatic acquisition of information on fishing operations in real time was concluded, in collaboration with a Portuguese company, based on the development of the capabilities of the continuous monitoring equipment (Portuguese MONICAP system) to give information on fishing operations, by placing electronic markers on deck equipment, namely on fishing winches and haulers, allowing tracking of the fishing operation through spatial and temporal recording of the beginning and end of the operation. The installation of the on-board component in two fishing vessels is foreseen during 2023.

References:

Szynaka, M. J., Fernandes, M., Anjos, M., Erzini, K., Gonçalves, J. M.S., Campos, A. (2022). Fishers, Let Us Talk: Validating Métiers in a Multi-Gear Coastal Fishing Fleet. Fishes 7, 174. https://doi.org/10.3390/fishes7040174

Leitão, P., Campos, A., 2022. Defining complex multi-species, multi-gear fisheries through species associations (2022). Trends in Maritime Technology and Engineering – Guedes Soares & Santos (eds), ISBN 978-1-032-33583-4

7.14.3.2 Project: SARDINHA2020

Project Full Title: SARDINHA2020 – Abordagem ecossistémica para a gestão da pesca da sardinha (Programa Operacional Mar 2020)

Project Timeframe: Q4 2018-2022

Institution(s): IPMA - Instituto Português do Mar e da Atmosfera/ Portuguese Institute for Sea and Atmosphere

Contact person: Diana Feijó (dfeijo@ipma.pt); Alexandra A. Silva (asilva@ipma.pt)

Link(s): NA

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary:

(1) Interaction between small cetaceans and the Portuguese purse seine fishery

Interactions between small cetaceans and the purse seine fishery on Portugal continental waters were studied using data collected by observers on-board fishing vessels over 15 years (2003 – 2018). Interactions were observed in 10% of the fishing sets, with accidental capture and mortality occurring in 1.6% and 0.8%, respectively (Dias et al., 2022a). The majority of interactions were with the common dolphin, the most abundant small cetacean in the Portuguese waters. The frequency of interactions and number of common dolphins involved in interactions increased with the increase of fishing effort and of their main prey, sardine and chub mackerel. Currently, within projects Data Collection Framework (PNAB-DCF) and Sardinha2020, an intensification of the observations and inquiries (due to pandemic situation during 2020/2021) is also in place and results are planned to be published within 2023.

(2) Survivability studies

One of the aims of the project is to evaluate the impact of the practice of slipping on the purse seine fishery. The collection of data on catches, slipping and discarding by observers on-board fishing vessels was intensified to complement the monitoring carried out by the national fisheries monitoring program (PNAB-DCF). These results have been presented in two international symposia (Feijó et al., 2021, 2022) and are to be published within 2023. Experiments were carried out at sea using a net pen to study stress reactions (physiological and biological) and survival of pelagic species, mainly chub mackerel (*Scomber colias*) and sardine (*Sardina pilchardus*), to capture and slipping (Figure 7.55 - Figure 7.57). In the first experiment, in Southwest Portugal (2020), using 2 small net pens moored in the open ocean, fish were monitored daily to evaluate survival rate by purse-seine slipping. Survival rates were 97.6% (control) and 94% (slipping) for chub mackerel and 85% (control) and 35% (slipping) for horse mackerel (Dias et al., 2022b). During 2021, two more experiments have been done in the South Portugal to evaluate the survival rate of sardine. It is planned to do the last experiment in the first semester of 2023. Preliminary results show differ-ences in susceptibility to slipping-related mortality in these species. These results are planned to be published within 2023.

Figure 7.55: Operation of the net pen in the sea. Source: project SARDINHA 2020

Figure 7.56: Experiment of slipping and daily sampling for evaluate survival rate. Source: project SARDIN-HA 2020.

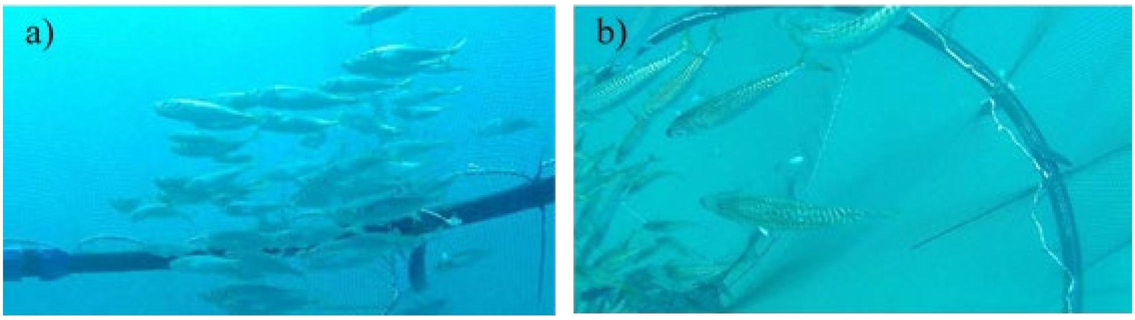


Figure 7.57: Visualization of schools of horse mackerel (a) and chub mackerel (b) inside the net pens. Source: project SARDINHA 2020

References:

Dias, I.C., Marçalo, A., Feijó, D., Domingos, I. & Silva, A.A. 2022a. Interactions between the com-mon dolphin, *Delphinus delphis*, and the Portuguese purse seine fishery over a period of 15 years (2003–2018). Aquatic Conservation: Marine and Freshwater Ecosystems, 1–14. https://doi.org/10.1002/aqc.3828

Dias, I.C.; Feijó, D.; Marçalo, A.; Guerreiro, P.M.; Nogueira, M.; Bandarra, C.; Silva, A., 2022b. Experiência piloto para avaliar a sobrevivência da cavala (*Scomber colias*) pós-slipping na pesca do cerco. Relatórios Científicos e Técnicos do IPMA (http//ipma.pt).

Feijó D., Rocha A., Riveiro I., Silva A.A. 2021. Assessment of slipping patterns of small pelagic in the Portuguese purse-seine fleet. SIMERPE, Vigo, Spain. Video presentation.

Feijó D., Rocha A., Dias A., Mendes J., Menezes R., Faria S., Marçalo A., Riveiro I., Silva A. A. 2022. Purse-seine fishery in Portugal: no sardine, no future? Small Pelagic Fish Symposium 2022. Lisboa, Portugal. Oral presentation.

7.14.4 Future projects and Ideas

7.14.4.1 Project: "TramSel" Schmidt Marine Fisheries Initiative 2022.

Project Full Title: Trammel Selectivity Studies in Portuguese fisheries

Estimated Project Timeframe: May 2023 – April 2025

Institution(s): CCMAR, IPMA

Contact person: Monika Jadwiga Szynaka, mjszynaka@gmail.com

Link(s):

Collaboration welcome? Y/N/NA

Funding secured? Yes

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Through this project, the scientific team is aiming to decrease invertebrate by-catch and habitat loss associated with the anthropogenic impacts of fishing in the Portuguese traditional cuttlefish and flatfish trammel net fisheries, whilst maintaining catch rates of the top commercial species. A further objective is to decrease the costs associated with gear damage in rocky areas by lifting the net from the seabed. This will be carried out by working in close collaboration with Portu-guese fishers, aiming at commercial introduction of this option to trammel net fisheries, securing future possibilities to continue fishing with this gear and catching commercially valuable and traditionally important species.

7.15 Spain

7.15.1 Contact person

- Mikel Basterretxea, AZTI, mbasterretxea@azti.es

7.15.2 Summary

The fishing technology area from AZTI-BRTA has been working last year on studies about selectivity improvements mainly on bottom trawl fleets operating in ICES subarea 8, but also in the tropical tuna purse seine fishery. All the projects include surveys at sea, performing and evaluating modifications of the fishing gears (geometry modification of the codend, performance of bycatch release devices, or testing the effectiveness of acoustic active deterrent devices).

7.15.3 Projects

7.15.3.1 Project: CASELEM

Project Full Title: Improvement of selectivity in trawl fisheries under the Landing Obligation of the C.F.P

Project Timeframe: January 2022 – December 2022

Institution(s): AZTI

Contact person: Mikel Basterretxea, mbasterretxea@azti.es

Link(s): www.azti.es

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: CASELEM was a one-year project, funded by Spanish Fishing Directorate. The aim of this project was to analyse the potential technical and operational solutions to reduce the capture of non-desired species in the Landing Obligation framework. The project aims at analysing the potential of shortening codend lastridge ropes to improve size selectivity of commercially relevant species in the Basque bottom trawl fishery operating in ICES 8abd. The sea trials consisted of modifying codend mesh geometry by shortening lastridge ropes by 10% and 20%. Sea trials were carried out onboard R/V Emma Bardan and selectivity data for hake, blue whiting, boarfish and megrim was collected. Results showed that hake, megrim and boarish were significantly less retained by the 20% shortened lastridge codend compared to the non-shortened one. Additionally, underwater recordings showed clear visual differences regarding mesh openness between two codend configurations and the baseline. The project will continue in 2023, improving technical aspects of the experiment and trying to obtain an optimal mesh for the analysed fishery.

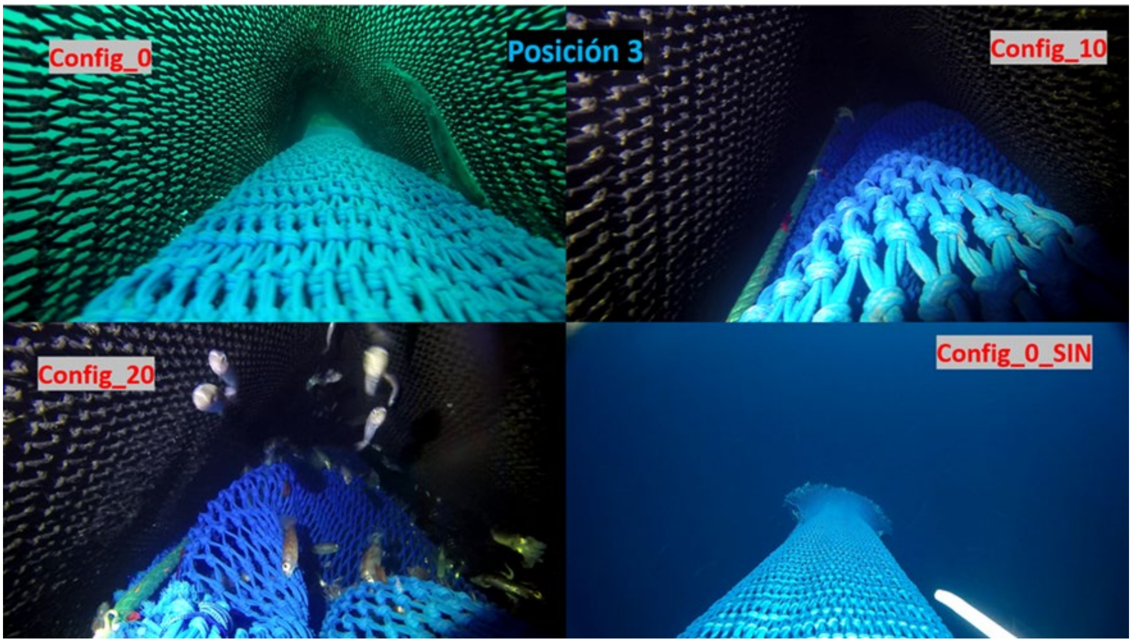


Figure 7.58: Baseline (Config_0), codend without cover (Config_0_SIN) and 10% and 20% shortened lastridge ropes (Config_10 and Config_20).

7.15.3.2 Project: MITICET

Project Full Title: Exhaustive testing of the effectiveness of acoustic active deterrent devices (pingers) in mitigating the incidental bycatch of dolphins in pair bottom trawling.

Project Timeframe: January 2021 – December 2023

Institution(s): AZTI

Contact person: Mikel Basterretxea, mbasterretxea@azti.es

Link(s): www.azti.es

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: MITICET is a three-year project, started in January 2021 and it is funded by the Spanish Fisheries Directorate. The testing of acoustic active deterrent devices (pingers) for dolphins started in March 2021, with the main objective of comparing the incidental bycatch of dolphins by imple-menting an alternate hauls experimental design (with and without pingers) of the pair trawl unit. In order to record the incidental by-catches, both vessels were equipped with Electronic Monitoring Systems (EMS), which allowed to visualize any cetacean bycatch onboard in all the fishing hauls. This equipment was operational during several months, covering all the period in which the major cetacean bycatch was expected in the fishing area. Given the known relatively low frequency of the cetacean bycatch events, one of the challenges was to obtain a number of observations high enough to perform a robust statistical analysis so that the pingers effectiveness can be estimated.

Results in 2022 showed a reduction of 92.2% in the proportion of hauls with bycatch of common dolphin and a 95% in the number of specimens per haul with bycatch.

In 2023 the project continues, with the same approach of the previous year but with a different model of pinger, less powerful but with the capacity to endure all the year without recharging the battery.

7.15.3.3 Project: HOPNEXT

Project Full Title: Design and validation of PET species bycatch release devices in tropical tuna purse seiners

Project Timeframe: March 2022 – December 2022

Institution(s): AZTI

Contact person: Jefferson Murua, jmurua@azti.es

Link(s): www.azti.es

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: HOPNEXT is a project funded by the Spanish Fisheries Secretariat with EU Next Generation funds continuing from 2021. The high mortality rate of bycaught threatened species like sharks and mobulids in tuna purse seiners has prompted studies in selective technologies to improve their release survival rates. This study worked on the development of bycatch release devices (BRD), such as mobulid sorting grids, shark velcros and others. The principal BRD tested have been hoppers, which operate as a sorting tray to identify and quickly release bycatch, before it goes down into the lower deck where release actions are greatly complicated. In addition, a release ramp has been fitted to the hoppers so that large or dangerous to handle species can be quickly released with minimum handling. Trials have been conducted in the Pacific Ocean in 2022, with satellite tagging of sharks to estimate survival rates. Preliminary data shows a very high survival rate (54%) compared to other studies evaluating release practices without BRDs which yield survival rates between 5-19%. The project will continue in 2023, conducting more at sea research cruises to evaluate survival rates of elasmobranchs.

Figure 7.59: Tuna purse seine BRD trials with (a) shark being tagged and released from a hopper with ramp, and (b) manta ray released from deck using a circular sorting grid.

7.16 Sweden

7.16.1 Contact person

- Hans Nilsson, Swedish University of Agricultural Sciences, hans.nilsson@slu.se

7.16.2 Summary

- Secretariat for selective fishing gear
- Round goby – from Risk to Resource
- Swedish lobster program (SWELOB)

7.16.3 Projects

7.16.3.1 Project: Secretariat for selective fishing gear

Project Full Title: Secretariat for selective fishing gear

Project Timeframe: 2014 – 2022

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources

Contact person: Hans Nilsson, hans.nilsson@slu.se

Link(s): https://www.slu.se/institutioner/akvatiska-resurser/forskning/hallbart-fiske/selektivt-och-skonsamt-fiske/sektretariatet/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Between 2014 and 2022 the Swedish government has set aside special funding for collaborative research on selective fishing gears. The main background was the need for a larger toolbox of documented and workable gears for the industry to choose from when the landing obligation in EU fisheries is being implemented. In this venture, SLU-Aqua has been contracted by the respon-sible authority (SwAM - Swedish Agency for Marine and Water Management) to set up a secre-tariat.

The aim of the secretariat has been to gather new ideas from fishers and industry. The industry´s initiative and engagement are crucial to the successful development of new ideas. Project proposals are worked out in close collaboration between fishers and scientists and are then evaluated and funded by SwAM.

During the project period between 2014 and 2022, over 50 projects have been completed with a great diversity ranging from the gentle handling of salmon in traps in the northern Baltic Sea to large grids excluding saithe in the industrial pelagic trawl-fishery of herring in the Skagerrak and experiment with pelagic trawl doors in the demersal trawl fishery.

7.16.3.2 Project: Round goby – from Risk to Resource

Project Full Title: Round goby – from Risk to Resource

Project Timeframe: Jan 2021 – Dec 2024

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources, Lund University, Umeå University

Contact person: Peter Ljungberg, peter.ljungberg@slu.se , Ann-Britt Florin, ann-britt.florin@slu.se

Link(s): https://www.slu.se/institutioner/akvatiska-resurser/forskning1/ekosystem/svartmunnad-smorbult--forvandla-risk-till-resurs/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: With start in 2021 nationally founded project containing aspects of catchability of the invasive round goby (Neogobius melanostomus) is part of a larger, four year project in Sweden. The fish-ery related part includes aims to evaluate how commercial fishing of round goby may be includ-ed in the coastal fishery. Two key issues are how round goby may be retained in the gear while European eel (*Anguilla anguilla*) may be released through selection panels. Also, the selection panels have to be evaluated also for their retention potential for other commercial species?

7.16.3.3 Project: Swedish lobster programme (SWELOB)

Project Full Title: Swedish lobster programme

Project Timeframe: Ongoing

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources

Contact person: Peter Ljungberg, peter.ljungberg@slu.se , Andreas Sundelöf, andre-as.sundelof@slu.se

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: SWELOB is the Swedish lobster program. It includes population monitoring along with volun-tary logbook data from recreational fishers. A part of the project 2022 aimed to evaluate behav-ioural aspects of intraspecific competition within European lobster (Hommurus gammarus). The project include video recordings of lobster pot fishery to allow for both catch efficiency in the gear along with behavioural analysis of size specific interactions within the species. The project is a part of a larger monitoring program evaluating the population regulations of the Swedish lobster fishery both in fished and no take areas.

7.17 United Kingdom (England)

7.17.1 Contact person

- Dan Watson, SafetyNet Technologies, dan@sntech.co.uk

7.17.2 Projects

7.17.2.1 Project: Piscesgate: Testing LED lights as a bycatch reduction tool

Project Full Title: Piscesgate: Test the effectiveness of artificial lights to change fish behaviour and reduce bycatch in Nephrops trawls and squid fisheries

Project Timeframe: February 2022 – February 2024

Institution(s): SafetyNet Technologies; Fishing into the Future; Agri-Food & Biosciences Institute Northern Ireland (AFBI); Scottish White Fish Producers Association Ltd

Contact person: Craig Syms, SafetyNet Technologies, craig@sntech.co.uk

Link(s): www.sntech.co.uk ; www.fishingintothefuture.co.uk ; www.afbini.gov.uk ; www.swfpa.com

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Project Piscesgate brings together fishing industry, technologies, and science partners to investigate how innovative passive LED technology may be able to reduce discards in trawl fisheries. This project builds on and uses lessons learnt from initial commercial trials undertaken by SNTech in 2021. This project is in the middle of its conduct. We have conducted systematic deployments of lights of different colours ranging from Deep blue, Blue, Cyan, Green and White and flash rates (Constant, 2 Hz, 16 Hz and 32 Hz). Trials have examined deployments on the headrope and false headrope to potentially deter non-target species, and on the Square Mesh Panel escape device to facilitate escape of undersized fish. Our findings on the effectiveness of light for deterring bycatch species from entering trawl nets deterrence has been equivocal. However our use of cameras have pointed to the potential for modifications to escape panel placement in combination with sediment suppression systems to improve visibility might be useful to reduce juvenile fish bycatch. Additionally, we developed a novel sampling technique developed for the squid fishery. The effect of lights on this fishery in the next season will be also be examined.

This project has generated much insight into catch, bycatch, and their interactions with gear and lighting. The raw data are publicly available and provide wider information for fishery management and assessment. Our increased use of cameras on the trawl gear has enabled a more agile problem-solving approach to be implemented. This approach will be developed further in 2023.

7.17.2.2 Project: Fish behaviour towards light in a controlled laboratory setting

Project Full Title: Assessing the behavioural responses of flatfish and elasmobranchs to different LED modalities (flashing, continuous and coloured LEDs)

Project Timeframe: May 2021 – August 2021

Institution(s): University of Exeter, SafetyNet Technologies, Marine Biological Association

Contact person: Jasmine Somerville, jas275@exeter.ac.uk

Link(s): N/A

Is the project directly addressing bycatch of PETS? Yes – elasmobranchs

Could this project indirectly decrease bycatch of PETS? Yes – looking at behavioural responses to light to see if this can be applied to reduce bycatch

Is the project addressing ALDFG? No

Summary: Lights were found to effect the behaviour of flatfish and elasmobranchs in a controlled laboratory setting.

Aim: Quantify behavioural responses towards light in elasmobranchs and flatfish, for future application with fishing-with-light trials

Status: Complete

Results: Certain colours caused stronger behavioural responses. Flashing light led to less time spent stationary (fish were more active). Flashing light could potentially be more aversive than continuous light (a general interest was shown towards light for elasmobranchs, which was reduced with flashing light; Figure 7.60). Flatfish were more active in the presence of certain colours. Habituation to light tended to occur over time.

Future: Applying this to fishing with light trials, to see if elasmobranch bycatch can be reduced

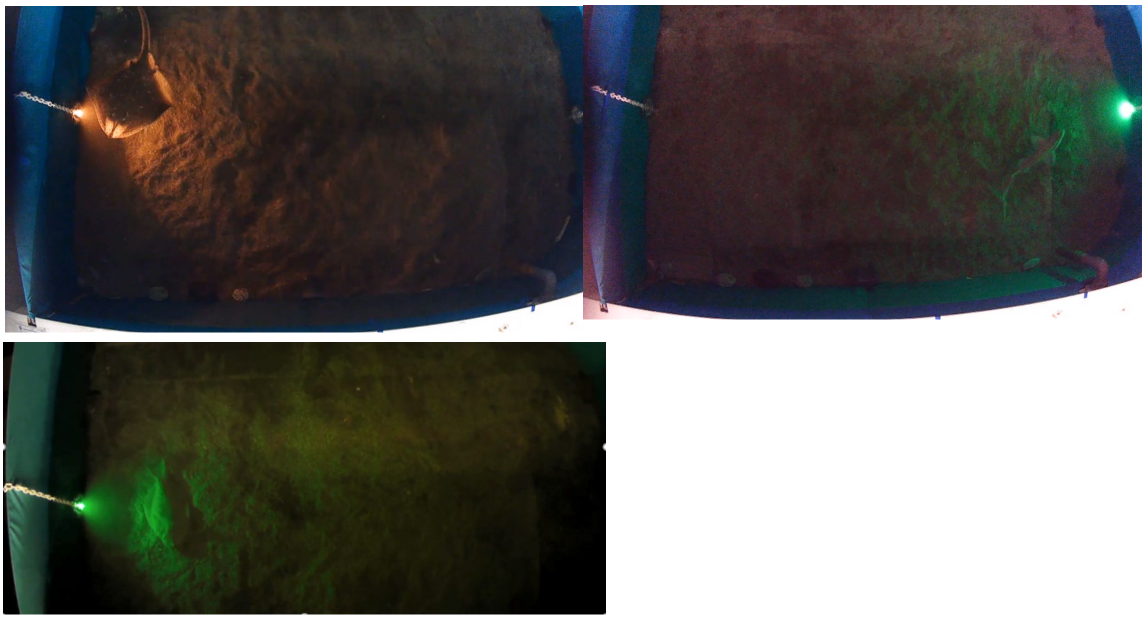


Figure 7.60: Still shots from video observation of fish reactions to light in a controlled tank setting. Top left: blonde ray (Raja brachyura); top right: small-spotted catshark (Scyliorhinus canicula); bottom left: plaice (Pleuronectes platessa).

7.17.2.3 Project: Assessing whether flashing LEDs can reduce elasmobranch bycatch

Project Full Title: Assessing whether flashing LEDs can reduce elasmobranch bycatch in a demersal beam trawl

Project Timeframe: April 2023 – July 2023

Institution(s): University of Exeter, SafetyNet Technologies, Marine Biological Association

Contact person: Jasmine Somerville, jas275@exeter.ac.uk

Link(s): N/A

Is the project directly addressing bycatch of PETS? Yes – elasmobranchs

Could this project indirectly decrease bycatch of PETS? Aiming to reduce capture of elasmobranchs in nets

Is the project addressing ALDFG? No

Summary: Flashing light on the headline of an otter trawl to reduce elasmobranch bycatch. In collaboration with the Marine Biological Association, with the use of their research vessel RV Sepia (small demersal otter trawl). The work will coincide with their usual demersal fish survey work, which has taken place since 1913. We will be attaching lights to the headline of the trawl net to see if we can catch less elasmobranchs then the control net, through alternated trawls (control net versus illuminated nets, alternated).

Aim: Test if flashing light reduces elasmobranch bycatch.

Status: Pending

Results: N.A

Future: Trials are taking place in April over 5 days.

7.17.3 Future projects and Idea

7.17.3.1 Project: Bycatch-reduction with lights

Project Full Title: Bycatch-reduction with lights with passive or active gears

Estimated Project Timeframe: 2023

Institution(s): University of Exeter, SafetyNet Technologies

Contact person: Jasmine Somerville, jas275@exeter.ac.uk

Link(s):

Collaboration welcome? Y

Funding secured? N

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? NA

Is the project addressing ALDFG? No

Summary: I would be open to collaborations with other institutes to try and reduce bycatch with fishing gear and light, passive or active gear, depending on trial results from previous project.

Aim: Reduce the capture of elasmobranchs/other species in fishing gear

Status: Pending

Future: N/A

7.18 United Kingdom (Scotland)

7.18.1 Contact person

- Emma Mackenzie, Marine Scotland Science, emma.mackenzie@gov.scot

7.18.2 Summary

- CodSELect - Using light to improve cod selectivity in North Sea Nephrop trawl gears
- Marine Scotland gear development trials
- Development of new IBTSWG survey trawl package

7.18.3 Projects

7.18.3.1 Project: CodSELect

Project Full Title: CodSELect - Using light to improve cod selectivity in North Sea Nephrop trawl gears

Project Timeframe: November 2022 – March 2024

Institution(s): Marine Scotland, Marine Environmental Solutions Limited owned by The Scottish Fishermen's Federation (SFF) and Photosynergy Limited owned by the University of St Andrews

Contact person: Emma Mackenzie, emma.mackenzie@gov.scot

Link(s): FISP projects: grants and contracts awarded in round 2 of the scheme - GOV.UK (www.gov.uk)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: CodSELect is a funded project through the Fisheries Industry Science Partnership (FISP) scheme as part of the UK Seafood Fund by DEFRA. CodSELect aims to support North Sea Nephrops fish-ers with a new technical measure to reduce the capture of cod and maintain catch of their target species.

CodSELect originated from previously observed behaviour of cod in an extensive series of labora-tory tank trials, completed by Marine Scotland (MS), where cod showed a constant and strong aversion to blue and green artificial light. The project will exploit this known behaviour using the SELTRA sorting box with a 300 mm square mesh panel (SMP) on the top panel and with the novel addition of fibre optic cables, illuminated by LED light pods created by Pho-tosynergy Lim-ited (Figure 7.61), on the lower panel (Figure 7.62). The addition of the artificial light would modify the natural behaviour of cod, to stay low down in the trawl where they re-main relatively inactive, by encouraging cod to swim up, increasing encounter rates with the SMP and subsequently in-creasing escape of cod. CodSELect comprises of a series of tank trials to understand cod behav-iour (including other commercially important species) in relation to artificial light and SMPs, a research sea trial and a commercial sea trial in collaboration with Marine Environmental Solu-tions Limited (Scottish Fishermen's Federation – SFF).

Expected outcome: CodSELect proposes to offer fishers a tool to improve selectivity of cod and reduce the likelihood of them becoming a choke species which has a significant negative financial impact for vessels. If this system is proven successful in this fishery it could be rolled out as a technical measure in fisheries elsewhere too.

Figure 7.61: Photosynergy Limited LED light pods to illuminate fibre optic (FO) cables

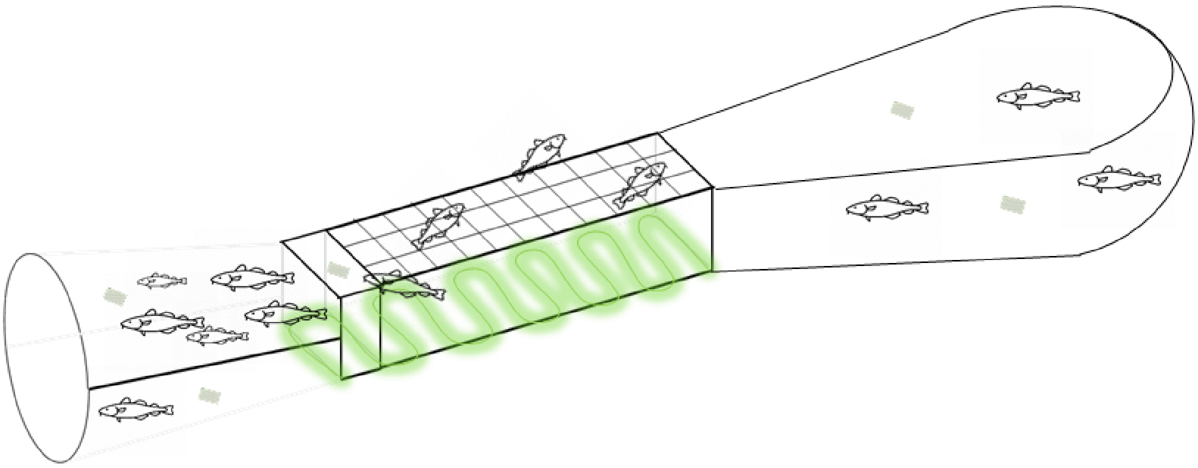


Figure 7.62: CodSELect Nephrops trawl trawl set-up. SELTRA sorting box within extension section of the trawl fitted with a 300 mm square mesh panel (SMP) in the upper panel and illuminated fibre optic cables fitted into the lower panel positioned ahead of the SMP but running the entire length of the SMP.

7.18.3.2 Project: Marine Scotland gear development trials

Project Full Title: Marine Scotland gear development trials

Project Timeframe: 7th – 15th August 2022

Institution(s): Marine Scotland and Photosynergy Limited owned by the University of St Andrews

Contact person: Alex Edridge, Alexius.Edridge@gov.scot

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary:

Objectives:

- Investigate whether artificial light can influence fish behaviour and enhance escape through a square mesh panel (SMP) in the extension of the trawl.
- Obtain video footage of fish behaviour when passing through the illuminated bottom panel of a SELTRA box fitted with 300 mm SMP on the top panel.

The trials used a BT201 nephrops trawl fitted with a SELTRA box that had a 300 mm SMP on the top panel, situated 9 m from the codline (Figure 7.62). The bottom panel was rigged with two fibre optic cables each illuminated by two Photosynergy LED pods (2 x SLS-2500 & 2 x PSL-5000) powered by 12 V battery packs. The SLS-2500 and PSL-5000 have the same output with the only difference being that the SLS-2500 is a newer, more compact unit. The light pod units emit green light and hauls were conducted either with lights off (control) or on (test). The catch was sorted into key species, weighed and individual total length measurements recorded. All hauls were conducted in daylight. The net was towed at three knots with Scanmar units monitoring wing spread and headline height during each haul.

The trip was successful in recording ambient light and turbidity conditions as well as light spectrum changes from the artificial light source in real time during fishing operations. Two LI-COR LI-192SA underwater quantum sensors, coupled on a LI-COR LI-1500 light sensor logger (in a custom made underwater housing by the MSS engineering team), were rigged and collected real time ambient and artificial light data, while turbidity was recorded by an RBR Solo3 logger equipped with a Seapoint turbidity sensor. A LI-COR LI-180 spectrometer recorded the light spec-trum emitted by the artificial light source (Figure 7.63). The data collected will provide information on the environmental conditions that might affect light propagation and how fish might perceive their surroundings during trawling. Further trials are scheduled for March 2023 to further data collection.

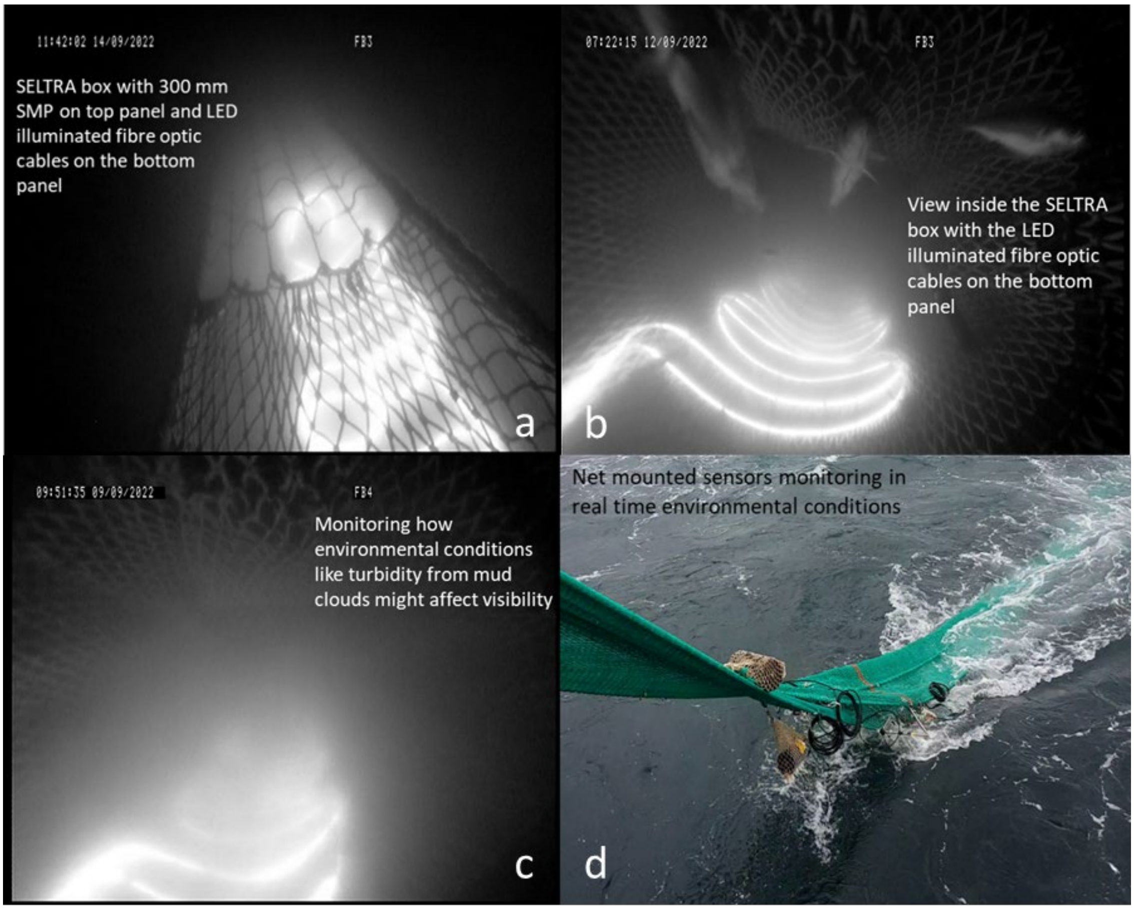


Figure 7.63: a, b Still images from underwater video footage of the net showing the illuminated fibre optic cables. c, d data on the effects of turbidity were recorded throughout.

7.18.3.3 Project: Development of new IBTSWG survey trawl package

Project Full Title: To undertake sea trials of a new survey gear to replace the GOV trawl

Project Timeframe: November 2021 – November 2022

Institution(s): Marine Scotland and IBTSWG

Contact person: Robert Kynoch, Robert.Kynoch@scot.gov

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The final design of a new survey gear package to replace the existing GOV was agreed at a meet-ing of the IBTS GOV gear sub-group during July 2022. It was agreed a number of full-scale test versions of the new package would be constructed and trailed over the next 12-15 months. It was further agreed these test versions would be shared amongst GOV users to reduce costs. As the new gear is trailed its expected there will be alterations to the final specification depending on feed-back to the IBTSWG.

The new gear has been developed and tested extensively by Marine Scotland on the research vessel Scotia since 2018. As results from each cruise has been reported back to IBTSWG fine tuning of the specification in terms of mesh size/ground gear configuration etc which has enabled the group to reach a consensus on the final design for full-scale evaluation.

Between 2022 and 2023 the development by Marine Scotland will focus on developing/testing a new trawl door setup to replace the existing design used with the GOV trawl. Another objective will be to assess the correct warp-to-depth ratios and standardise for all institutes adopting the new survey gear.

7.19 United Kingdom (Northern Ireland)

7.19.1 Contact person

- Ben Collier, Anglo-North Irish Fish Producers Organisation/ Northern Ireland Fish Producers Organisation ni-geartrials@outlook.com

7.19.2 Summary

- The Northern Ireland Gear Trials Project has been operational since 2017 and is an industry led project involving both of Northern Ireland's fish producer organisations (ANIFPO & NIFPO) and partners from the Agri-Food and Biosciences Institute (AFBI), the Department of Agriculture, Environment & Rural Affairs (DAERA) and Seafish. The work was initially driven by the full implementation of the Landing Obligation in 2019 and is now additionally covered by the by-catch objective of the (UK) Fisheries Act 2020. The project is supported by the European Maritime & Fisheries Fund with funding secured up until March 2023. The projects focus is on working directly with fishermen and local gear manufacturers to design, trial and implement innovative trawl designs into the Irish Sea commercial nephrops fishery. The overall aims are to reduce the catch of unwanted quota species and to avoid the capture of all juvenile fish species whilst retaining the commercially valuable nephrops catch.
- During 2022 the project has continued the development and trialling of a design of nephrops trawl called the coverless trawl. In March 2022 the second trial of a set of coverless trawls was undertaken at sea using 2 >12m nephrops trawlers fishing in parallel tows. Coverless trawls and control trawls were rotated between both vessels. In May 2022 the same coverless trawls with modifications were trialled again using the same vessels as had been used during March 2022. The modification was to replace the standard 80mm diamond mesh topsheets with 160mm diamond mesh netting. In 2023 further trials of the modified coverless trawls will continue and include the collection of longer term observations of catch to allow comparisons to be made against the background of the rest of the fleet.
- In addition, a new project has recently commenced that aims to improve the evidence base around demersal towed fishing gear and seabed interactions. A before/ after controlled impact study will be carried out over a range of simulated fishing intensities within Northern Irish nephrops fishing grounds. A suite of analytical techniques will be deployed.

7.19.3 Projects

7.19.3.1 Project: Northern Ireland Gear Trials (NIGT)

Project Full Title: Northern Ireland Gear Trials Project

Project Timeframe: February 2017 – March 2023 onwards

Institution(s): Anglo-North Irish FPO, Northern Ireland FPO, Agri-Food & Biosciences Institute, Dep of Agriculture, Environment & Rural Affairs, Seafish

Contact person: Ben Collier, ni-geartrials@outlook.com

Link(s): Northern Ireland Gear Trialling project 2017-2022 | Facebook

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Since 2017 some 25 ideas on ways to further improve the selectivity of nephrops trawls have been provided by local fishermen and gear manufacturers. All Northern Ireland commercial nephrops trawlers are currently fitted with an STECF approved highly selective device and so this project aims to reduce the component of unwanted catch that is most difficult to avoid. In the context of the Irish Sea <MCRS whiting is the priority species however other fish species are also considered.

Between 2017-2022 multiple trials at sea onboard chartered commercial fishing vessels have been undertaken (Figure 7.64) and include lights attached to a square mesh panel (Figure 7.64), lights on the bottom panel of a SELTRA box section (Figure 7.65 left), luminous netting on the bottom panel of a SELTRA box section (Figure 7.65 left), two different versions of an inclined net grid (Figure 7.66), lights attached to an inclined net grid, replacing the front cover of a nephrops trawl with 400mm diamond mesh (Figure 7.67) and nephrops trawls with the front cover removed in addition to other modifications (Figure 7.68 - Figure 7.70).

Figure 7.64: Lights attached to square mesh panel fitted into nephrops trawl

Figure 7.65: Left: Lights on bottom panel of SELTRA box section, Right: A.3 Luminous netting on bottom panel of SELTRA box section.

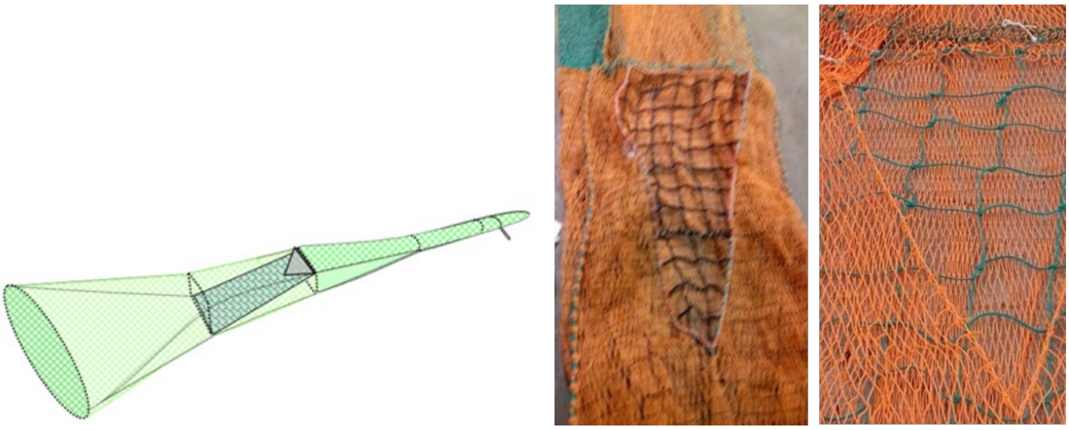


Figure 7.66: Selection devices tested: Left: Diagram of inclined net grid section; Right: photos of each version trialled (different mesh sizes in grid).

Figure 7.67: Font cover of nephrops trawl replaced with 400mm diamond mesh netting

Since 2020 the project has focused on modifications to the front of the trawl and in March/ May 2022 the second/ third trials at sea of a set of two nephrops trawls that were manufactured with the front cover absent were undertaken. On these trials, two 3 warp twin rig nephrops trawlers were chartered. The vessels performed parallel tows over a week and sets of experimental gears and control gears were rotated between the two vessels to account for any vessel bias.

The results from the March 2022 trial of the "coverless trawls" indicated the potential of this modification with respect to reducing the capture of <MCRS whiting (Figure 7.68).

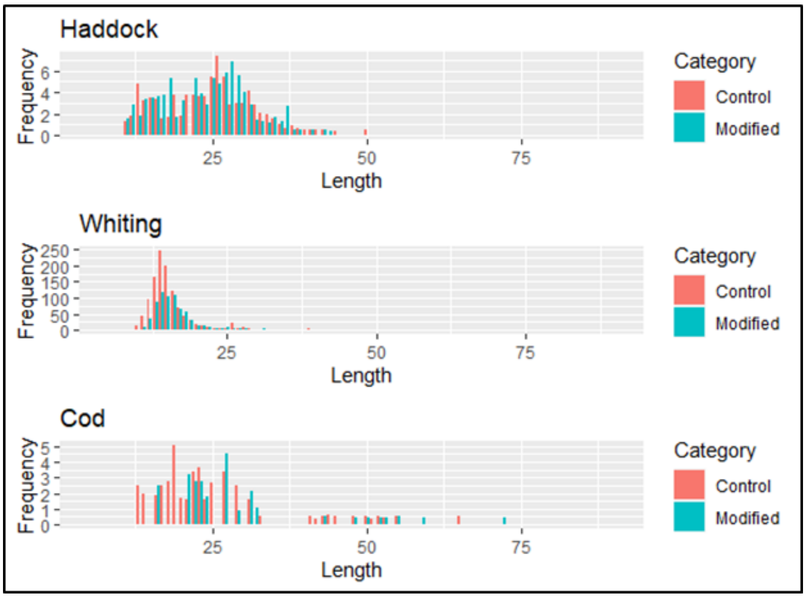


Figure 7.68: Length/ Frequency distribution for selected fish species recorded during March 2022 gear trial of coverless nephrops trawls against standard nephrops trawls fitted with an STECF approved selec-tive device.

During May 2022 the coverless trawls that began development in 2020 and were subsequently trialled again in March 2022 underwent another week of sea trials. Before this trial the coverless trawls had a large proportion of their 80mm diamond mesh top sheets replaced with 160mm diamond mesh. The larger mesh netting was also fitted into the wings of the experimental trawls (Figure 7.69).

Figure 7.69: Coverless nephrops trawl with 160mm diamond mesh netting fitted into the top sheet (left) and wings (right). The original 80mm netting in the top sheets remained in the first part of the tapered section to prevent loss of nephrops.

The results from the May 2022 trial were less consistent than those obtained during the earlier trial in March 2022. The modified coverless trawls appear to be effective at reducing <MCRS haddock but less so for the smallest <MCRS whiting that were recorded in the sample (A.8). On a haul-by-haul basis the modified coverless trawls outperformed the control gears on several tows with respect to reducing whiting capture.

The main point to note from the gear trials that have involved the coverless trawls and modified coverless trawls to date is that they appear to perform as selectively, and perhaps better than the current options that are available. Without the need for a square mesh panel, a SELTRA or other STECF approved highly selective device the coverless trawls are more easily manufactured and offer an attractive alternative for Northern Ireland based nephrops fishermen. In addition to this, with no front cover and larger mesh in the top sheets, drag is potentially reduced which may be beneficial in aiding to reduce fuel consumption and emissions.

It is anticipated that during 2023 further trials of the modified coverless trawls will be undertaken, including longer durations observations to allow catch comparisons to be made against the background of the rest of the Northern Ireland commercial nephrops fleet.

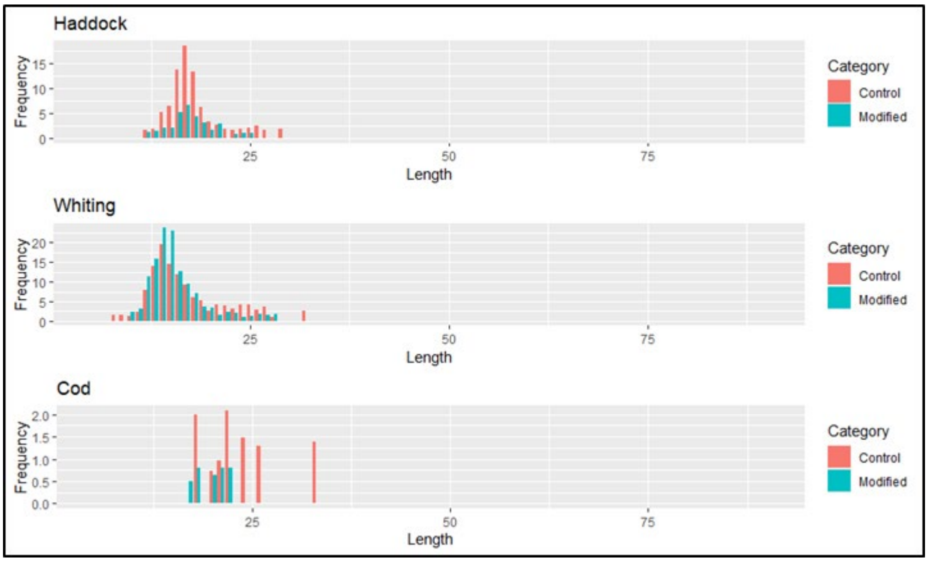


Figure 7.70: Length/ Frequency distribution for selected fish species recorded during May 2022 gear trial of mod-ified coverless nephrops trawls against standard nephrops trawls fitted with an STECF approved selective device.

7.19.4 Future projects and Ideas

7.19.4.1 Project: RESONANCE

Project Full Title: Improved estimates of bottom contact and recovery

Estimated Project Timeframe: July 2022 – July 2024

Institution(s): Ulster University, Anglo-North Irish Fish FPO, Northern Ireland FPO, Agri-Food & Biosciences Institute, University of Limerick, Cornell University, Alaska Pacific University, Fisheries Inshore New Zealand, Zebra Tech

Contact person: Dr Chris McGonigle, cd.mcgonigle@ulster.ac.uk

Collaboration welcome? NA

Funding secured? Y

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project will a) test and implement novel tools to directly assess seafloor – fishing gear interactions, b) assess the seafloor ecosystem response to fishing gear disturbance, and c) apply these tools to support technical solutions to mitigating seafloor impacts from fishing by directly assessing potential benthic impact reductions from modified fishing gears. This project will seek to refine methods for the quantification of gear-bottom interaction for bottom contact fishing for areas of priority for the Northern Irish fishing industry. In summary, this project will deal with experimental fishing using commercial gear in a beyond Before After Control Impact (BACI) framework. This will take the form of a Randomised Complete Block (RCB) design spa-tially structured to give sufficient replication and procedural controls to mitigate the impacts of natural perturbations. The fishing impacts will be carried out along a gradient of intensities in Northern Irish waters across a range of priority habitats to understand the regionally specific impacts and associated recovery potential in the short (~24 hours) and medium term (~28 days).

Approaches that will be applied include seabed imaging techniques, chemical analysis of blue carbon habitat and deployment of contact sensors along the length of nephrops trawl footropes (Figure 7.71- Figure 7.72).

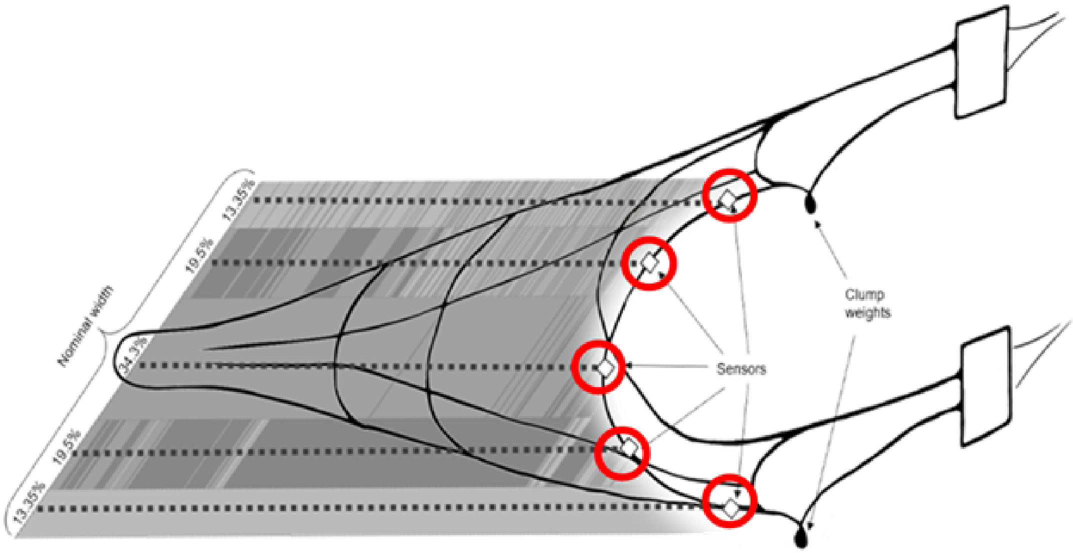


Figure 7.71: Position of contact sensors on trawl footrope.

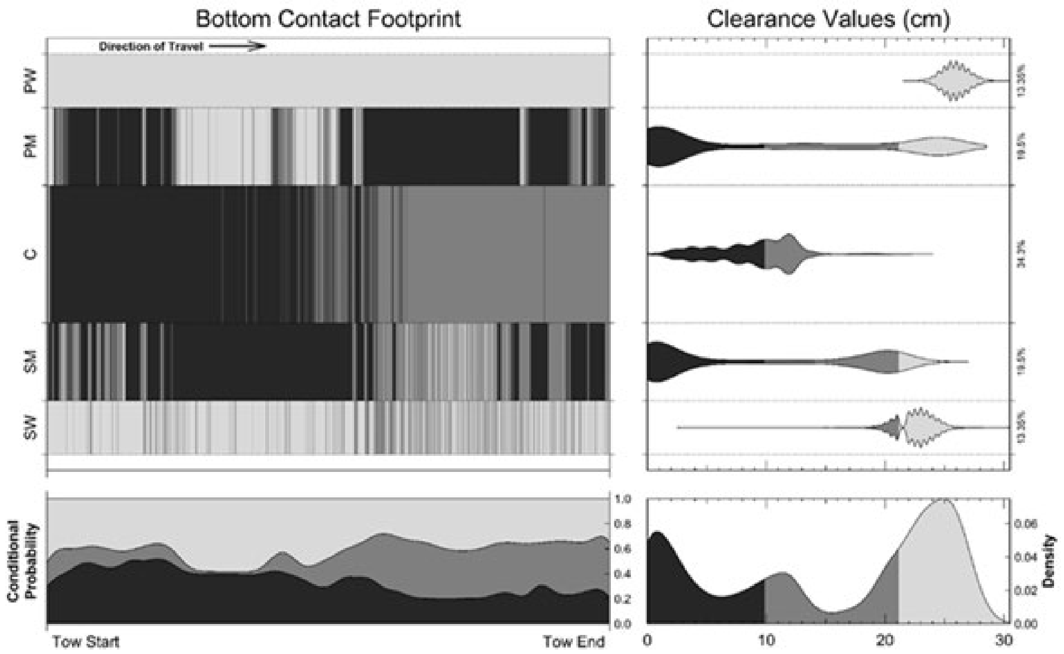


Figure 7.72: Outputs from footrope contact sensors

7.20 United States of America

7.20.1 Contact person

- Noëlle Yochum, Trident Seafoods, nyochum@tridentseafoods.com

7.20.2 Summary

- The 2023 WGFTFB national report from the U.S.A. describes 21 projects from states around the country.
- Projects from the U.S.A. are focused on the following topics:
  - Preventing whale entanglement by using ropeless fishing gear and rope with weak links, and modelling whale behaviour
  - Preventing whale depredation through catch protection devices
  - Using artificial light to increase species selectivity (i.e., reduce bycatch)
  - Developing bycatch reduction devices (BRDs) in whelk pot fisheries, and trawl fisheries for shrimp, silver hake, and groundfish
  - Using physical acoustics to quantify sea turtle encounters in shrimp trawls
  - Comparing catch from demersal and pelagic (or semi-pelagic) gear in bottom trawl fisheries
  - Studying connectivity, movement, and distribution of fish in an offshore wind farm area
  - Incorporating machine learning into electronic monitoring programs
  - Testing hook sizes, appendages, and a change from demersal to semi-demersal gear to reduce bycatch in a longline fishery
  - Evaluating survey gear performance using camera monitoring
  - Developing active selection devices in trawl gear

7.20.3 Projects

7.20.3.1 Project: Laboratory Observations of Channeled Whelk (WhelkCam)

Project Full Title: Developing a small whelk bycatch reduction device for channeled whelk pots in Massachusetts

Project Timeframe: November 2019 – March 2022

Institution(s): Massachusetts Division of Marine Fisheries

Contact person: David Chosid, david.chosid@mass.gov

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes (reduction of ghost gear effectiveness)

Summary: Our goal was to develop a workable modification to whelk pots to allow escapement and reduce surfacing of undersized channeled whelk (*Busycotypus canaliculatus*). Channeled whelk were initially observed in tanks without pots and inside or outside of industry standard wire and wooden conch pots (whelk traps) to understand their basic behaviours - movement, pot entry and escape, and bait preferences. We completed seven examinations and collected 164 hours of video in 2019 observing behaviours of 33-35 channeled whelk and their bait preferences.

Five additional examinations were conducted in 2020 with varied numbers of whelk and over 98 hours of video collected. In 2021, two bait preference examinations were completed on 23 whelk without video. Whelk activity levels appeared linked to water temperature. It is inconclusive if light levels affected activity levels as visibilities during dark periods were usually low. Standard wire pots effectively kept all whelks inside. Whelk preferred lobster bait over bluefish and green crab with little time of food deprivation prior. It is less clear if the whelk preferred tautog over black sea bass as both were largely consumed or if the whelk were less discerning due to hunger from extended periods of food deprivation or environmental factors.

Various pot modifications were tested in 16 trials for escapement of undersized whelk (using shell width was the primary metric) and for observations of escape behaviours. Each trial used a maximum of 14 whelk. Over 769 hours of video from escape trials were collected. Rectangular escape vents (5.1 cm smallest dimension) were set in wire pots as modifications and set singly in a horizontal direction, singly in a vertical direction, or with two escape vents in vertical directions on opposite pot sides (Figure 7.73). A wood pot comprised of vertical wooden slats with a maximum gap of 4.9 cm was also tested (Figure 7.74). Best escapement of undersized whelk were achieved in the wood pot and the wire pot with two vents. Further vent size testing and field trials are recommended.

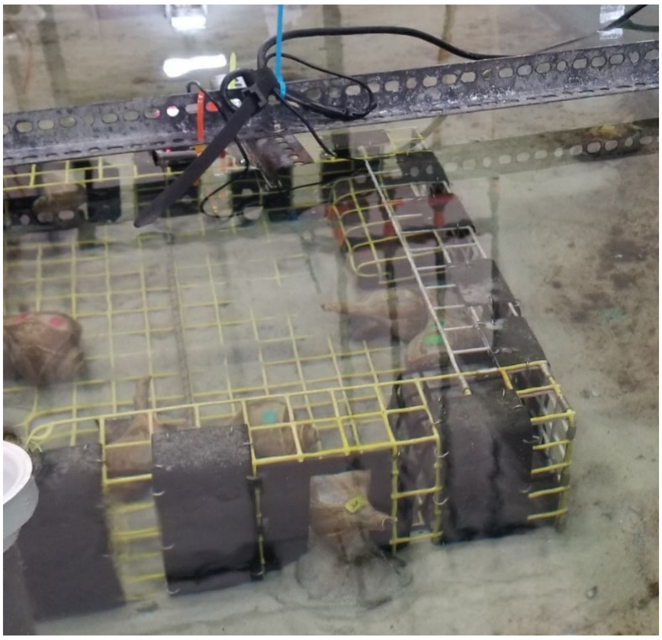


Figure 7.73: Modified wire whelk pot with two escape vents. Whelk seen attempting to es-cape.

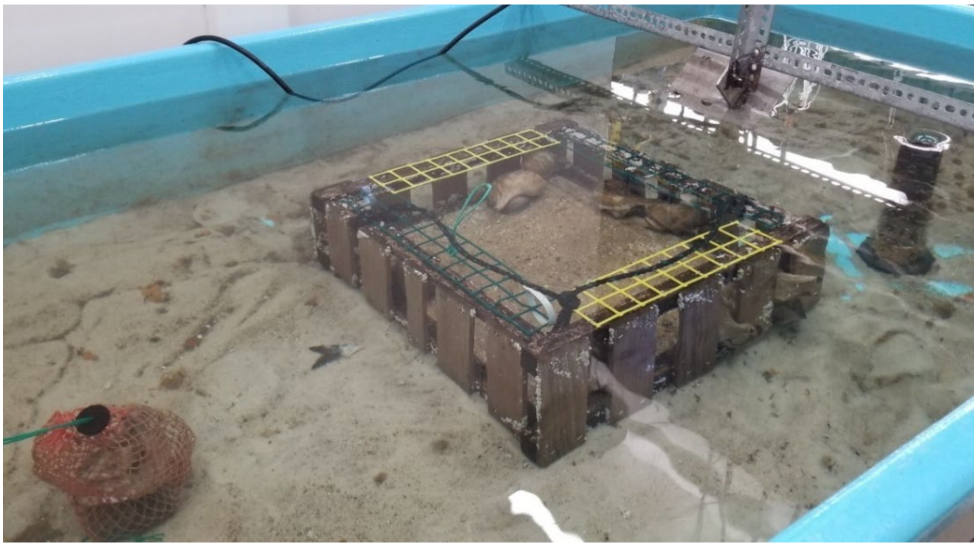


Figure 7.74: Wood whelk pot used during escape trials. Whelk seen attempting to escape.

7.20.3.2 Project: Off-Bottom Trawl (OBT)

Project Full Title: Complementary testing of off-bottom trawls to target Georges Bank haddock

Project Timeframe: January 2017 – March 2020

Institution(s): Massachusetts Division of Marine Fisheries; Gulf of Maine Research Institute; School for Marine Science and Technology – Univ. of Massachusetts Dartmouth

Contact person: David Chosid, david.chosid@mass.gov

Link(s): (Submitted for publication)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: We tested the catch, bycatch, and handling of two pelagic or off-bottom trawls (OBTs), where the doors and nets are intended to fish completely off-bottom, and compared them against a demer-sal selective trawl (the Ruhle trawl) targeting haddock (*Melanogrammus aeglefinus*) without cap-turing less robust, but still valuable groundfish stocks like Atlantic cod (*Gadus morhua*) and some flatfish species on Georges Bank, USA. The OBTs use innovative, large mesh "helix" twine on the front ends with coils in the twine to self-spread the meshes while towing (Figure 7.75). Multiple mensuration methods were used to try to determine if OBTs could be fished consistently near, but not touching, the seafloor. Tuning trips were conducted for the two different OBTs on-board a groundfish trawler, followed by catch comparative testing vs. a bottom-tending Ruhle trawl. For both OBTs, during catch comparison testing, drop chains were added near the wingends for most tows, creating some contact with the bottom.

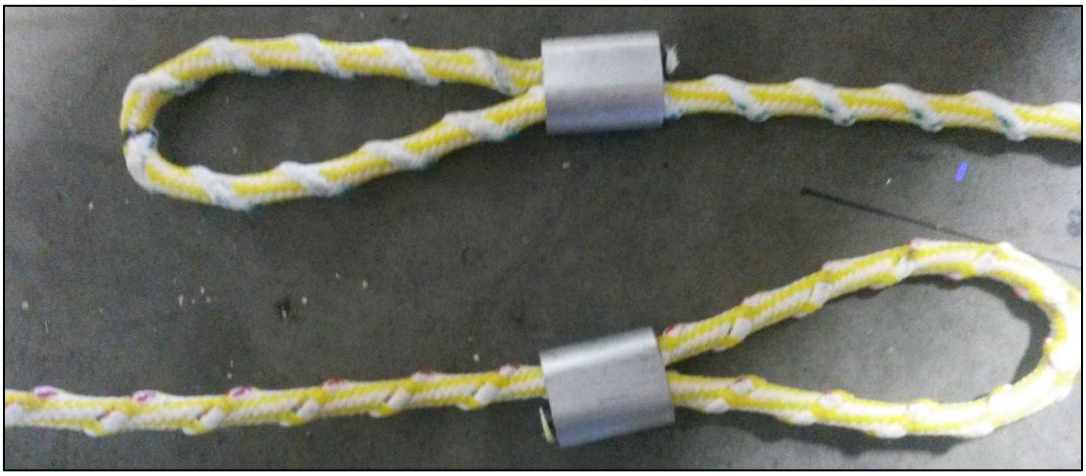


Figure 7.75: Helix twine with markings delineating the direction of coils, clockwise (red; bot-tom) and counterclockwise (green; top).

The first OBT revealed that the fishing line could maintain the desired height of under one meter, even without additional drop chains, although frequent attention to the vessels RPMs or adjustments of the amount of warp wire were required to maintain that height and optimal door spread. There was no significant difference in RPMs between this OBT and the Ruhle trawl although tow speed was significantly different. The other OBT, about double the size of the first, was difficult to set in the work area, which likely did not have adequate depth for the required amount of warp wire to achieve optimal door spreads. It also required significantly more RPMs than any other trawl used in this project.

Both OBTs successfully maintained haddock catches while reducing several non-target species as compared to the Ruhle trawl. No significant difference in fish lengths were identified for any species between the OBTs and Ruhle trawl which was unexpected due to the use of smaller OBT codend mesh sizes (13 cm square mesh vs. 15.4 cm diamond mesh). Probably due to the size of the larger OBT, more pelagic species became captured in this net or enmeshed for unknown periods and, in some cases, damaged parts of the net.

Bottom contact was likely reduced for both OBTs compared to the Ruhle trawl but not eliminated as indicated by the reduction in bottom dwelling species in both designs. This outcome may be sufficient to open new regulated areas for access, but perhaps not in all habitats where disturbances are problematic for the ecosystem. Further practice may allow for the elimination of drop chains and all seafloor contact and the targeting of additional healthy fish stocks.

7.20.3.3 Project: Southern Hake

Project Full Title: Bycatch reduction of red hake in the Southern New England silver hake trawl fishery

Project Timeframe: August 2019 – December 2022

Institution(s): Massachusetts Division of Marine Fisheries; School for Marine Science and Technology – Univ. of Massachusetts Dartmouth

Contact person: David Chosid, david.chosid@mass.gov

Link(s): (In preparation for final report)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The red hake (*Urophycis chuss*) stock in the USA southern New England whiting trawl fishery is overfished with overfishing occurring and requires rebuilding. Our goal was to reduce red hake catch and catch of other fish stocks in rebuilding statuses, without reducing catches of more healthy stocks such as silver hake/whiting (*Merluccius bilinearis*), by using a large-mesh belly panel modification in a whiting net. The modification was a colour-matched 38.1 cm mesh-sized panel across the bottom sheet, 62 meshes across gore-to-gore and 15.5 meshes deep, in the stand-ard trawl net's mouth, replacing panels, starting near the footrope, that were 13.0 cm sized meshes and partially replacing another panel aft that was 6.5 cm sized mesh. The large-mesh belly panel was hypothesized to exploit behavioural differences between species allowing escapement of some weaker stocks including red hake.

We conducted two Georges Bank trips and 64 valid alternate tows on-board a groundfish trawler, day and night and consistent with commercial length tows times and distances. The large-mesh belly panel and the standard-mesh belly panel were swapped for two similar nets between trips (switching experimental and control nets). Experimental net catches were compared against paired control net catches. Video were also collected at the nets' front ends to assess any vertical positioning differences between the silver and red hakes during tows.

Data are still being analysed but preliminary results indicate that there are no significant differences in catches between gear types for either red hake or silver hake and no trip or day/night effects for these species. Additionally, there are no significant differences in the ratio of red to silver hake catches for each gear. Most other species also demonstrated no significant catch differences with some bottom-tending fish exceptions such as small flounders and little skates (*Leucoraja erinacea*). For species with length measurements taken and caught in totals over 100 kg, there are no major differences detected in length frequencies between gear types except for sig-nif-icant reductions in smaller sizes of fourspot flounders (*Hippoglossina oblonga*) and larger sizes of spotted hake (*Urophycis regia*).

7.20.3.4 Project: Gear-based Hook and Line Catch Protection from Depredation

Project Full Title: Gear-based approaches to catch protection as a means for minimizing whale depredation in longline fisheries.

Project Timeframe: November 2021 – October 2023

Institution(s): International Pacific Halibut Commission (IPHC), National Oceanic Atmospheric Administration (NOAA)

Contact person: Claude L. Dykstra, claude.dykstra@iphc.int

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Possibly. Breaking the depredation reward cycle could lead to less interactions in and around fishing gear, thereby reducing any theoretical bycatch risks to the depredators.

Is the project addressing ALDFG? No

Summary:

Aim: This project will help refine potential devices that can be used in the Pacific halibut fishery to protect catch on the gear from removal or damage by whales and to potentially interrupt the reward cycle leading to depredation.

Status: This project takes a two-step approach to protecting fish already caught on hooks from marine mammal depredation: 1) Work with fishermen and gear manufacturers, via direct communication and through an international workshop, to identify effective methods for protecting hook captured flatfish from depredation; and 2) develop and pilot test some simple low-cost catch-protection designs that can be deployed on vessels currently operating in the Northeast Pacific.

Rather than develop a new fishing gear or method, the goal is to generate ideas for the creation of low cost, easy to adopt gear modifications, to securely retain demersal longline catch of flatfish (e.g., Pacific halibut (*Hippoglossus stenolepis*) or Greenland turbot (*Reinhardtius hippoglossoides*)): essentially creating some additional tools for the fishermen's toolbox.

Results: The first phase of this project consisted of recruiting participants for a catch protection workshop from the scientific community and from the harvesters active in the waters of Alaska, British Columbia and the U.S. west coast. Three globally diverse groups actively working on development of catch protection devices (Sago Solutions, Norway; National Institute for Sustainable Development (IRD) – Marine Biodiversity, Exploitation, and Conservation Unit (MARBEC), University of Montpellier – CNRS-INFREMER-IRD National Centre for Scientific Research, Centre d'Etudes Biologiques de Chisé, France; and Fish Tech Inc., United States) presented on their varied research avenues and highlighted both failures and successes. Harvesters active in the Pacific halibut and Greenland Turbot fisheries as well as scientists involved in marine mammal research contributed their experiences and ideas through a structured interactive discussion. The workshop was held electronically on 9 February 2022 and brought together 74 participants from 6 countries. Subsequent to the workshop, a report summarizing material presented and discussion was produced and posted in the IPHC's website along with video recordings of the entire workshop: https://www.iphc.int/venues/details/1st-international-workshop-on-protecting-fishery-catches-from-whale-depredation-ws001 .

Subsequent to the workshop, two catch protection device designs to be tested were developed: a) an underwater shuttle (Figure 7.76) and b) a branchline gear with a sliding shroud system (Figure 7.77). These are now being manufactured for expected pilot testing in Alaska in the spring or early summer of 2023.

The purpose of the testing will be to investigate (1) the logistics of setting, fishing, and hauling of the two pilot catch protection designs, and (2) the basic performance of the gear on catch rates and fish size compared to non-protected gear.

Future: Provided initial testing demonstrates that one or both of the devices have potential as simple to use devices, further testing in the presence of whales will need to be conducted subject to available funding.

[For now not completing the following section until we have results to report from the pilot testing described above. In next year's report, we should be able to comment on the section below.]

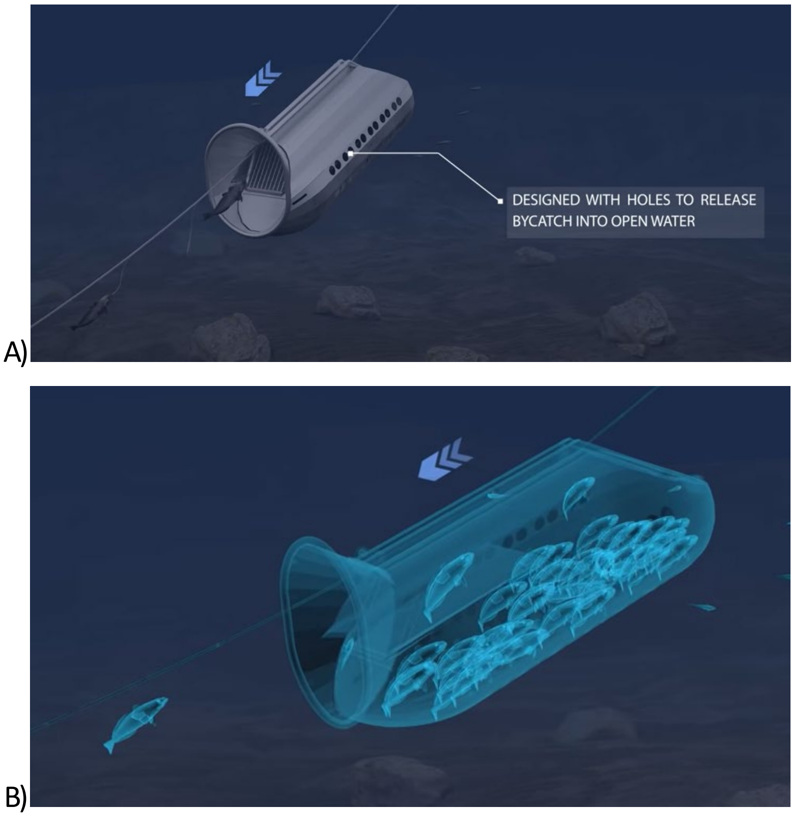


Figure 7.76: Schematic of underwater shuttle device, as it slides down the groundline (A) and cross-sectional view of fish released and contained within the device (B) (images from Sago Solutions presentation). Shuttle devices are approximately 2.60m (8.5ft) long by 0.80m (2.6 ft) in diameter, each weighing approximately 100 kg (220 lb.) when empty.

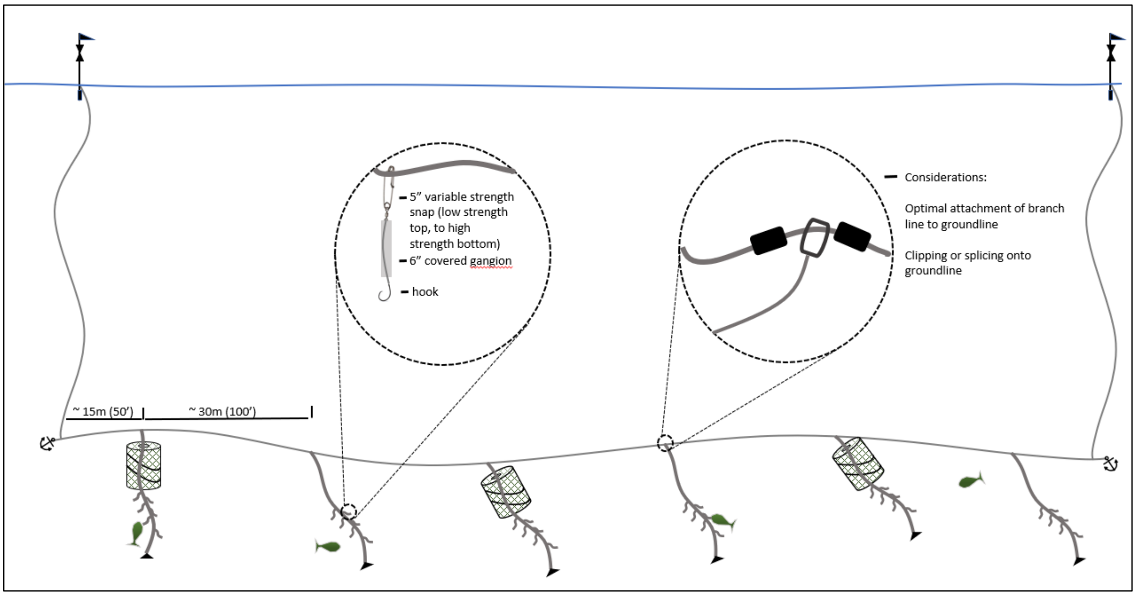


Figure 7.77: Schematic (not to scale) of branchline gear with a sliding shroud system as viewed from the side during the soak. Branchlines are 15 m (~48ft) long and are affixed at 30m (~100 ft) spacing. Ten (10) short covered gangions with hooks are snapped (with variable grab strength to allow slippage during hauling) to the branchlines on 1.2m (4') spacing. Weighted spring coiled shroud devices are approximately 2m (6.5ft) long by 1m (3.25ft) in diameter, each weighing approx-imately 24kg (52lb), are covered in mesh with an open end allowing devices to slide down and over the gangions and any catch.

7.20.3.5 Project: Sea Turtle Encounters

Project Full Title: Acoustic enumeration of sea turtle encounters in shrimp trawls

Project Timeframe: May 2022 – June 2023

Institution(s): NOAA Fisheries, University of Mississippi, National Center for Physical Acoustics

Contact person: Dan Foster, daniel.g.foster@noaa.gov

Link(s):

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Turtle Excluder Devices (TEDS) are required by law in the southeastern United States shrimp trawl industry. The device is a large metal grid that allows the passage of shrimp and small fish into the trawling net but forces larger animals (particularly turtles) out through an escape open-ing. With the implementation of TEDs, it is difficult to quantify trawl interactions with sea turtles because by design most of the turtles escape from the net. In addition, some turtles that are caught and drown are excluded from the net during haul-back and never observed. Shrimping operations typically occur at night and in turbid water, thus making camera systems inadequate for accurate estimation of turtle interactions.

Researchers have discovered that sea turtle impacts on the grid have a distinct acoustic signature as compared to other marine organisms. Beginning in 2022, NOAA Fisheries is collaborating with the University of Mississippi, National Center for Physical Acoustics to develop a method to quantify sea turtle encounters by the acoustic signature. Trawls will be equipped with video and acoustic recorders (Ocean Instruments Sound Trap).

In 2022, researchers conducted 9 days of fieldwork, where they obtained acoustic recordings of 52 sea turtles interacting with the grid. Additional work is planned for 2023 to increase the sample size. An algorithm is being developed to distinguish sea turtle impacts from that of other marine organisms. This algorithm will allow more accurate estimates of turtle takes and, when paired with vessel GPS data, could provide valuable information about turtle populations, distribution and movements.

7.20.3.6 Project: Shrimp Trawl Bycatch

Project Full Title: Better bycatch reduction devices for the Gulf of Mexico commercial shrimp trawl fishery

Project Timeframe: 2020 – 2027

Institution(s): NOAA Fisheries, Texas Sea Grant and Louisiana Sea Grant

Contact person: Dan Foster, daniel.g.foster@noaa.gov

Link(s): https://www.gulfspillrestoration.noaa.gov/restoration-areas/open-ocean

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: On April 20, 2010, an explosion occurred on the Deepwater Horizon drilling platform in the Gulf of Mexico causing the largest offshore oil spill in U.S. history. Fish and water column resources injured by the oil spill include species from all levels of the marine food web.

Restoration work focuses on restoring the living marine resources and their services that were injured by the spill. Efforts to restore fish includes incentivizing Gulf of Mexico commercial shrimp fishers to in-crease gear selectivity and environmental stewardship. The DWH restoration project termed the “Better BRDs Project” is a 7-year ($17M) project that will focus on identifying new advances in Bycatch Reduction Device (BRD) technology, validate the effectiveness of improved BRDs through testing, maximize the use of BRDs through outreach and incentives, and maximize res-toration benefits through dockside BRD training.

In 2022, NOAA researchers conducted field trials of three new BRD designs that have been developed both internationally and domestically. The next phase of testing will take place industry vessels starting in 2023. Once industry testing is complete, the most suitable devices will be distributed to the fishery through an incentivized use program.

7.20.3.7 Project: Fish Behaviour and Distribution around Offshore Wind Farms

Project Full Title: Connectivity, movement and distribution of fish in offshore wind farm areas

Project Timeframe: January 2023 – December 2024

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project combines acoustic telemetry, stationary bottom and midwater stereo cameras (spaced at different distances from the turbines), and an acoustic imaging sonar camera (ARIS, capable of observation at night) to study connectivity, movement and spatial distribution (verti-cal and horizontal) of three commercially and recreationally important fish species (black sea bass, striped bass and summer flounder) in the Block Island Wind Farm area. The study will address if there is connectivity for some species between turbines and if this results in a larger impact to ecosystems than if impacts are localized to an individual turbine. The study will improve our understanding on the ecosystem interactions of fish with offshore wind farms.

7.20.3.8 Project: Machine Learning and Electronic Monitoring

Project Full Title: Incorporating machine learning into the NE Multispecies Groundfish Electronic Monitoring Programs to quantify species and sizes of discards

Project Timeframe: January 2021 – December 2023

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The UMass Dartmouth School for Marine Science and Technology (SMAST) has partnered with the leading cloud-based electronic monitoring company, Integrated Monitoring Inc. (IM), the nation's largest at-sea observer company, AIS Inc. and the largest groundfish company in New England, Blue Harvest Fisheries LLC to develop and incorporate AI and machine learning tools onboard high-volume groundfish vessels in New England. The goal is to reduce the cost of EM programs with AI technology that improves the operational efficiency, accuracy, and timeliness of EM discard data for science and management. The project will develop a new automated dis-card system with integrated stereoscopic cameras to automatically identify, count, measure, and estimate volume/weight of sub-legal groundfish that is to be discarded in real time.

7.20.3.9 Project: Intelligent Discard Chute

Project Full Title: Developing an innovative electronic monitoring program for New England gf by integrating an intelligent discard chute for high volume discards

Project Timeframe: November 2022 – May 2024

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project is to design and test an intelligent discard chute to compliment electronic monitor-ing for high-volume New England groundfish industry. The project will incorporate high tech-nology optical system, and artificial intelligence to document species and sizes of fish that is being discarded from the fishery. The project collaborates between a fishery observer enterprise, an electronic monitoring enterprise, SMAST and College of Engineering at the University of Mas-sachusetts Dartmouth. The project has just started with initial chute design and software devel-opment commenced.

7.20.3.10 Project: Testing of Modified Hooks in the Pacific Halibut Fishery

Project Full Title: Testing of hook sizes and appendages to reduce yelloweye rockfish bycatch in a Pacific halibut longline fishery

Project Timeframe: September 2021 – January 2023

Institution(s): Pacific States Marine Fisheries Commission; Oregon State University - Marine Resource Management Program; Oregon State University - Cooperative Institute for Marine Ecosys-tems and Resources Studies; International Pacific Halibut Commission; SINTEF Ocean; Universi-ty of Tromsø; DTU Aqua, Technical University of Denmark, Hirtshals, Denmark

Contact person: Mark Lomeli, mlomeli@psmfc.org

Link(s): n/a

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: In U.S. Pacific halibut (*Hippoglossus stenolepis*) longline fisheries off the West Coast and Alaska, bycatch of yelloweye rockfish (*Sebastes ruberrimus*) is a concern as their stock status along the West Coast is "rebuilding" from being overfished, while the SE Alaskan stock has shown a ~60% decline since at least 1994 and through 2015 where it stabilized. In this study, we evaluated how size 16/0 and 18/0 circle hooks (QiHook brand) affect the catch efficiency of Pacific halibut and yelloweye rockfish. Further, we examined the catch efficiency of these hooks modified with a 3.1 mm stainless-steel wire appendage extending 7.6 cm from their shank at either a 45o or 90o angle (Figure 7.78). We also wanted to estimate probabilities for modes of capture (hooking locations) for Pacific halibut and yelloweye rockfish for the hooks tested, and determine by using hook tim-ers if there is a temporal component in the catch between Pacific halibut and yelloweye rockfish. Results showed hook size did not significantly affect catch efficiency of Pacific halibut or yel-loweye rockfish. However, hooks with a 45o appendage angle caught significantly fewer yel-loweye rockfish than hooks without an appendage, irrespective of hook size. Apendage angle did not affect the catch efficiency of Pacific halibut. For both Pacific halibut and yelloweye rockfish, the most frequent mode of capture was the *hook through cheek*, both with and without an append-age. Catches of Pacific halibut and yelloweye rockfish did not differ temporally; however, most individuals were caught within 3 hours of gear deployment. Results from our study suggest that hook appendages could have potential use in reducing catch rates on yelloweye rockfish in Pacif-ic halibut longline fisheries. Funding for this research was provided by the NOAA Bycatch Re-duction Engineering Program.

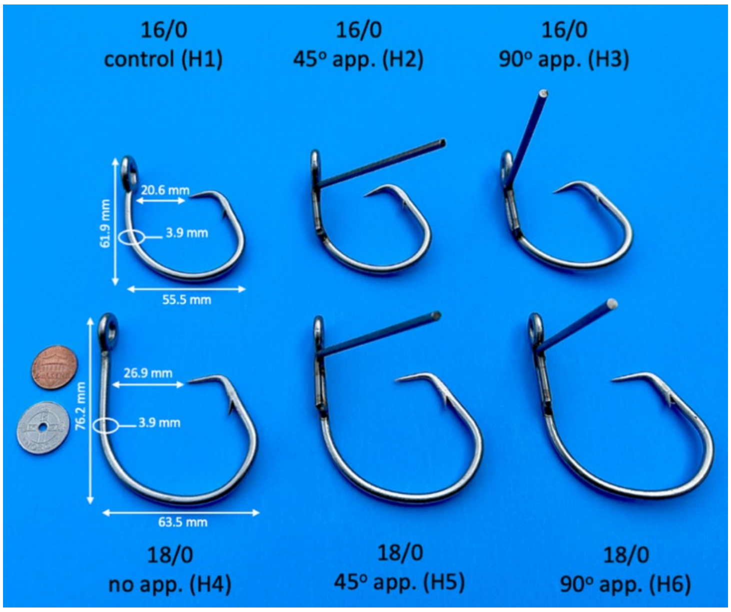


Figure 7.78: Image of the control hook (H1) and the five experimental hooks (H2-H6) exam-ined. app. = appendage. Scale: Diameter of the Norwegian 1 krone displayed is 21 mm, diameter of the United States 1 cent displayed is 19 mm.

7.20.3.11 Project: Evaluating Semi-Pelagic Trawl Gear in a Bottom Trawl Fishery

Project Full Title: Evaluating the efficacy of semi-pelagic trawl gear to harvest demersal fishes in the U.S. West Coast groundfish bottom trawl fishery

Project Timeframe: September 2021 – December 2022

Institution(s): Pacific States Marine Fisheries Commission; Oregon State University - Marine Resource Management Program; Oregon State University - Cooperative Institute for Marine Ecosys-tems and Resources Studies; SINTEF Ocean; University of Tromsø; DTU Aqua, Technical Univer-sity of Denmark, Hirtshals, Denmark

Contact person: Mark Lomeli, mlomeli@psmfc.org

Link(s): n/a

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study involved catch comparison sampling and analyses to determine how changing from a conventional trawl rigged with bottom tending doors to a semi-pelagic trawl rigged with mid-water doors affect the catch efficiency of demersal fishes in the West Coast groundfish bottom trawl fishery. For both trawl designs, the most abundant species caught by weight were sablefish (*Anoplopoma fimbria*), Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), petrale sole (*Eopsetta jordani*), and lingcod (*Ophiodon elongatus*). Mean CPUE values for Dover sole, lingcod, and petrale sole were slightly higher in the semi-pelagic trawl, whereas the conventional trawl showed a slightly higher mean CPUE effort value for shortspine thornyhead. However, these results were only trends and not significant. For sablefish, a significant catch result was observed with the semi-pelagic trawl catching significantly more sablefish (a mean CPUE increase of 169.8% [95% CLs: 38.9-327.9]) than the conventional trawl (Figure 7.79). Trawl door sensors showed the semi-pelagic trawl exhibited a 42.1 m increase in door spread com-pared to the conventional trawl, while bottom contact sensors showed the midwater trawl doors outfitted on the semi-pelagic trawl fished on average a minimum of 0.8 m above the seafloor; Thus, providing sufficient height for lower-profile epifaunal and infaunal organisms to pass under the door without contact or disturbance. Our research demonstrates that semi-pelagic trawl gear can effectively harvest demersal groundfishes in the West Coast groundfish bottom trawl fishery while significantly reducing trawl-seafloor interactions. Lastly, this research is con-tributing to the Master of Science degree of a student enrolled in the Marine Resource Manage-ment program at Oregon State University. Funding for this research was provided by the NOAA Bycatch Reduction Engineering Program and Deep Sea Coral Research and Technology Program.

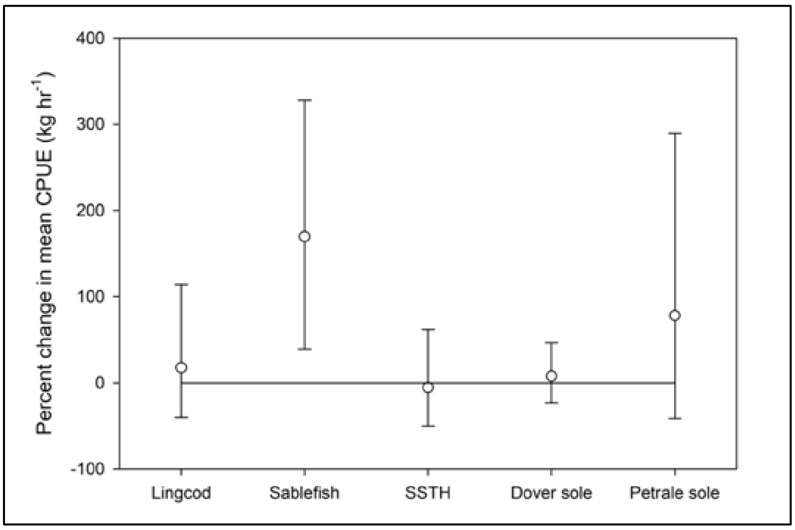


Figure 7.79: Percent change in mean CPUE (kg hr-1) for the semi-pelagic trawl for lingcod, sablefish, shortspine thornyhead (SSTH), Dover sole, and petrale sole. Open cir-cles are mean CPUE . Vertical lines are the 95% CLs.

7.20.3.12 Project: Testing of Semi-Demersal Longlines in a Pacific Halibut Fishery

Project Full Title: Testing of semi-demersal longlines to reduce yelloweye rockfish bycatch in the West Coast directed Pacific halibut longline fishery

Project Timeframe: October 2022 – February 2024

Institution(s): Pacific States Marine Fisheries Commission; NOAA NMFS Northwest Fisheries Science Center; Oregon State University - Marine Resource Management Program; Oregon State University - Cooperative Institute for Marine Ecosystems and Resources Studies; International Pacific Halibut Commission

Contact person: Mark Lomeli, mlomeli@psmfc.org

Link(s): n/a

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study will conduct catch comparison and catch ratio sampling and analyses to determine if changing from a demersal to semi-demersal longline affects the catch rates of Pacific halibut (*Hippoglossus stenolepis*) and yelloweye rockfish (*Sebastes ruberrimus*). The difference between the two gear designs is that the semi-demersal longline will utilize 14" center-hole floats spaced apart along its groundline to elevate sections up to 5 m above the seafloor. We plan to fish 63-72 skates (6,300-7,200 hooks) during our sea trials. All species caught will be measured for subse-quent length-dependent catch comparison and catch ratio analyses. To determine if there is a temporal component in the catch of Pacific halibut and/or yelloweye rockfish, hook timers will be placed on gangions (Figure 7.80). Comparison of time-to-capture between Pacific halibut and yelloweye rockfish will allow for evaluation of potential behavioral differences in the capture of each species. Further, we will estimate probabilities for modes of capture (hooking locations) for Pacific halibut and yelloweye rockfish caught between the longline configurations. This study will occur off the U.S. West Coast during 2023 and contribute to the Master of Science degree of a student enrolled in the Marine Reource Management program at Oregon State University. Fund-ing for this research was provided by the NOAA NMFS Northwest Fisheries Science Center Cooperative Research Program.

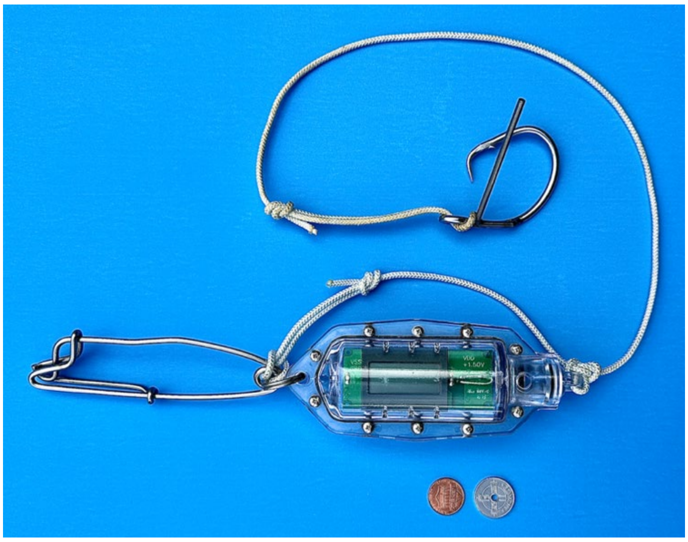


Figure 7.80: Examine of a hook timer rigged to a gangion. Scale: Diameter of the Norwegian 1 krone displayed is 21 mm, diameter of the United States 1 cent displayed is 19 mm.

7.20.3.13 Project: Juvenile Sablefish Bycatch Reduction in Bottom Trawl Fishery

Project Full Title: Further development of a flexigrid system to reduce juvenile sablefish catches in the West Coast groundfish bottom trawl fishery

Project Timeframe: September 2022 – December 2024

Institution(s): Pacific States Marine Fisheries Commission; Oregon State University - Marine Resource Management Program; Oregon State University - Cooperative Institute for Marine Ecosys-tems and Resources Studies; NOAA NMFS Northwest Fisheries Science Center.

Contact person: Mark Lomeli, mlomeli@psmfc.org

Link(s): n/a

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study will build off prior research where we worked with fishers to quantify the efficacy of a modified flexigrid system designed to further increase the reduction of juvenile sablefish (*Anoplopoma fimbria*) catches in the West Coast groundfish bottom trawl fishery. Gear performance will be directly measured using the covered gear method. Mean size-selection properties (L50, SR) will be modeled for sablefish and other target groundfishes. Gear trials will occur onboard a commercial fishing vessel. Following gear trials, results will be presented to fishers, industry managers, and the Pacific Fishery Management Council highlighting the economic and ecologi-cal benefits of the modified flexigrid system if applied to the fishery. Lastly, this research is con-tributing to the Master of Science degree of a student enrolled in the Marine Reource Management program at Oregon State University. Funding for this research was provided by the NOAA By-catch Reduction Engineering Program.

7.20.3.14 Project: Use of Artificial Light to Reduce Pacific Halibut Bycatch

Project Full Title: Artificial illumination of trawl gear components to reduce Pacific halibut (*Hippoglossus stenolepis*) bycatch in West Coast bottom trawl fishery

Project Timeframe: July 2021 – January 2024

Institution(s): Pacific States Marine Fisheries Commission; Virginia Institute of Marine Science; NMFS Alaska Fisheries Science Center; International Pacific Halibut Commission; Oregon State University - Cooperative Institute for Marine Ecosystems and Resources Studies; Trident Seafoods

Contact person: Mark Lomeli, mlomeli@psmfc.org

Link(s): n/a

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study used catch comparison and catch ratio sampling and analyses techniques to deter-mine if catches of Pacific halibut and groundfishes differ between illuminated and non-illuminated high-rise bottom trawls. In a collaborative effort, our research team worked in the U.S. West Coast groundfish bottom trawl fishery where Pacific halibut (*Hippoglossus stenolepis*) are a prohibited species barring their post capture retention. CPUE (by weight) and length data were collected on species of commercial importance. Biological data (e.g., length-weight relationships, somatic fat content, and blood samples to look at physiological stress indicators glucose, lactate, cortisol) on Pacific halibut was also collected to see if physiological condition could be related to their ability to avoid trawl capture (these analyses are currently occurring). Preliminary length-integrated analysis results show the illuminated trawls on average caught fewer Pacific halibut than the non-illuminated trawls as well as fewer sablefish (*Anoplopoma fimbria*), Dover sole (*Microstomus pacificus*), and petrale sole (*Eopsetta jordani*). However, these catch reductions were not statistically significant. The Length-dependent analysis for these species is currently occurring. In addition to the potential application of project results to fishery management, this research is contributing to the Master of Science degree of a student enrolled in the School of Ma-rine Science - Fisheries Science concentration at the Virginia Institute of Marine Science. Funding for this research was provided by the NOAA Bycatch Reduction Engineering Program.

7.20.3.15 Project: HD Camera for Monitoring Scallop Dredge

Project Full Title: *In Situ* high-definition camera monitoring to evaluate catch efficiency and performance of a survey dredge

Project Timeframe: January 2019 – December 2022

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology (in collaboration with Virginia Institute of Marine Science)

Contact person: Chris Rillahan, Crillahan@umassd.edu

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project was to conduct *in situ* observation and monitoring of a sea scallop survey dredge to understand and evaluate its catch efficiency and selectivity under different habitat conditions. High-definition video cameras equipped with synchronized strobe lights was used to document size and density of scallop in front of the dredge. An inclinometer was placed on the survey dredge to measures dredge tilt angle and bottom contact. Together with bag sampling, dredge efficiency, selectivity, saturation and other aspects of dredge performance across a range of habi-tat types and survey conditions (i.e., densities of scallops and debris) were determined. Infor-mation on bycatch species were also collected in an effort to estimate species-specific dredge efficiency estimates.

7.20.3.16 Project: LED Light Technology to Reduce Bycatch

Project Full Title: Artificial light as a tool to reduce bycatch in the sea scallop, Placopecten, magel-lanicus, dredge fishery

Project Timeframe: April 2021 – March 2023

Institution(s): Virginia Institute of Marine Science, SafetyNet Technologies

Contact person: Sally Roman, saroman@vims.edu

Link(s): https://www.vims.edu/research/units/centerspartners/map/comfish/scallop/index.php

https://sntech.co.uk/products/pisces/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The Virginia Institute of Marine Science and SafetyNet Technologies tested the effectiveness of SafetyNet Technologies Pisces LED light system to reduce bycatch in the sea scallop dredge fish-ery. Three sea trials were conducted in what is referred to as Closed Area II on eastern Georges Bank in the Northwest Atlantic from August through October 2022, in collaboration with the F/V KATE and its commercial crew. This is an important resource area for the fishery. The fishery has limited access to the area because of high catch rates of yellowtail and windowpane flounder at certain times of the year. Accountable measures (gear restrictions and area closures) are al-ready in place to mitigate catches of these flatfish; however, there is a need to further reduce by-catch as the fishery has exceeded its annual catch limit in 2020 and 2021.

Three light colours (white, green and blue) were tested on the scallop dredge in two locations (Figure 7.81). Lights were wielded to the bale bar looking out from the dredge, and on twine top in two locations in conjunction with a two row 2.5 cm square mesh escape panel. A constant light and an 8 Hz flash rate were also tested for white and green colours, as well as two brightness levels for white (79 and 46 lumens) and green (79 and 55 lumens) colours. The escape panel was tested in the middle of the twine top and at the bottom of the twine top ahead of the skirt portion of the dredge bag. The effect of the square mesh escape panel was also tested by turning off the Pisces light system on the dredges.

Data analysis is ongoing. Preliminary catch data for windowpane flounder has indicated a reduction in catch for both square mesh escape panel configurations. The escape panel located at the bottom of the twine top had a higher reduction in windowpane with and without the Pisces light system illuminating the panel. The escape panel located in the centre of the twine top only had a reduction in catch when the Pisces light system was on. Reductions were observed across all light colours, flash rates, and brightness levels. There was no difference in the target species catch for either escape panel configuration or Pisces light colour, flash rate or brightness level. Having the Pisces light system attached to the bale bar did not affect catch rates of windowpane flounder. This is believed to be a result of the commercial towing speed of approximately 9 km/hr, where flatfish do not have time to react to the oncoming gear.

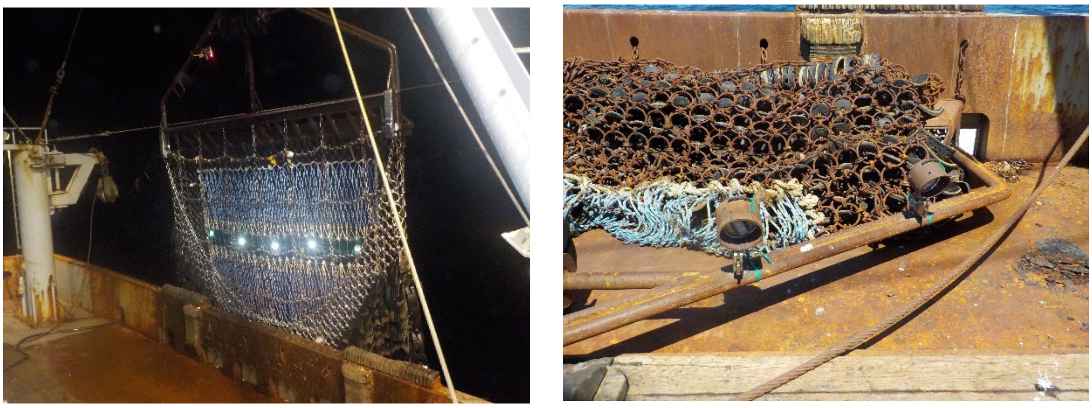


Figure 7.81: (Left) Pisces LED lights located in the middle of the twine top with the square mesh escape panel in constant white light. (Right) location of Pisces LED lights welded to the bale bar of the scallop dredge.

7.20.3.17 Project: Continued Development and Deployments of Active Selection (ActSel) Systems

Project Full Title: Improving and encouraging adoption of active selection (ActSel) systems to reduce bycatch in catch-share trawl fisheries of the North Pacific

Project Timeframe: May2022 – February 2024

Institution(s): FishNext Research

Contact person: Craig S. Rose, fishnextresearch@gmail.com

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project follows one (Rose et al. 2022, https://youtu.be/4tcELNZUYG0) that developed a practical and effective system (Active Selection, ActSel; Figure 7.82) allowing captains to trigger the release of unwanted fish (bycatch) when they are observed in real-time video from their trawl. Continuing this effort, the current project 1) provides ActSel systems to trawling vessels to gain experience with incorporating them into routine fishing operations, and 2) continues develop-ment of ActSel systems and components. So far, three systems were deployed on trawl vessels. These deployments identified needs to standardize adjustments to and configuration of the con-trol lines that manipulate the kites that cause net panels to open or cover escape openings. Sys-tem improvements have included replacing binary (open or close) actuator controls with programming that allows incremental adjustments. Scale model trials are planned to explore differ-ent kite and control line designs to optimize system performance. Commercial trawler captains and crew are being engaged in both the deployments and the conceptualization, development and testing of improvements.

Rose, C.S. and D. Barbee. 2022. Developing and testing a novel active-selection (ActSel) bycatch reduction device to quickly alternate trawls between capture and release configurations with real-time triggering. Fisheries Research 254 #106380 https://doi.org/10.1016/j.fishres.2022.106380

Figure 7.82: ActSel selection panel (lighter grey, smaller mesh) and kite installed in a trawl.

7.20.3.18 Project: Ropeless Fishing Prototypes

Project Full Title: Testing a ropeless fishing prototype for eliminating large whale entanglements in pot fishing gear

Project Timeframe: July 2018 – October 2022

Institution(s): Consortium for Wildlife Bycatch Reduction, New England Marine Monitoring, Woods Hole Oceanographic Institution, New England Aquarium, UMASS-Boston

Contact person: Tim Werner, timothy.werner@umb.edu

Link(s): www.bycatch.org

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? N/A

Is the project addressing ALDFG? Yes

Summary: The focus of this project was on evaluating the potential for implementing ropeless fishing (Figure 7.83) to reduce the entanglement of large whales and sea turtles, in particular the North Atlantic right whale (*Eubalaena glacialis*). There were three components to this project: (1) collabora-tive trials with a fisherman to test two ropeless fishing systems using acoustic releases; (2) a test of a system for remotely monitoring lobster fishing; and (3) a GIS study to identify priority loca-tions for siting pilot ropeless fishing in the Gulf of Maine.

Results: Mean differences in gear redeployment time were not significant between the two gears tested and with the control (current) fishing method. This is important because greater deployment time across multiple trawls over an entire fishing season would quickly add up to several days of additional time at sea which may pose a significant burden to a fisher. Snarled lines, partic-ularly in ropeless systems that use containers, continued as a problem in this trial and even after several years of developing and improving these types of gear to lower the probability of their occurrence. To what extent snags occurred because of some inherent design flaw or human error was not resolved.

Encouragingly, the gear held up well in all kinds of oceanographic conditions, but it needs also to be tested in even deeper waters than the average 79m depth fished during this trial.

The EMS (electronic monitoring system) functioned well as a first attempt at monitoring lobster fishing in this region. It can act as an alternative to at sea monitoring by government officials operating at sea, but likely not for confirming the legal size of lobsters caught, which however can occur at dockside.

The GIS analysis undertaken under this project was intended to assist in this effort by identifying the best candidate areas for implementing ropeless fishing at an initial phase. In doing so, ropeless fishing can become more established and advance from the proof-of-concept stage into implementation, and achieve wider acceptance among more and more members of the fishing community. Our results are being consulted by NOAA and other stakeholders to identify possible applications in ropeless fishing.

Figure 7.83: The two ropeless systems tested during the field trial. Left: the Edgetech trap in which the vertical line is coiled inside an empty trap before hauling. Upper right: the flotation spool with the line coiled about and showing place-ment of a "coil pack" over an empty spool; at bottom is an engineering diagram of the spool. An acoustic release is placed in the center of the spool.

7.20.3.19 Project: Computer Modeling of Whale Entanglement

Project Full Title: Whale release ropes as a large whale bycatch mitigation option

Project Timeframe: July 2019 – October 2022

Institution(s): Consortium for Wildlife Bycatch Reduction, Tension Tech International, New Eng-land Aquarium, Blue Water Research and Conservation

Contact person: Tim Werner, timothy.werner@umb.edu

Link(s): www.bycatch.org

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? N/A?

Is the project addressing ALDFG? Yes

Summary: We developed a computer model using *Orcaflex* software that simulates large whale entangle-ments in vertical crustacean pot lines (Figure 7.84). The primary objective was to deter-mine loads on lines under different entanglement scenarios such as different pot configurations, depths, hauling speed, and whale contact points. Specifically, the emphasis was on identifying the sce-narios in which ropes of reduced breaking strength might still be fished practically while parting under contact with large baleen whales such as the North Atlantic right whale.

Results from this project are being consulted by NOAA and lobster fishermen to determine where weak "links" (Figure 7.85) might be inserted into vertical lines to decrease the probability of per-sistent and severe whale entanglements. A second phase of this project is in progress with the same collaborators.

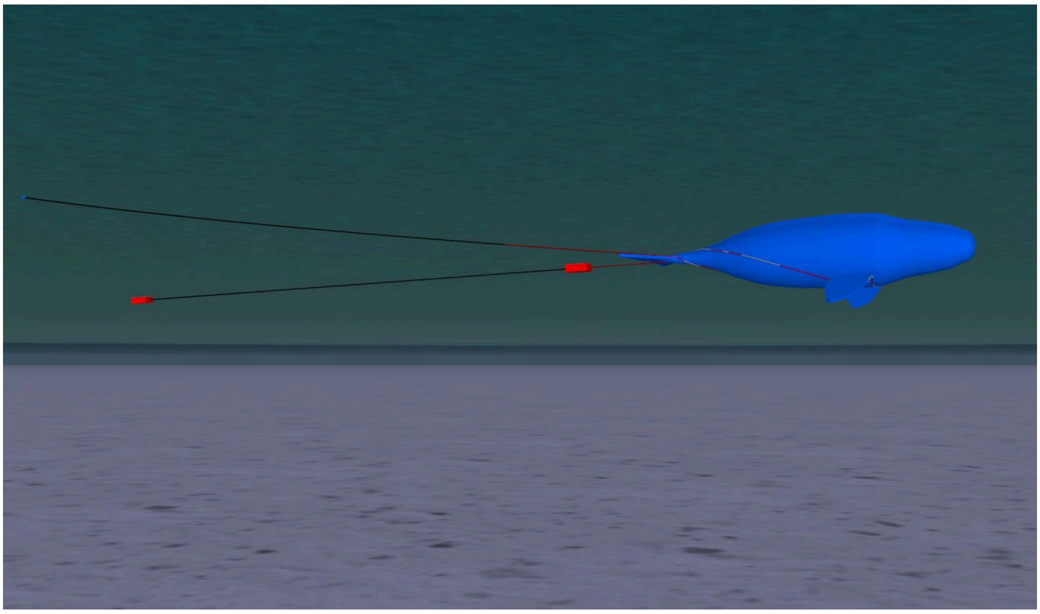


Figure 7.84: Image from Orcaflex showing the late-stage simulation of a right whale entan-gled in lobster pot gear. Dif-ferently shaded parts of the rope designate whether the rope section if negatively or positively buoyant, based on how lobster fishers configure their gear in the Gulf of Maine.

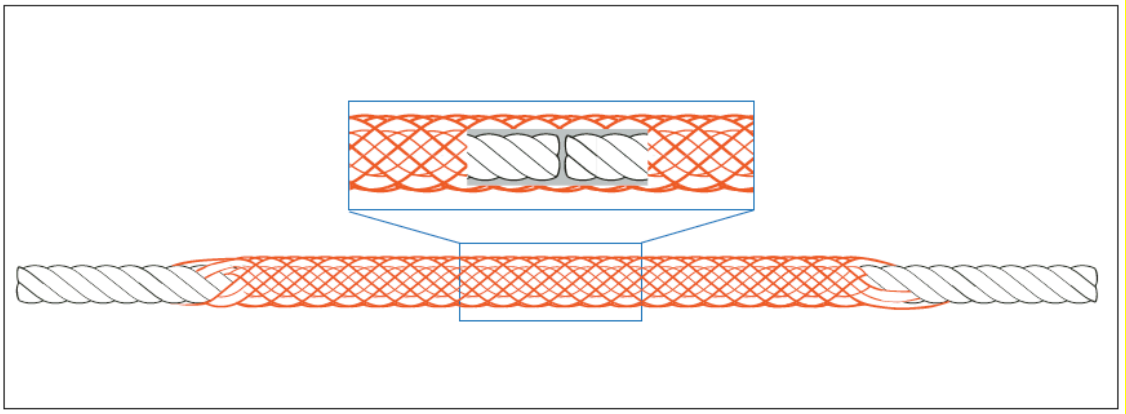


Figure 7.85: The braided sleeve (orange) rope designed by the South Shore Lobstermen's As-sociation and Novabraid, which was tested and being used by some lobster pot fishermen off the eastern US. The section shown acts as a "weak link" where the rope will part if a force of 1700lbf or higher is exerted.

7.20.4 Future projects and Ideas

7.20.4.1 Project: Whale Release Ropes

Project Full Title: Optimizing the implementation of whale-release (1700lbf breaking strength) ropes to reduce large whale entanglement risk

Project Timeframe: August 2022 – July 2023

Institution(s): Ocean Associates Inc., New England Aquarium

Contact person: Tim Werner, timothywerner@umb.edu

Link(s): www.bycatch.org

Collaboration welcome? Yes

Funding secured? No

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? NA

Is the project addressing ALDFG? Yes

Summary: The computer model we developed under the first phase of this project is being applied towards improving our understanding of how "fully formed" reduced breaking strength ropes or weak contrivances placed at different points along a vertical line in crustacean pot gear affects the out-come of whale entanglements, especially where and how quickly vertical line breaks occur when a whale collides with them. We will further develop and then use the computer model to simu-late whale entanglements in fixed-fishing gear using different weak (1700lbf) ropes and rope contrivances. This will include adding an open mouth component to the whale model, running entanglement scenarios with different whale behaviors and gear configurations, examining the effect of different rope elasticities, conducting at-sea testing to ground-truth our model, informing the performance of NMFS-approved weak gear, and providing the agency with details about change in entanglement risk with different weak rope configurations and properties for integra-tion into their Decision Support Tool.

7.20.4.2 Project: Ropeless Fishing

Project Full Title:

Project Timeframe: June 2023 – December 2024

Institution(s): Multiple

Contact person: Tim Werner, timothywerner@umb.edu

Link(s): www.bycatch.org

Collaboration welcome? Yes

Funding secured? No

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? NA

Is the project addressing ALDFG? Yes

Summary: Within the final ropeless fishing project report the following research priorities were identified:

- Continue at-sea testing and refinement of ropeless gear systems, led by the private sector which tends to catalyze change faster and more efficiently than NGOs and governments.
- Ensure that field trials have independent monitoring by researchers or electronic monitoring systems so that they are unbiased assessments of ropeless fishing. This removes the incentive among fishermen and the non-profit sector to spend valuable resources test-ing gear only to make public conclusions about its effectiveness without a degree of transparency that credibly supports their conclusions.
- Support studies of ropeless fishing systems with offshore fishermen in the U.S. fishing in the deepest waters and under the harshest oceanographic conditions.
- Study the economic implications of changing to ropeless fishing, such as the likely increase in fishing time, to inform its implementation.
- Consider, at least in a pilot phase, authorizing the use of ropeless trawls that permit on one end an endline tethered to a surface buoy as a back-up safety line, and evaluate the potential risk reduction achievable under this partial ropeless trawl design.

- Compare the kinds of information that an EMS can provide with the needs of fishery monitors to identify its potential utility as a tool for regulatory enforcement and data collection.
- Publish the results of the GIS study, and work collaboratively with NOAA Fisheries to further develop it as a tool for helping the agency implement its *Ropeless Roadmap*.

Carry out a detailed analysis of the potential impacts on whales and other marine spe-cies from introducing sound resulting from the implementation of ropeless fishing at the scale of a fishery.

8 Other business

8.1 Meeting dates and venue

WGFTFB proposed that its 2024 meeting will be held at the Marine Institute, St.-Johns, Newfoundland, Canada. Confirmation of venue availability and dates will be provided following the meeting. This meeting will be a regular ICES-FAO WGFTFB-meeting.

It was further proposed that the WGFTFB 2025 meeting will be held in Belgium hosted by Flanders Research Institute for Agriculture, Fisheries and Food (IVLO), Oostende, Belgium. Confirmation of venue availability and dates to be provided following the meeting.

8.2 Topic groups for the 2024 WGFTFB meeting

Two Topic Group will pass on the work to the next year

a) Topic Group on "The use of indicators to describe and compare the performance of fishing gears (Indicators)" was proposed during the 2021 meeting and first meeting was held in 2023 (see chapter 5 for detailed information). This topic group will have its second meeting in 2024.

b) Topic Group on "Abandoned, lost or otherwise discarded fishing gear (ALDFG)" was proposed during the 2021 meeting and first meeting was held in 2023 (see chapter 6 for detailed information). This topic group will have its second meeting in 2024.

During the 2023 meeting of WGFTFB, a new Topic Group was suggested. Details given below in chapter 8.2.1.

Additionally, a new Focus Session was suggested to be held during plenary. Details given below in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**

8.2.1 Operational and technical constraints of fishing gears to support coexistence with offshore wind and open-ocean aquaculture (Multi-use)

Conveners:

- Esther Savina (Denmark), esav@aqua.dtu.dk
- Mattias van Opstal (Belgium), vanopstal@ilvo.vlaanderen.be
- Thomas Noack (Germany), thomas.noack@thuenen.de

8.2.1.1 Introduction

We believe that a science-based approach to better understand the operational and technical constraints from the offshore wind, open-ocean aquaculture and fishing industries can facilitate coexistence. Focus will be given to discuss how one can design wind and aquaculture projects that guarantee safe conditions of work for the fishers given the specificities of their traditional gears and operational tactics with respect to e.g., alignment, space between machines/cages or cable burial, as well as the potential for innovative fishing capture techniques to accommodate for other users.

8.2.1.2 Terms of Reference

- Better understanding of the constraints from the different stakeholders by inviting key-note speakers from the various industries (e.g., wind, aquaculture, fisheries, insurance, collision risk)
- Share experiences from the different countries on multi-use of marine areas including presentations of findings from ongoing research projects
- Identify knowledge gaps in our current understanding of fishing gear operations, e.g., penetration depth or space required to manoeuvre, to support scientific documentation of the fisheries constraints with respect to multi-use
- Discuss the potential for innovative fishing capture techniques to accommodate for other users (e.g. within offshore wind farms) incl. passive gears

8.2.1.3 Justification

With increased competition for space at sea, maritime multi-use is key to enhance the sustainable joint use of resources such as wind, capture of wild fish and fish farming. However, coexistence is not always straightforward, as each industry holds technical specificities required to provide economic viability and safe operation. The objective of the topic group is to develop scientific documentation that provides practical solutions, guidelines, and recommendations to support the harmonious coexistence of all stakeholders, ensuring sustainable resource utilization and minimizing potential conflicts.

8.2.2 Focus Session: Sampling instruments and AI for fishing technology and fish behaviour research (Sampling)

Conveners:

Pieke Molenaar (Netherlands), molenaar@wur.nl

Daniel Stepputis (Germany), daniel.stepputis@thuenen.de

8.2.2.1 Introduction

In WGFTFB a wide range of sampling instruments and technologies are used to collect data on gear performance and fish behaviour. Research groups are developing innovative technologies that can be useful for other groups that aim for similar research. This focus session will be in plenary to focus discussions on this topic that affects all of the work WGFTFB does. This focus session provides a platform to share recent developments in sampling instruments and AI used for fishing technology and fish behaviour data.

8.2.2.2 Terms of Reference

- Summarize current and past work in relation to technological developments in sampling instruments used for obtaining fishing technology and fish behaviour (FTFB) observation and data
- Discuss instruments and methods and their limitations that are used to collect FTFB data on (commercial fishing) vessels.
- Identify synergies, developments and make recommendations on how to improve technologies used in FTFB research

8.2.2.3 Justification

In fishing technology and fish behaviour research a wide range of technologies is used to collect data on gear performance, catch composition and species behaviour related to innovative fishing gear solutions. For example, for assessing trawl- and fish behaviour often under water camera systems are used, with in some circumstances specialized solutions to project camera systems, extend battery life or deployment on great depths. Within WGFTFB presentations on those specialized solutions and what is on the marked, can inform members and help them acquiring better data. Besides most WGFTFB research is involving catch comparisons between conventional en innovative gears. Those comparisons involve usually length and weight measurements. Especially weight measurements can be challenging on a moving vessel. Information about sea state compensated (or other) solutions that have been developed to assess the catch weight and comparisons between solutions will help working group members in their search to optimize research procedures. Other interesting innovations on fish detection, artificial intelligence, sensor systems or fish morphology measurement systems that could be of relevance for the WGFTFB members might be included in this focus session.

8.2.2.4 Examples of topics that can be presented during this focus session

Camera

- Underwater camera systems (including batteries and lights)
- Protective housing for underwater camera systems and advances in attachment to the gear
- Drone, kite or sheet applications for clear images of underwater camera systems

Software

- Application of AI to analyse (fish behaviour) under water recordings

Catch weighing/estimations

- Sea state compensated weighing equipment for accurate measurements at sea (on commercial vessels)
- Applications for total catch measurements (weight/volume)
- Electronic monitoring catch composition and length distribution

(Fish) detection without visibility

- LIDAR
- Electroscopy
- Side scan sonar

Trawl behaviour

- Instruments for trawl flow measurements
- Instruments for in trawl tilt/shape measurements

Morphology and fish condition

- Instruments to analyse fish morphology (advances on fish select)
- Swim tunnels/donuts

Sensor systems

- Collect environmental data
- Fishing gear position

And any other relevant technological innovation related to WGFTFB research.

8.3 Working group (WGSSSE)

A Working Group on Size and Species Selection Experiments (WGSSSE) chaired by Haraldur Arnar Einarsson, Iceland/FAO, and Michael Pol, USA, was established in 2020 and will work on

ToRs listed in the Table below. This working group is listed here, as it was initiated within WGFTFB with strong interlinkages in content and members.

ToR Descriptors

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	Identify current areas of the Wileman manual in need of updating or improving	Science Requirements	5.4	1 year (2020-21)	Work plan
b	Draft an outline of the new manual, considering the updating opportunities identified in ToR (a) including data collection, data analysis, and reporting of results.	Science Requirements	5.4	1 year (2020-21)	Outline
c	Establish thematic subgroups with individual chairs to address individual topics (e.g. editing and oversight, field methods, statistical theory and tools, drawings, publishing)	Science Requirements	5.4	2 years (2020-2022)	Chapters of subsections by each subgroup
d	Create a draft manual from all contributions	Science Requirements	5.4	1 year (2022-23)	Draft report
e	Provide preliminary advice on develop of a manual for static gears	Science Requirements	5.4	1 year (2023)	Recommendation

Summary of Work Plan

Year 1	Meet to address areas to be updated in the Wileman manual, develop an outline of the new manual, and create thematic subgroups
Year 2	Bring text together for group editing and approval
Year 3	Produce final draft

Supporting information

Priority	The activities of this group will provide a much-needed update to a primary reference document, ICES Cooperative Research Report No. 215: Manual for Methods of Measuring the Selectivity of Towed Fishing Gears. The Manual is now nearly 25 years old, and was developed before the availability of open-source statistical software and newer statistical methodology accessible due to computing power. ICES Report No. 215 is a foundational document for gear technologists.
Resource requirements	Additional resources to undertake these activities is minimal, and will be drawn from members' institutions
Participants	The Group is expected to consist of at least 10 members, most drawn from WGFTFB
Secretariat facilities	Standard support
Financial	Publishing or hosting of final product, or none
Linkages to ACOM and groups under ACOM	

Linkages to other committees or groups	Annual or more frequent updates to WGFTFB are planned
Linkages to other organizations	FAO Fishing Operations and Technology Branch

Pressure for sustainable exploitation of natural resources is increasing from all sectors of society, triggering the search for better management of human activities. To achieve selective and sustainable fisheries, there is a growing trend among fishing management plans around the world to adopt (catch-) restrictive regulations, often challenging the economical sustainability of the Industry. The bycatch of unwanted species or juvenile fish is today more than ever under the focus, challenging fishing technologists and fishers the developments and use highly selective fishing gears. The search for highly efficient and selectivity gears often lead to complex concept designs, with selectivity properties that only can be accessed and quantified by sophisticated experimental methods and analytical tools. This is especially the case for towed gears, where the application of several selection devices has become a common practice to improve selectivity in mixed fisheries. A brief review of scientific literature shows such a methodological breakthrough occurred during the last years. Unfortunately, it also reveals the out-of-date status of the ICES manual of methods of measuring the selectivity of towed gears (Wileman et al 1996). The ICES manual has been for many years the main reference for students in fisheries science, and the guideline for young and senior scientists to conduct their selectivity studies soundly. However, the current version is no longer the most relevant tool for educational or professional purposes: It misses more than 20 years of development in fisheries science, and therefore does not provide experimental descriptions and/or access to analytical tools required for current research topics. Consequently, the FTFB community has identified a compelling need to collect, catalogue, describe and make available current methodologies and tools by updating the current manual of methods. These are the main aims of the "Working Group on Size and Species Selection Experiments" (WGSSSE).

This effort is too substantial to be conducted by a subgroup or topic group of WGFTFB. WGFTFB meets on an annual basis and members are often occupied in multiple topic groups that meet concurrently. A new manual will require more frequent meetings and by creating a new WG, all WGFTFB members and others are potentially available to contribute.

Further information can be found on ICES website:

https://www.ices.dk/community/groups/Pages/WGSSSE.aspx

8.4 Requests from other WGs

8.4.1 ICES Working Group on Bycatch of Protected Species (WGBYC)

WGBYC (delivered by Kelly Macleod and Sara Königson) requested to collect information on work conducted to evaluate and/or mitigate bycatch of PETS (Protected, Endangered and Threatened Species).

Therefore, it was agreed to collect this information from 2021 onwards. The following lines were added to each project description in the National reports (section 7):

Is the project directly addressing bycatch of PETS? Yes / No (delete as appropriate)*

Could this project indirectly decrease bycatch of PETS? Yes / No (delete as appropriate)*

*Protected, Endangered and Threatened Species = all marine mammal, seabird and turtle species and any protected, prohibited (see Table 1.4 of the WGEF 2019 report for a list of EU-prohibited elasmobranchs) or zero TAC elasmobranchs and protected fish species (see Table 18 WGBYC 2019 report)

8.4.2 ICES International Bottom Trawl Survey Working Group (IBTSWG)

The ICES international Bottom Trawl Survey Working Group initiated a process to replace the currently used GOV-trawl. Within this process, a Workshop on the Further Development of the New IBTS Gear (WKFDNG) will be conducted. This workshop will focus on updating results of gear trails with the potential new gears and will bring survey and gear technology experts together to produce a final revised survey trawl design based on the sea trials carried out by IBTS in recent years.

See https://www.ices.dk/community/groups/Pages/WKFDNG.aspx for more details.

8.5 Requests for advice

8.5.1 Workshop 2 on Innovative Fishing Gear (WKING2)

In 2019, the EU Commission (EU DG-MARE) seeked ICES advice on the progress that has been made, or impact arising from innovative gears within EU waters. By 31 December 2020 **and every third year thereafter**, and on the basis of information supplied by Member States and the relevant Advisory Councils and following evaluation by STECF, the Commission shall submit a report to the European Parliament and to the Council on the implementation of this Regulation. This advice should assess the benefits for, or negative effects on, marine ecosystems, sensitive habitats and selectivity. Specifically, and to the extent possible, the advice sought should provide information on what kind of innovative gears are being used, their objective, their technical specificities and the impact on both target species, non-target species and the environment in which they had been deployed.

Building on the work of WKING 2020, and in response to a new DG MARE request for ICES advice on the progress and impact that has been made in innovative gear use within EU waters since, a **Workshop 2 on innovative fishing gear (WKING2)** met online 23-25 August 2023 to:

- ToR a: Evaluate/endorse the catalogue of gears considered ‘innovative’, including their objectives, technical specificities, and known impacts/benefits (in terms of selectivity and catch efficiency on target and non-target species and environmental impact in terms of benefits for, or negative effects on, marine ecosystems and sensitive habitats);
- ToR b: Assess the level of uptake of innovative gears (for innovations ready for deployment), by the EU industry (per sea basin and fishery). Investigate what aspects impact the uptake of innovative gears. Depending on data and knowledge availability, assess the impact of finance, user-friendliness, health, and safety. For those innovations which are already taken up, present the results for the fleets;
- ToR c: To discuss the main drivers, for those innovations not implemented, that prevented their use, if known. Where possible, include analysis of the socio-economic trade-offs and propose ways to facilitate their implementation.

A Core Group of members, formed by Antonello Sala and Steve Eayrs from the ICES WGFTFB worked by correspondence to address ToR (a) ahead of the workshop.

The Core Group, with input from other WGFTFB experts, facilitated information collection and discussed the Innovative Gears conceptualization. The Core Group also collected information on the types of innovative gear that have been used in EU fisheries in recent years. At the WKING2 meeting, the Core Group presented results to review and deliberate the findings to date (i.e. ToRs b and c).

This workshop will be followed up by a meeting between experts and ACOM Leadership. WKING2 will report by 15 September 2023 for the attention of FRSG, ACOM, and SCICOM. The WKING2 public page can be found here:

https://www.ices.dk/community/groups/Pages/WKING2.aspx

Annex 1: Lists of participants

List of participants 2023

The meeting was conducted as hybrid meeting. It was difficult to follow up the real participating members during the online sessions. Therefore, the following table list all participants who registered for the meeting.

ID	Name	Institution	Country	Email
1	Jatindra Nath Swain, IAS	Secretary, DoF	India	secy-fisheries@gov.in
2	J Balaji, IAS	Joint Secretary, DoF	India	jsfy@nic.in
3	Sagar Mehra, CSS	Joint Secretary, DoF	India	sagar.mehra@nic.in
4	A Antony Xavier	FDC, DoF	India	antonyxavier@caa.gov.in
5	Shankar Laxman	JC, DoF	India	shankarjcfy@gmail.com
6	Archit Sukhla	DoF	India	shuklaarchit2010@gmail.com
7	C Suvarna, IFS	CE, NFDB	India	cenfdb@gmail.com
8	L N Murthy	SED, NFDB	India	senior-ed@nfdb.gov.in
9	Dipin K M	NFDB	India	dipinnfdb@gmail.com
10	R Jeyabaskaran	DG, FSI	India	ds@fsi.eov.in
11	Ansuman Das	FSI	India	ansuman@fsi.gov.in
12	A Siva	FSI	India	anandhan.siva@fsi.sov. In
13	Ashok S Kadam	FSI	India	ashoka_fsi@rediffmail.com
14	Harshavardhan D Joshi	FSI	India	harshijoshicofsn@ gmail.com
15	S Ramachandran	FSI	India	marine_ramc@yahoo.co. in
16	Raju S Nagpure	FSI	India	rajusnagpure@ gmail.com
17	Nashad M	FSI	India	nashadfsi@gmail.com
18	Sijo P Varghese	FSI	India	varshesefsi@hotmail. com
19	Jacob Thomas	FSI	India	jacobtjerin@vahoo.com
20	S K Pattnayak	FSI	India	sunubeta@gmail.com
21	Solly Solomon	FSI	India	lazarsolly@hotmail.com
22	A Tiburtius	FSI	India	tibufsi@yahoo.co.in
23	John Chembian	FSI	India	johnchembian@yahoo.co.in

24	K Silambarasan	FSI	India	silambuplankton@hotmail.com
25	Bhami Reddy	FSI	India	fsi_vizag@Yahoo.co.in
26	GVA Prasad	FSI	India	gummadiprasad09@gmail.com
27	Vinodkumar Mudumala	FSI	India	vmudumala@gmail.com
28	AK Choudhury	Director, CIFNET	India	akch0507@gmail.com
29	A Ravichandran	CIFNET	India	aravichandran1965@gmail.com
30	Hrusikesh Bisoyi	CIFNET	India	mhabi305@gmail.com
31	Habibullah	CIFNET	India	manjigmakwana@gmail.com
32	MG Makwana	CIFNET	India	neelcifnet@gmail.com
33	M Neelakandan	CIFNET	India	bijumonkbdr@gmail.com
34	KB Bijumon	CIFNET	India	ksvinod72@gmail.com
35	KS Vinod	CIFNET	India	babufsi@gmail.com
36	C Babu	CIFNET	India	achyutashaji@yahoo.com
37	S Shaji	CIFNET	India	pradeepmarines@gmail.com
38	Vipin PM	CIFNET	India	vipinpm83@gmail.com
39	Pradeep K	CIFNET	India	pradeepmarines@gmail.com
40	G Venkateswarulu	CIFNET	India	venkateshmarine@gmail.com
41	Shine Kumar CS	NIFPHATT	India	ifpchn@nic.in
42	J K Jena	DDG (Fy), ICAR	India	jkjena2@gmail.com
43	A Gopalakrishnan	Director, ICAR-CMFRI	India	agopalkochi@gmail.com
44	J Jayasankar	ICAR-CMFRI	India	jjsankar@gmail.com
45	Eldho Varghese	ICAR-CMFRI	India	eldhoiasri@gmail.com
46	EM Abdussamad	ICAR-CMFRI	India	emasamadg@gmail.com,
47	R Ratheesh Kumar	ICAR-CMFRI	India	ratheeshkl4u2@gmail.com,
48	Rajan Kumar	ICAR-CMFRI	India	rajanfrmcife@gmail.com
49	Bhendekar Sathosh	ICAR-CMFRI	India	santucofs@gmail.com
50	V Venkatesan	ICAR-CMFRI	India	venkatcmfri@yahoo.co.in,
51	Geetha Sasikumar	ICAR-CMFRI	India	gs.pallath@gmail.com
52	KV Akhilesh	ICAR-CMFRI	India	akhikv@gmail.com

53	U Ganga	ICAR-CMFRI	India	ganga66@rediffmail.com
54	KR Sreenath	ICAR-CMFRI	India	LECOLOGISTE@GMAIL.COM
55	C Ramachandran	ICAR-CMFRI	India	ramchandrancnair@gmail.com,
56	P Shinoj	ICAR-CMFRI	India	shinoj.p@icar.gov.in
57	Shyam Salim	ICAR-CMFRI	India	shyam.icar@gmail.com
58	AP Dinesh Babu	ICAR-CMFRI	India	dineshbabuap@yahoo.co.in
59	Shoba J Kizhaku-dan	ICAR-CMFRI	India	jkshoba@gmail.com
60	Vinay Kumar Vase	ICAR-CMFRI	India	v.vinaykumarvs@gmail.com
61	Abul Azeez P	ICAR-CMFRI	India	azeez.cr7@gmail.com
62	Rekha J Nair	ICAR-CMFRI	India	rekhacmfri@gmail.com
63	Reshma Gills	ICAR-CMFRI	India	reshma1818@gmail.com
64	K Mohammed Koya	ICAR-CMFRI	India	koya313@gmail.com
65	Shikha Rahangdale	ICAR-CMFRI	India	shikha.rahangdale@icar.gov.in
66	Divya V	ICAR-CMFRI	India	divyaarinu@gmail.com
67	Vipin Kumar	ICAR-CMFRI	India	vipincmfri@gmail.com
68	B Jenni	ICAR-CMFRI	India	jennihsharma@yahoo.co.in
69	Ancy Sebastian	ICAR-CIFT	India	ancbabu@yahoo.co.in
70	Baiju MV	ICAR-CIFT	India	Vishnubaiju@yahoo.com
71	Chinnadurai	ICAR-CIFT	India	chinnaduraitvl@gmail.com
72	Dhiju Das PH	ICAR-CIFT	India	dhijudas@gmail.com
73	George Ninan	Director, ICAR-CIFT	India	george66jiji@gmail.com
74	Leela Edwin	ICAR-CIFT	India	leelaedwin@gmail.com
75	Madhu VR	ICAR-CIFT	India	Madhu.VR@icar.gov.in
76	Manju Lekshmi N	ICAR-CIFT	India	manjuaem@gmail.com
77	Muhamed Ashraf P	ICAR-CIFT	India	ashrafp2005@hotmail.com
78	Mohammed Jabir KK	ICAR-CIFT	India	mohammedjabz44@gmail.com
79	Paras Nath Jha	ICAR-CIFT	India	parasincof@gmail.com
80	Prajith KK	ICAR-CIFT	India	prajithkk@gmail.com

81	Remesan MP	ICAR-CIFT	India	mpremesan@gmail.com
82	Rithin Joseph	ICAR-CIFT	India	josephrithin@gmail.com
83	Renjith PK	ICAR-CIFT	India	renjith.rk05@gmail.com
84	Saly N Thomas	ICAR-CIFT	India	alynthomas@gmail.com
85	Sandhya KM	ICAR-CIFT	India	sandhyafrm@gmail.com
86	Sreejith S Kumar	ICAR-CIFT	India	ssreejith1985@gmail.com
87	Vipin V	ICAR-CIFT	India	vipinvamadevan@hotmail.com
88	Harsha K	ICAR-CIFT	India	harshakrishna2018@gmail.com
89	CN Ravishankar	Director / VC, ICAR-CIFE	India	ravishankar@cife.edu.in
90	KK Ramteke	ICAR-CIFE	India	kkramteke@gmail.com
91	Abuthagir Iburahim	ICAR-CIFE	India	iburahim@cife.edu.in
92	Thavasi	ICAR-CIFE	India	thavasi.fecmb107@cife.edu.in
93	Aiswarya Sali	ICAR-CIFE	India	aiswarya.fexmb101@cife.edu.in
94	B K Das	Director, ICAR-CIFRI	India	basantakumard@gmail.com
95	Kailasam	ICAR-CIBA	India	Kailasam.M@icar.gov.in
96	Kumaraguru	ICAR-CIBA	India	Kumaraguru.Vasagam@icar.gov.in
97	Suburaj	ICAR-CIBA	India	subburaj@ciba.res.in
98	G Sugumar	VC, TNJFU	India	vc@tnfu.ac.in
99	Arun Jenish	TNJFU	India	dajenish@gmail.com
100	Ravikumar T	TNJFU	India	ravikumar@tnfu.ac.in
101	Velmurugan R	TNJFU	India	rvelmurugan@tnfu.ac.in
102	Santhosh Kunar	TNJFU	India	s.santhoshkumar@tnfu.ac.in
103	Durai V	TNJFU	India	duraicp2003@gmail.com
104	Mariappan	TNJFU	India	mariappan@tnfu.ac.in
105	Kalaiarasan	TNJFU	India	kalaiarasan@tnfu.ac.in
106	A Karthy	TNJFU	India	karthi.fischo@gmail.com
107	Archana	TNJFU	India	fishco.archana@gmail.com
108	Dinesh E	TNJFU	India	edineshramukedk@gmail.com
109	S Sabu	CUSAT	India	sabuif@cusat.ac.in

110	Mini Sekharan	CUSAT	India	minisekharan@cusat.ac.in
111	Mujeeb Rahiman	CUSAT	India	mujeebrkm@cusat.ac.in
112	Hareesh N Rama-nathan	CUSAT	India	hareeshramanathan@cusat.ac.in
113	Damaris Daniel	CUSAT	India	damarisbennydaniel@gmail.com
114	Abhirami Subash	CUSAT	India	abhiramisubash@cusat.ac.in
115	MK Sajeevan	KUFOS	India	sajeevanfsi@gmail.com
116	R Abinaya	KUFOS	India	abinayabfsc@gmail.com
117	Amrutha K	KUFOS	India	amrutha.ir@gmail.com
118	Lalima Inwati	KUFOS	India	invatilali@gmail.com
119	Kumarakannan	KUFOS	India	kvasanthkvasanth29122@gmail.com
120	Sunbula Kareem	KUFOS	India	sunbulakareem91@gmail.com
121	Shivakumar Magada	COF, Mangalore	India	deanfisheries@gmail.com
122	Kumar Naik	COF, Mangalore	India	kumarasnaik@gmail.com
123	Jaya Naik	COF, Mangalore	India	jayanaik23@yahoo.com
124	Mridula Rajesh	COF, Mangalore	India	mridularajesh789@yahoo.co.in
125	Nayana P	COF, Mangalore	India	nayana.p.nayak@gmail.com
126	Abhisek	Ashokha Univ	India	abhishek_phd22@ashoka.edu.in
127	Divya Karnad	Ashokha Univ	India	divya.karnad@ashoka.edu.in
128	Sebastian Mathew	ICSF	India	sebastian1957@gmail.com
129	Venu Rajamony, IFS	Senior Advisor for SA, HD	India	rajamony@hdcentre.org
130	Willem Punt	HD	Singapore	punt@hdcentre.org
131	Sreejith Sugunan	HD	India	sugunan@hdcentre.org
132	Dayaratna Silva	PATHFINDER	Sri Lanka	ed@pathfinderfoundation.org
133	Debesh Lahiri	NMF	India	execdir.nmf@gmail.com
134	R K Srivatsava	NMF	India	icg1.nmf@gmail.com
135	Ayushi Srivatsava		NMF	India
136	Dharani	NIOT	India	dhara@niot.res.in
137	Nimit Kumar	INCOIS	India	nimitkumar.j@incois.gov.in
138	Aswathi Pacha	INCOIS	India	aswathinisha@gmail.com

139	Nahid Rashid	Secretary, MoFL	Bangladesh	naheedkhalid72@gmail.com
140	Kamal Haque	DG, MoFL	Bangladesh	dg@fisheries.gov.bd
141	Yahia Mahmud	DG, BFRI	Bangladesh	dgbfri@bfri.com
142	Md Abdul Mansur	Dean, BAU	Bangladesh	mansurft63@gmail.com
143	M Shiham Adam	IPNLF	Maldives	msadam@mrc.gov.mv
144	Ahmed Rizyas Jau-haree	MMRI	Maldives	riyaz.jauharee@mmri.gov.mv
145	Md Shainee	Former Minister, MoFA	Maldives	shainee2267@gmail.com
146	Talangama Chaminda Namal	Additional Secretary, MFARD	Sri Lanka	namalthalangama@live.com.sa
147	Ranatunga Dhammika Sanath	DG (T), MFARD	Sri Lanka	dhammikadsr@yahoo.com
148	Sushantha Kaha-watta	DG, MFARD	Sri Lanka	dg@fisheriesdept.gov.lk
149	Wijeyarathne M J S	Chairman, NARA	Sri Lanka	chairman@nara.ac.lk
150	Oscar Amara-singhe	Chancellor, OCU	Sri Lanka	oamarasinghe@yahoo.com
151	NMS Jeyasekara	USJ	Sri Lanka	madhavisulochana97@gmail.com
152	KHKL Piyasiri	NARA	Sri Lanka	kaumi.khklpiyasiri@gmail.com
153	Lasuni Chathurima	OCU	Sri Lanka	lasunichathuri@gmail.com
154	Salin KR	AIT	Thailand	salinkr@ait.ac.th
155	Thaweesak Thim-krap	SEAFDEC	Thailand	thaweesakt@seafdec.org
156	Suriyan T S	KU	Thailand	ffissrt@ku.ac.th
157	Sitti Raehanah Binti Muhamad	UMS	Malaysia	sittirae@ums.edu.my
158	Muta Harah Za-karia	UPM	Malaysia	muta@upm.edu.my
159	Nyo Nyo Tun	MU	Myanmar	t.nyonyo@yahoo.com
160	Yin Yin Htay	PU	Myanmar	seagrass772018@gmail.com
161	E Vivekanandan	Pr. Scientist (Rtd) , ICAR-CMFRI	India	evivekanandan@hotmail.com
162	Dam Roy	Former Director ICAR-CIARI	India	sibnarayan@gmail.com

163	Latha Shenoy	Pr. Scientist (Rtd) , ICAR-CIFE	India	shenoylatha1@hotmail.com
164	B Meenakumari	Former DDG, ICAR	India	meenakumarib@gmail.com
165	Pravin Putra	Former ADG, ICAR	India	pravinp2005@gmail.com
166	B Manimaran	Former VC, TNJFU	India	prof.maaran@gmail.com
167	A.G. Ponniah	Former Director, ICAR-CIBA	India	agponniah@gmail.com
168	Jitendra Soni	Garware	India	jsoni@garwarefibres.com
169	Sumesh	Garware	India	jsoni@garwarefibres.com
170	Rakhil Gopal	Garware	India	jsoni@garwarefibres.com
171	Reyan K	Garware	India	jsoni@garwarefibres.com
172	Xaiver L	Odaku	India	info@odaku.in
173	M J Elmo	Odaku	India	info@odaku.in
174	Akansha Tiwari	Captain Fresh	India	akansha13.work@gmail.com
175	Mattias Van Opstal	ILVO	Belgium	mattias.vanopstal@ilvo.vlaanderen.be
176	Jasper Van Vlas-selaer	ILVO	Belgium	jasper.vanvlasselaer@ilvo.vlaan-deren.be
177	Paul Winger	MI	Canada	paul.winger@mi.mun.ca
178	Valentina Melli	DTU	Denmark	vmel@aqua.dtu.dk
179	Junita D Karlsen	DTU	Denmark	jka@aqua.dtu.dk
180	Barry O'Neill	DTU	Denmark	barone@aqua.dtu.dk
181	Zita Bak-Jensen	DTU	Denmark	zitba@aqua.dtu.dk
182	Tiago Veiga Malta	DTU	Denmark	timat@aqua.dtu.dk
183	Mette Svante-mann Lyngby	DTU	Denmark	msvly@aqua.dtu.dk
184	Thomas Noack	Thuenen	Germany	thomas.noack@thuenen.de
185	Daniel Stepputtis	Thuenen	Germany	daniel.stepputtis@thuenen.de
186	Karsten Bredder-man	Uni Rostock	Germany	karsten.breddermann@uni-rostock.de
187	Sara Alvarez Ber-zosa	Thuenen	Germany	sara.berzosa@thuenen.de
188	Georg Haney	Hampiðjan	Iceland	georg.haney@gmail.com
189	Haraldur A Einars-son	FAO	Italy	haraldur@mfri.is

190	Daragh Browne	BIM	Ireland	daragh.browne@bim.ie
191	Martin Oliver	BIM	Ireland	martin.oliver@bim.ie
192	Mathew McHugh	BIM	Ireland	matthew.mchugh@bim.ie
193	Maria Amparo Pérez Roda	FAO	Italy	amparo.perezroda@fao.org
194	Antonello Sala	CNR, FAO	Italy	antonello.sala@cnr.it
195	Kelsey Richardson	FAO	Italy	Kelsey.Richardson@fao.org
196	Jon Lansley	FAO	Italy	jon.lansley@fao.org
197	Julio Antonio Zitha	NIDFA	Mozambique	jzithamoz@gmail.com
198	Pieke Molenaar	WMR	Netherlands	pieke.molenaar@wur.nl
199	Allard van Mens	WMR	Netherlands	allard.vanmens@wur.nl
200	Kristine Cerbule	UIT	Norway	kristine.cerbule@uit.no
201	Ulf Lundvall	OSAC	Norway	ulflundvall@gmail.com
202	Paritosh Deshpande	NTNU	Norway	paritosh.deshpande@ntnu.no
203	Elsa Cuende	AZTI	Spain	ecuende@azti.es
204	Mikel Basterretxea	AZTI	Spain	mbasterretxea@azti.es
205	Ignacio Soler	Kongsberg	Spain	ignacio.soler@km.kongsberg.com
206	Sarath K Karumathil	UC	Spain	sarath.karumathil@udc.es
207	Peter Ljunberg	SLU	Sweden	peter.ljungberg@slu.se
208	Claire Collins	ZSL	United Kingdom	claire.collins@ioz.ac.uk
209	Noelle Yochum	Trident Seafoods Corporation	United States of America	nyochum@TridentSeafoods.com
210	Drake Ssempijja	UMass	Uganda	drakesempijja@gmail.com
211	Ricardo Roberto Roth	(online)	Argentina	rroth@inidep.edu.ar
212	Roth Ricardo	(online)	Argentina	rroth@inidep.edu.ar
213	Steve Eayrs	(online)	Australia	smartfishing1@hotmail.com
214	Helen Lenoir	(online)	Belgium	heleen.lenoir@ilvo.vlaanderen.be
215	Liming Song	(online)	China	lmsong@shou.edu.cn
216	Esther Savina	(online)	Denmark	esav@aqua.dtu.dk
217	Jordan Feekings	(online)	Denmark	jpfe@aqua.dtu.dk

218	Kindt-Larsen Lotte	(online)	Denmark	lol@aqua.dtu.dk
219	Ludvig Ahm Krag	(online)	Denmark	lak@aqua.dtu.dk
220	Morteza Eighani	(online)	Denmark	moei@aqua.dtu.dk
221	Rikke Petri Frand-sen	(online)	Denmark	rif@aqua.dtu.dk
222	Sven Uhlmann	(online)	Denmark	sven.uhlmann@gmx.net
223	Hannah Schart-mann	(online)	Germany	hannah.schartmann@thuenen.de
224	Mathis Mahler	(online)	Germany	mathis.mahler@thuenen.de
225	Theresia Eke	(online)	Germany	theresia.eke@t-online.de
226	Thomas Noack	(online)	Germany	thomas.noack@thuenen.de
227	Chryssi Mytilineou	(online)	Greece	chryssi@hcmr.gr
228	Adf Mangaluru	(online)	India	dilipkumarz@gmail.com
229	Ajay Nakhawa	(online)	India	ajaynakhawa@hotmail.com
230	Asha Landge	(online)	India	ashalandge@cife.edu.in
231	Baiju Malikayil Vi-jayan	(online)	India	vishnubaiju@yahoo.com
232	Bejawada Naidu	(online)	India	chanikya.aykinahc2@gmail.com
233	Bibin Xavier V F	(online)	India	bibinxavier28@gmail.com
234	Chandrashekara Adf	(online)	India	adf2kumta@gmail.com
235	Deputy Director Of Fisheries Malpe Fishing Harbour	(online)	India	adf1malpe@gmail.com
236	Divakar Kharvi	(online)	India	adf2udupi2@gmail.com
237	Dr Ranjith L	(online)	India	ranjith.l@icar.gov.in
238	Dr. Gipson Edap-pazham	(online)	India	e.gipson@jainuniversity.ac.in
239	Dr. Remya L	(online)	India	lremya9@gmail.com
240	Dr. Shailendra Ku-mar Dwivedi	(online)	India	sk.dwivedi0310@fsi.gov.in
241	Dr.Sudarsi Angeli	(online)	India	comfishap@gmail.com
242	G J Pramoda Malli	(online)	India	gjpramodamalli@gmail.com
243	Geetha Sasikumar	(online)	India	gs.pallath@gmail.com
244	Gyanaranjan Dash	(online)	India	gyanranjandashcmfri@gmail.com

245	Herald Immanuel David	(online)	India	heraldimmanuel53@gmail.com
246	Jasmin Felix	(online)	India	jasmin.f.cmfri@gmail.com
247	Jasmin	(online)	India	jillu002@gmail.com
248	Jayaprakash Men-don	(online)	India	jayaprakashudupi@yahoo.co.in
249	Joint Director Of Fisheries Udupi	(online)	India	ddfudupi@gmail.com
250	Karuppasamy K	(online)	India	karuppasamy@tnfu.ac.in
251	Kavitha P	(online)	India	kavitaprashanth@gmail.com
252	Komal Nandagawali	(online)	India	komalnandagawali1234@gmail.com
253	Kumarswamy R	(online)	India	kumarswamy356@gmail.com
254	Lalima Inwati	(online)	India	invatilali@gmail.com
255	Loveson Edward L	(online)	India	loveson_edward@yahoo.co.in
256	Mayur Tade	(online)	India	mayur.tade@gmail.com
257	Mukeshkumar Bhendarkar	(online)	India	mk.bhendarkar@icar.gov.in
258	Muktha Menon	(online)	India	muktha2007@gmail.com
259	Nagaraj Challa-jjimane	(online)	India	challajjimanen@gmail.com
260	Poonam Rani	(online)	India	poonam.ranii@gov.in
261	Prathibha Rohit	(online)	India	prathibharohit@gmail.com
262	Purushottama Gante Bosuna-obaiah	(online)	India	puru44@gmail.com
263	Raghu Prakash R	(online)	India	drraghuprakash@gmail.com
264	Rajesh K M	(online)	India	rajeshmkm3@rediffmail.com
265	Rajesh Kumar	(online)	India	rajesh.frmmb109@cife.edu.in
266	Rajesh Kumar Pra-dhan	(online)	India	rajeshfrm220@gmail.com
267	Ramana Kumar Kotha	(online)	India	ramankumarkotha@gmail.com
268	Ravi	(online)	India	ravitalekar53@gmail.com
269	Rekha Devi Chakraborty	(online)	India	rekhadevi7674@gmail.com

270	Rekha M	(online)	India	rekhamuralidharan73@gmail.com
271	Renjith R K	(online)	India	renjith.rk05@gmail.com
272	Reshma Gills	(online)	India	reshma1818@gmail.com
273	Revathi JA	(online)	India	revathija.adf@gmail.com
274	Saranya Raju	(online)	India	saranyakallurumbil.sr@gmail.com
275	Sheetal Bharda	(online)	India	sheetal.frmpb101@cife.edu.in
276	Shivakumar G M	(online)	India	sradfudp@gmail.com
277	Shoba Kizhakudan	(online)	India	shoba.joe@icar.gov.in
278	Shridevi P	(online)	India	shrideviprabhu29@gmail.com
279	Subal Roul	(online)	India	subalroul@gmail.com
280	Sujitha Thomas	(online)	India	sujithathomascmfri@gmail.com
281	Sukar Anjani	(online)	India	fish-diu-dd@nic.in
282	Sumalatha .	(online)	India	adf2kundapur@gmail.com
283	Surya S	(online)	India	revandasurya@gmail.com
284	Swatipriyanka Sen	(online)	India	swatipriyank1a@gmail.com
285	Tejaswini Karale	(online)	India	tejaswinipk20@gmail.com
286	Thanga Anusya S	(online)	India	anusya1507@gmail.com
287	Vasant Hegde	(online)	India	sadftadri@gmail.com
288	Vinod Kavungal	(online)	India	vinod_kavungal@yahoo.co.in
289	Vinod Malayilethu	(online)	India	vinodm@wwfindia.net
290	Elizabeth Tray	(online)	ireland	elizabeth.tray@bim.ie
291	Geir Gudmunds-son	(online)	ireland	geir@optitog.com
292	Andrea Petetta	(online)	Italy	andrea.petetta@irbim.cnr.it
293	Daniel Li Veli	(online)	Italy	daniel.liveli@irbim.cnr.it
294	Nazzareno Paci	(online)	Italy	nazzarenopaci@gmail.com
295	Chiyo Takahashi	(online)	Japan	miikosea@gmail.com
296	Alessa Mattens	(online)	Netherland	alessa.mattens@wur.nl
297	Melanie Under-wood	(online)	New Zealand	melanie.underwood@niwa.co.nz
298	Anja Alvestad	(online)	Norway	anja.alvestad@sintef.no

299	Enis Kostak	(online)	Norway	enis.n.kostak@uit.no
300	Neil Anders	(online)	Norway	neil.anders@hi.no
301	Roger B. Larsen	(online)	Norway	roger.larsen@uit.no
302	Aida Campos	(online)	Portugal	acampos@ipma.pt
303	Monika Szynaka	(online)	Portugal	mjszynaka@gmail.com
304	Alex Edridge	(online)	Scotland	alexius.edridge@gov.scot
305	Emma Mackenzie	(online)	Scotland	emma.mackenzie@gov.scot
306	Robert Kynoch	(online)	Scotland	robert.kynoch@gov.scot
307	Mona Ljungberg	(online)	Sweden	monaljungberg52@gmail.com
308	Stefan Eiler	(online)	Sweden	stefan.eiler@slu.se
309	Kamonpan Awai-wanont	(online)	Thailand	kawaiwanont@yahoo.com
310	Nakaret Yasuk	(online)	Thailand	ynakaret@seafdec.org
311	Santiphong Putsa	(online)	Thailand	santiphong@seafdec.org
312	Nopporn Manajit	(online)	Thailand	nopporn@seafdec.org
313	Siriwan Priwan	(online)	Thailand	62330047@go.buu.ac.th
314	Taweekiet Amorn-piyakrit	(online)	Thailand	taweekiet@seafdec.org
315	Watcharapong Chumchuen	(online)	Thailand	w.chumchuen@gmail.com
316	Adnan Tokaç	(online)	Turkey	adnan.tokac@ege.edu.tr
317	Robert Enever	(online)	United Kingdom	rob.enever@fishtekmarine.com
318	Dan Watson	(online)	United Kingdom	dan@sntech.co.uk
319	Samantha Stott	(online)	United Kingdom	samantha.stott@cefas.gov.uk
320	Yann Rouxel	(online)	United Kingdom	yann.rouxel@rspb.org.uk
321	Jesse Senko	(online)	United States of America	jesse.senko@gmail.com
322	Mark Lomeli	(online)	United States of America	mlomeli@psmfc.org
323	Pingguo He	(online)	United States of America	phe@umassd.edu
324	Joanna Haffling	(online)	Sweden	joannahaffling@gmail.com

List of participants 2022

The following table list all participants who registered for the online meeting.

Name	Affiliation	Country	Email
Daniel Stepputtis	Thünen Institute	Germany	daniel.stepputtis@thuenen.de
Andrea Petetta	National Research Council (CNR)	Italy	andrea.petetta@irbim.cnr.it
Tiago Veiga Malta	DTU	Denmark	Timat@aqua.dtu.dk
Emilio Notti	National Research Council (CNR)	Italy	emilio.notti@cnr.it
Morteza Eighani	DTU	Denmark	moei@aqua.dtu.dk
Michele Luca Geraci	National Research Council (CNR)	Italy	micheleluca.geraci2@unibo.it
Craig S. Rose	FishNext Research	USA	fishnextresearch@gmail.com
Ricardo Roberto Roth	INIDEP	Argentina	rroth@inidep.edu.ar
Benoit Vincent	IFREMER	France	benoit.vincent@ifremer.fr
Michael Pol	Massachusetts Division of Marine Fisheries	USA	mike@rosascience.org
Ronan Cosgrove	BIM	Ireland	ronan.cosgrove@bim.ie
Emma Mackenzie	Marine Scotland Science	Scotland	emma.mackenzie@gov.scot
Georg Haney	Hampiðjan Group	Iceland	georg.haney@gmail.com
Gokhan Gokce	Ege University	Turkey	gokhan.gokce@ymail.com
He Pingguo	University of Massachusetts	USA	phe@umassd.edu
Pyungkwan Kim	National Institute of Fisheries Science	Republic of Korea	trawl98@gmail.com
Uwe Lichtenstein	Thuenen-Institute	Germany	uwe.lichtenstein@thuenen.de
Jeff Gearhart	National Marine Fisheries Service	USA	jeff.gearhart@noaa.gov
Tomas Araya-Schmidt	Fisheries and Marine Intitute of Memorial University of Newfoundland	Canada	Tomas.Schmidt@mi.mun.ca
Noëlle Yochum	NOAA	USA	noelle.yochum@noaa.gov
David Chosid	Massachusetts Division of Marine Fisheries	USA	david.chosid@mass.gov
F. Carwyn Hammond	-	USA	carwyn.hammond99@gmail.com
Isara Chanrachkij	Southeast Asian Fishereis Development Center	Thailand	isara@seafdec.org

Madhu Vettiyattil	Indian Council of Agricultural Research	India	madhucift@gmail.com
Robert Kynoch	Marine Science Scotland	UK	robert.kynoch@gov.scot
Mikel Basterretxea	AZTI	Spain	mbasterretxea@azti.es
Jasper Van Vlasselaer	ILVO	Belgium	jasper.vanvlasselaer@ilvo.vlaanderen.be
Thomas Noack	Thuenen-Institute	Germany	thomas.noack@thuenen.de
Rikke Frandsen	DTU	Denmark	rif@aqua.dtu.dk
Valentina Melli	DTU	Denmark	vmel@aqua.dtu.dk
Christopher Rillahan	University of Massachusetts Dartmouth	USA	crillahan@umassd.edu
Alessandro Lucchetti	National Research Council (CNR)	Italy	alessandro.lucchetti@cnr.it
Daniel Li Veli	National Research Council (CNR)	Italy	daniel.liveli@irbim.cnr.it
Adnan Tokaç	Ege University	Turkey	adnan.tokac@ege.edu.tr
Monika Szynaka	Centro de Ciências do Mar	Portugal	mjszynaka@gmail.com
Ben Collier	Geartrials	Northern Ireland	ni-geartrials@outlook.com
Matthew McHugh	Bord Iascaigh Mhara (BIM)	Republic of Ireland	matthew.mchugh@bim.ie
Haraldur Einarsson	MFRI	Iceland	haraldur@hafogvatn.is
Ludvig Krag Ahm	DTU	Denmark	lak@aqua.dtu.dk
Daragh Browne	Bord Iascaigh Mhara (BIM)	Ireland	daragh.browne@bim.ie
Anne Christine Utne Palm	Institute of Marine Research of Norway	Norway	annecu@hi.no
Mollie Elizabeth Brooks	DTU	Denmark	molbr@dtu.dk
Manu Sistiaga	Institute of Marine Research of Norway	Norway	manu.sistiaga@hi.no
Mathis Mahler	Thuenen-Institute	Germany	mathis.mahler@thuenen.de
Jennifer Lynch	Hawaii Pacific University	USA	jennifer.lynch@nist.gov
Maria Tenningen	IMR	Norway	maria.tenningen@hi.no
Esther Savina	DTU	Denmark	esav@aqua.dtu.dk
Samantha Stott	CEFAS	UK	samantha.stott@cefas.co.uk
Jordan Feekings	DTU	Denmark	jpfe@aqua.dtu.dk

Aida Campos	IPMA	Portugal	acampos@ipma.pt
Pedro Leitão	IPMA	Portugal	pedro.leitao@ipma.pt
Geir Gudmundson	Optitog ehf	Iceland	geir@optitog.com
Jon Lansley	FAO	FAO	Jon.Lansley@fao.org
Alondra Sofia Rodriguez	ICES	Denmark	alondra.sofia.rodriguez@ices.dk
Pedro Sá	Euronete	Portugal	alcindolopes@lankhorsteuronete.com
Meagan Abele	Oregon State University	USA	abelem@oregonstate.edu
Karsten Breddermann	University of Rostock	Germany	karsten.breddermann@uni-rostock.de
Dorothée Kopp	IFREMER	France	dorothee.kopp@ifremer.fr
Martin Oliver	Bord Iascaigh Mhara	Ireland	martin.oliver@bim.ie
Ramazan Celebi	FAO	FAO	ramazan.celebi@fao.org
Roger B. Larsen	UiT The Arctic University of Norway	Norway	roger.larsen@uit.no
Enis N. Kostak	UiT The Arctic University of Norway	Norway	enis.n.kostak@uit.no
Nadine Jacques	UiT The Arctic University of Norway	Norway	nadine.jacques@uit.no
Heui Chun An	Korea Institute of Fisheries and Ocean Engineering	Korea	anhc0903@gmail.com
Narcisse Ebango Ngando	Shanghai Ocean University	China	narcisseebango@yahoo.fr
Kristine Cerbule	UiT The Arctic University of Norway	Norway	kristine.cerbule@uit.no
Juan Santos	Thünen Institute	Germany	juan.santos@thuenen.de
Frederik Furkert	Thuenen-Institute	Germany	frederik.furkert@thuenen.de
Jesse Brinkhof	UiT The Arctic University of Norway	Norway	jesse.brinkhof@uit.no

List of participants 2021

The following table list all participants who registered for the online meeting.

Name	Institution	Country	Email
Angeliki Adamidou	Fisheries Fisheries Research Institute, ELGO-DIMITRA	Greece	adamidou@inale.gr
Heui Chun An	Korea Institute of Fisheries & Ocean Engineering	Republic of Korea	anhc0903@gmail.com
Neil Anders	Institute of Marine Research	Norway	neil.anders@hi.no
Sidney Andrade	Marine Institute of Memorial University of Newfoundland	Canada	sidney_marcelo95@hotmail.com
Tomas Araya-Schmidt	Fisheries and Marine Institute of Memorial University on Newfoundland	Canada	Tomas.Schmidt@mi.mun.ca
Mikel Basterretxea Iragorri	AZTI	Spain	mbasterretxea@azti.es
Shannon Bayse	Memorial University	Canada	shannon.bayse@mi.mun.ca
Jade Boughton	University of Ghent /IMBRSea	Belgium	jade.boughton@imbrsea.eu
Jure Brčić	University of Split	Croatia	jure.brcic@unist.hr
Karsten Breddermann	University of Rostock	Germany	karsten.breddermann@uni-rostock.de
Mike Breen	IMR	Norway	michael.breen@hi.no
Jesse Brinkhof	UiT, The Arctic University of Norway	Norway	jesse.brinkhof@uit.no
Mollie Elizabeth Brooks	DTU Aqua	Denmark	molbr@aqua.dtu.dk
Daragh Browne	BIM	Ireland	daragh.browne@bim.ie
Beate Büttner	Thuenen Institute of Baltic Sea fisheries	Germany	beate.buettner@thuenen.de
Aida Campos	IPMA, the Portuguese Institute for the Sea and Atmosphere	Portugal	acampos@ipma.pt
Tom Catchpole	Cefas	UK	thomas.catchpole@cefas.co.uk
Kristine Cerbule	Sintef OCEAN	Norway	kristine.cerbule@sintef.no
Milani Chaloupka	University of Queensland	Australia	m.chaloupka@uq.edu.au
Zhaohai Cheng	Hubei Polytechnic Univeristy	China	chengzhaohai@hbpu.edu.cn
Jérome Chladek	Thuenen Institute of Baltic Sea Fisheries	Germany	chladek-sc@posteo.de
David Chosid	Massachusetts Division of Marine Fisheries	USA	david.chosid@mass.gov

Fabio Cortesi	The University of Queensland	Australia	f.cortesi@uq.edu.au
Ronan Cosgrove	BIM	Ireland	ronan.cosgrove@bim.ie
Elsa Cuende	AZTI (BRTA)	Spain	ecuende@azti.es
Kopp Dorothée	IFREMER	France	dkopp@ifremer.fr
Claude Dykstra	International Pacific Halibut Commission	USA	Claude.Dykstra@iphc.int
Steve Eayrs	Smart Fishing Consulting.	Australia	smartfishing1@hotmail.com
Alex Edridge	Marine Scotland Science	UK	Alexius.Edridge@gov.scot
Haraldur Einarsson	MFRI & FAO	Iceland	haraldur@hafro.is
Robin Faillettaz	Ifremer	France	robin.faillettaz@ifremer.fr
Min Fan	Bejing Global Environmental Institute	China	minfan@geichina.org
Jordan Feekings	DTU Aqua	Denmark	jpfe@aqua.dtu.dk
Lauren Fields	NOAA	USA	lauren.fields@noaa.gov
Shaun Fraser	NAFC Marine Centre	UK	shaun.fraser@uhi.ac.uk
Julio Garcia	National Institute for Fishery Research & Development	Argentina	jgarcia@inidep.edu.ar
Michele Luca Geraci	University of Bologna	Italia	micheleluca.geraci2@unibo.it
Eric Gilman	Pelagic Ecosystems Research Group	USA	FisheriesResearchGroup@gmail.com
Gildas Glemarec	DTU Aqua	Denmark	ggle@aqua.dtu.dk
Gökhan Gökçe	Cukurova University Fisheries Faculty	Turkey	gokhan.gokce@ymail.com
Eduardo Grimaldo	SINTEF Ocean	Norway	eduardo.grimaldo@sintef.no
Martin Hall	Inter-American Tropical Tuna Commission	USA	mhall@iattc.org
Constanze Hammerl	Thünen-Institute for Baltic Sea Fisheries	Germany	constanze.hammerl@icloud.com
Georg Haney	Marine and Freshwater Research Institute	Iceland	georg.haney@hafogvatn.is
Kirstin Hansen	Fjord and Bælt Center	Denmark	kirstin@fjord-baelt.dk
Yuxin Hao	Shanghai Ocean University	China	1162108645@qq.com
Pingguo He	University of Massachusetts Dartmouth	USA	phe@umassd.edu
MinAH Heo	Korea Institute of Fisheries and Ocean Engineering	Republic of Korea	alsdk8430@naver.com

Andreas Hermann	Thuenen Institute of Baltic Sea fisheries	Germany	andreas.hermann@thuenen.de
Bent Herrmann	Sintef Ocean	Norway	bent.herrmann@sintef.no
Jack Hollins	University of Windsor	Canada	jpwholl@uwindsor.ca
Sunkita Howard	independent	New Zealand	sunkita.howard@outlook.com
Olafur Ingolfsson	IMR, Norway	Norway	olafur@hi.no
Nadine Jacques	UIT The Arctic University of Norway	Norway	nadine.jacques@uit.no
Tonje Kristin Jensen	UiT The Arctic University of Norway	Norge	tonje.k.jensen@uit.no
Sönke Johnson	Duke University	USA	sjohnsen@duke.edu
Emma Jones	NIWA	New Zealand	Emma.Jones@niwa.co.nz
Terje Jørgensen	Institute of Marine Research, Norway	Norway	terjej@hi.no
Jung-Mo Jung	Nagasaki University	South Korea	jjm6538@gmail.com
Junita Karlsen	DTU Aqua	Denmark	jka@aqua.dtu.dk
Pyungkwan Kim	National Institute of Fisheries Science, Korea	Republic of Korea	trawl98@gmail.com
Al Kingston	University of St Andrews	UK	ark10@st-andrews.ac.uk
Enis Kostak	Ege University	Turkey	enis.kostak@gmail.com
Ludvig Krag	Technical University of Denmark	Denmark	lak@aqua.dtu.dk
Isabella Kratzer	Thünen-Institute of Baltic Sea Fisheries	Germany	isabella.kratzer@thuenen.de
Franziska Kühnel	University of Rostock	Germany	franziska.kuehnel@uni-rostock.de
Rob Kynoch	Marine Scotland Science	UK	Robert.Kynoch@gov.scot
Eva Lambert	University of Ghent /IMBRSea	Belgium	eva.lambert@imbrsea.eu
Jon Lansley	FAO	Italy	jon.lansley@fao.org
Finn Larsen	DTU Aqua	Danmark	fl@aqua.dtu.dk
Roger B. Larsen	UiT the Arctic University of Norway	Norway	roger.larsen@uit.no
Pedro Leitao	IPMA	Portugal	pedro.leitao@ipma.pt
Heleen Lenoir	ILVO	Belgium	heleen.lenoir@ilvo.vlaanderen.be
Yuwei Li	shanghai ocean university	China	ywli@shou.edu.cn
Daniel Li Veli	Italian National Research Council (CNR)	Italy	daniel.liveli@irbim.cnr.it
Uwe Lichtenstein	Thuenen-Institute of Baltic Sea Fisheries	Germany	uwe.lichtenstein@thuenen.de

Peter Ljungberg	Swedish University of Agricultural Sciences	Sweden	peter.ljungberg@slu.se
Svein Løkkeborg	Institute of Marine Research	Norway	svein.loekkeborg@hi.no
Mark Lomeli	PSMFC	USA	mlomeli@psmfc.org
Alessandro Lucchetti	Italian National Research Council (CNR)	Italy	alessandro.lucchetti@cnr.it
Jamie MacAulay	Århus University	Denmark	jdjm@st-andrews.ac.uk
Emma Mackenzie	Marine Scotland Science	UK	emma.mackenzie@gov.scot
Graham Martin	Birmingham University	UK	g.r.martin@bham.ac.uk
Lucas Martínez-Ramírez	CCMAR	Spain	lucasmartnezramrez@yahoo.es
Marina Mašanović	University of Zagreb	Croatia	masanovic.marina@gmail.com
Yoshiki Matsushita	Nagasaki University	Japan	yoshiki@nagasaki-u.ac.jp
Alessa Mattens	Wageningen Marine Research IJmuiden	The Nederlands	3026964@aeres.nl
Matthew McHugh	BIM (Ireland's Seafood Development Agency)	Ireland	matthew.mchugh@bim.ie
Sonia Mehault	IFREMER	France	sonia.mehault@ifremer.fr
Valentina Melli	DTU Aqua	Denmark	vmel@aqua.dtu.dk
Yoshinori Miyamoto	Tokyo University of Marine Science and Techinology	Japan	miyamoto@kaiyodai.ac.jp
Pieke Molenaar	Wageningen Marine Research	Netherlands	pieke.molenaar@wur.nl
Chryssi Mytilineou	Hellenic Centre for Marine Research - Institute of Marine Biological Resources and Inland Waters	Greece	chryssi@hcmr.gr
Truong Nguyen	Fisheries and Oceans Canada	Canada	truong.nguyen@dfo-mpo.gc.ca
Thomas Noack	DTU Aqua	Denmark	thno@aqua.dtu.dk
Emilio Notti	Italian National Research Council (CNR)	Italy	emilio.notti@cnr.it
Martin Oliver	Bord Iascaigh Mhara	Ireland	martin.oliver@bim.ie
Barrry O'Neill	DTU Aqua	Danmark	barone@aqua.dtu.dk
Hüseyin Ozbilgin	FAO, GFCM Black Sea Technical Unit	Turkey	huseyin.ozbilgin@fao.org
Eva Papaioannou	Geomar Helmholtz Centre for Ocean Research	Germany	epapaioannou@geomar.de

Andrea Petetta	Institute for Biological Resources and Marine Biotechnologies (IRBIM), National Research Council (CNR), Ancona, Italy	Italia	andrea.petetta@irbim.cnr.it
Rikke Petri Frandsen	DTU Aqua	Denmark	rif@aqua.dtu.dk
Josep Planas	International Pacific Halibut Commission	USA	josep.planas@iphc.int
Michael Pol	Massachusetts Division of Marine Fisheries	USA	mike.pol@mass.gov
Christopher Rillahan	University of Massachusetts	USA	crillahan@umassd.edu
Sally Roman	Virginia Institute of Marine Science	USA	saroman@vims.edu
Craig Rose	FishNext Research	USA	Fishnextresearch@gmail.com
Shale Rosen	Institute of Marine Research	Norway	shale.rosen@hi.no
Ricardo Roth	INIDEP	Argentina	rroth@inidep.edu.ar
Franco Rubio	INIDEP	Argentina	frubio@inidep.edu.ar
David Rudders	Virginia Institute of Marine Science	USA	rudders@vims.edu
Pedro Sá	Lankhorst Euronete	Portugal	pedrosa@lankhorsteuronete.com
Antonello Sala	Italian National Research Council (CNR)	Italy	antonello.sala@cnr.it
Juan Santos	Thuenen Institute of Baltic Sea fisheries	Germany	juan.santos@thuenen.de
Esther Savina	DTU Aqua	Denmark	esav@aqua.dtu.dk
Kim Sawicki	University of Massachusetts-Dartmouth	USA	ksawicki@umassd.edu
Annemarie Schütz	Thuenen Institute of Baltic Sea fisheries	Germany	annemarie.schuetz@thuenen.de
Julien Simon	IFREMER	France	julien.simon@ifremer.fr
Manu Sistiaga	Institute of Marine Research in Norway	Norway	manu.sistiaga@hi.no
Maria Sokolova	DTU Aqua	Denmark	msok@aqua.dtu.dk
Liming Song	shanghai Ocean University	China	lmsong@shou.edu.cn
Daniel Stepputtis	Thuenen Institute of Baltic Sea Fisheries	Germany	daniel.stepputtis@thuenen.de
Petri Suuronen	Natural Resources Institute Finland (Luke)	Finland	petri.suuronen@luke.fi
Monika Szynaka	CCMAR - Center of Marine Sciences	Portugal	mjszynaka@gmail.com
Hao Tang	Shanghai Ocean University	China	htang@shou.edu.cn
Maria Tenningen	IMR	Norway	maria.tenningen@hi.no
Adnan Tokac	Ege University Fisheries Faculty	Turkey	adnan.tokac@ege.edu.tr

Thomas Tvedt	Visioneers	Norway	thomas@visioneers.no
Sven Sebastian Uhlmann	Flanders Research Institute for Agriculture, Fisheries and Food	Belgium	sebastian.uhlmann@ilvo.vlaanderen.be
Melanie Underwood	INSTITUTE OF MARINE RESEARCH	Norway	melanie.underwood@hi.no
Anne Christine Utne-Palm	Institute of Marine Research	Norway	annecu@hi.no
Daniel Valentinsson	Department of Aquatic Resources	Sweden	daniel.valentinsson@slu.se
Bob van Marlen		Germany	bob.vanmarlen@outlook.com
Mattias Van Opstal	Instituut voor Landbouw Visserij en voedings-Onderzoek (ILVO)	Belgium	mattias.vanopstal@ilvo.vlaanderen.be
Jasper Van Vlasselaer	research institute for agriculture fisheries and food (ILVO)	Belgium	jasper.vanvlasselaer@ilvo.vlaanderen.be
Tiago Veiga Malta	DTU Aqua	Denmark	timat@aqua.dtu.dk
Lennard Noah Viertel	University of Rostock	Germany	lennard.viertel@uni-rostock.de
Benoit Vincent	IFREMER	France	benoit.vincent@ifremer.fr
Massimo Virgili	Italian National Research Council (CNR)	Italy	massimo.virgili@cnr.it
Magnus Wahlberg	Southern Denmark University	Denmark	Magnus@biology.sdu.dk
Waldo Wakefield	Oregon State University	USA	waldo.wakefield@oregonstate.edu
Jing Wang		China	jingwang26@163.com
Paul Winger	Fisheries and Marine Institute, Memorial University	Canada	Paul.Winger@mi.mun.ca
Yu Xiao	Shanghai Ocean University	China	groot123@126.com
Guoqiang Xu	Zhejiang Marine Fisheries Research Institute	China	1357108821@qq.com
Liuxiong Xu	shanghai Ocean University	China	lxxu@shou.edu.cn
Noëlle Yochum	NOAA	USA	noelle.yochum@noaa.gov
Hu Yuanyuan	Shanghai Ocean University	China	hyywork97@163.com
Tongzheng Zhang	Ocean university of china	China	zhangtongzheng7@163.com
Cheng Zhou	shanghai Ocean University	China	c-zhou@shou.edu.cn
Wenbin Zhu	Zhejiang marine fisheries research institute	China	foolse@126.com

List of participants 2020

As the meeting did not take place, only the chairs and the contact persons for the national reports are listed below (alphabetically order).

Name	Institute	Country (of institute)	Email
Mikel Basterretxea	AZTI	Spain	mbasterretxea@azti.es
Daragh Browne	Irish Seafood Develoment Agency	Ireland	daragh.browne@bim.ie
Georg Haney	Marine and Freshwater Research Institute	Iceland	georg.haney@hafogvatn.is
Pingguo He (chair)	Food and Agriculture Organization (FAO) / University of Massachusetts Dartmouth	USA	phe@umassd.edu pingguo.He@fao.org
Pascal Larnaud	Ifremer	France	pascal.larnaud@ifremer.fr
Emma Mackenzie	Marine Scotland Science	Scotland	emma.mackenzie@gov.scot
Mike Pol	Massachusetts Division of Marine Fisheries	USA	mike.pol@mass.gov
Antonello Sala (chair)	Institute of Marine Biological Resources and Biotechnologies (CNR-IRBIM)	Italy	antonello.sala@cnr.it
Daniel Stepputtis (chair)	Thünen Institute of Baltic Sea Fisheries	Germany	daniel.stepputtis@thuenen.de
Maria Tenningen	Institute of Marine Research	Norway	maria.tenningen@hi.no
Paul Winger	Memorial University/ Fisheries and Marine Institute	Canada	paul.Winger@mi.mun.ca

Annex 2: Resolutions

WGFTFB resolution 2020-2023

The ICES-FAO **Working Group on Fishing Technology and Fish Behaviour** (WGFTFB), chaired by Daniel Stepputtis, Germany, Antonello Sala, Italy and Jon Lansley (on behalf of FAEO), Italy, will meet to work on the following Terms of References (ToRs) and produce deliverables as listed in the following table for the years 2020 through 2023. WGFTFB will report on the activities and findings by 25 June each year to EOSG.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2020	By correspondence		Interim report by 22 May to EOSG	Incoming Chair Daniel Stepputtis, and Antonello Sala Pingguo He Chair on behalf of FAO No online meeting this year only by correspondence
Year 2021	19-23 April	Online meeting	Interim report by 25 June to EOSG	Outgoing: Pingguo He Chair on behalf of FAO Incoming: Jon Lansley, Italy
Year 2022	23 May 2022	Online meeting	Final report by 25 June to EOSG	Regular WGFTFB-meeting. FAO-sponsored meeting, postponed to 2023
Year 2023	13-17 February	Kochi (India)	Final report by 25 June to EOSG	FAO-sponsored meeting. Election of new chair(s)

ToR descriptors

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
a	Deliberate, discuss and synthesize recent research on topics related to: i) Designing, planning, and testing of fishing gears used in abundance estimation; ii) Selective fishing gears for the reduction of bycatch, discard and unaccounted mortality, especially as they relate to EU Landing Obligation; iii) Environmentally benign fishing gears and methods, iv) Improving fuel efficiency and reduction of emission from fisheries, and v) Summaries of research activities by nation	Through open sessions and focused, multiyear topic groups, the Working Group provides opportunities for collaboratively developing research proposals, producing reports and manuscripts, and creating technical manuals on current developments and innovations.	3.3, 4.5, 5.4	3 Years	ICES report
b	Organize a FAO-sponsored FAO-ICES mini-symposium with thematic issues. Symposium themes will be determined at Year 2, and included in the updated ToR.	Under mutual agreement between ICES and FAO, FAO develops and leads a mini-symposium of relevant topics, while also continuing ICES commitments.	2.1, 4.5, 5.4	Year 3	FAO report, ICES report

c	Organize a Joint Workshop on Fishing Technology, Acoustics and Behavior (JTFAB) to review research topics of mutual interest to both the Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and the Working Group on Fisheries Acoustics, Science and Technology (WGFAST).	Every three years, WGFAST and WGFTFB meet for a one-day Joint workshop on Fishing Technology, Acoustics and Behaviour (JFTAB) to review and share information on topics of mutual interest.	3.2, 4.5, 5.4	Year 1	JFATB report
d	Help organize an international fishing technology and fish behaviour symposium or workshop	The last similar symposium was 13 years ago (2006).	2.1, 4.5, 5.4	Fall 2020	Symposium or workshop with proceedings published in a special issue in ICES JMS
e	Support survey working groups with fishing gear expertise upon request	EOSG has identified gear expertise gaps in survey working groups.	3.2	Year 1,2,3	Report of relevant survey trawl working groups or associated workshop
f	Working with WGSFD, provide a commentary based on expert judgement as well as NEAFC VMS and catch report data analysis on current and potential maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area.	Advisory requirement. In the context of setting up OECMs, NEAFC will require infomation on areas that may be fished in the future. As such, an analysis of current NEAFC fishing practices in terms of maximum depth and in terms of general bathymetric features is required to inform the likely future extent by depth of fishing. This commentary by WGFTFB/ WGSFD will serve as input to an ICES workshop, 7-11 August, that will also look at the long-term biodiversity/ ecosystem benefits of 1) areas restricted to bottom fishing, and 2) closed areas according to the VME Recommendation (19:2014).		1 year	Material provided to ACOM by 28 July 2023.

Summary of the Work Plan

Year 1	PRODUCE THE ANNUAL REPORT; HOLD JOINT SESSION WITH WGFAST; CONNECT TO SURVEY WGS
Year 2	Produce annual report; Continue development of relationships with survey WGs
Year 3	Produce the annual report; organize FAO-ICES mini-symposium

Supporting information

Priority	The activities of WGFTFB will provide ICES with knowledge and expertise on issues related to the ecosystem effects of fisheries, especially the evaluation and reduction of the impact of fishing on marine resources and ecosystems and the sustainable use of living marine resources and other topics related to the performance of commercial fishing gears and survey gears.
Resource requirements	The research programmes that provide the main input to this working group already exist, and resources are already committed by individual institutions. FAO has committed to support the WG by sponsoring a WG meeting every third year. There are no additional resource requirements for the EG beyond the secretariat support for group organisation
Participants	The group is normally attended by about 60–100 regular members and chair-invited members. Participation is about 100 - 140 in the year when FAO-ICES mini-symposium is held. The numbers of attendees to the meeting have been growing over the last years.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Linkages to advisory groups via reports on changes to fleets and fleet effort.
Linkages to other committees or groups	There is a very close working relationship with other groups of EOSG, e.g. WGFAST, and the acoustic survey groups.
Linkages to other organizations	The WG is jointly sponsored with the FAO.

WGFTFB resolution 2024-2026

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB), chaired by Noëlle Yochum (U.S.A.), Antonello Sala (Italy), and Jon Lansley (on behalf of FAO), will meet to work on the following Terms of References (ToRs) and produce deliverables as listed in the following table for the years 2024 through 2026. WGFTFB will report on the activities and findings within three months of meetings to EOSG.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2024	3-7 June	St. Johns, Canada	Final report by September 30, 2024 to EOSG	Outgoing chair: Daniel Stepputtis Incoming chair: Noëlle Yochum Renew FAO chair: Jon Lansley
Year 2025	TBD	TBD	Final report within three months of the meeting to EOSG	Outgoing chair: Antonello Sala. Incoming chair: TBD ILVO (Belgium) has offered to host the meeting. At the meeting in 2024, it will be confirmed with a formal agreement.
Year 2026	TBD	TBD	Final report within three months of the meeting to EOSG	FAO-sponsored meeting. Election of new chair(s)

ToR descriptors

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	During annual meetings, deliberate, discuss and synthesize recent research on topics related to: i) designing, planning, and testing of fishing gears used in abundance estimation; ii) selective fishing gears for the reduction of bycatch, discard and unaccounted mortality; iii) environmentally benign fishing gears, including innovations to mitigate ALDFG and the risk of 'ghost fishing' and methods; iv) improving fuel efficiency and reduction of emission from fisheries; v) fish behaviour near and inside fishing gear as it relates to the previous topics; vi) summaries of relevant research activities by nation; and vii) innovative technologies improving the safety of fishing operations.	Through open sessions and focused, multi-year topic groups, the Working Group provides opportunities for collaboratively developing research proposals, producing reports and manuscripts, and creating technical manuals on current developments and innovations.	3.3, 4.5, 5.4	Years 1 and 2	ICES report
b	Organize an FAO-ICES symposium as described in (a) with additional thematic sessions to be determined in year 2.	Under mutual agreement between ICES and FAO, FAO develops and leads a symposium of relevant topics, while also continuing ICES commitments.	2.1, 4.5, 5.4	Year 3	FAO report, ICES report
c	Support FAO members, and ICES working groups and workshops with fishing gear and fish behaviour expertise upon request.	EOSG has identified gear expertise gaps in other working groups (e.g., survey) and workshops.	3.2	Years 1-3	Report of relevant working groups or associated workshops

Summary of the Work Plan

Year 1	Organize an annual meeting; produce a meeting report; provide expertise to FAO and other ICES WGs and workshops upon request
Year 2	Organize an annual meeting; produce a meeting report; provide expertise to FAO and other ICES WGs and workshops upon request
Year 3	Organize an FAO-ICES symposium; produce meeting reports (ICES and FAO); provide expertise to FAO and other ICES WGs and workshops upon request

Supporting information

Priority	The activities of WGFTFB will provide ICES and FAO members with knowledge, expertise, and guidance on issues related to the ecosystem effects of fisheries, especially the evaluation and reduction of the impact of fishing on marine resources and ecosystems and the sustainable use of living marine resources and other topics related to the performance of commercial fishing gears and survey gears and their safe operation.
Resource requirements	The research programmes that provide the main input to this working group already exist, and resources are already committed by individual institutions. FAO has committed to supporting the WG by sponsoring a WG symposium every third year. There are no additional resource requirements for the EG beyond the secretariat support for group organization.
Participants	The group is normally attended by about 60–100 regular members and chair-invited members. Participation is approximately 100-150 in the year when FAO-ICES symposium is held. The numbers of attendees to the meeting have been growing in recent years.
Secretariat facilities	None
Financial	A new group website (wgftfb.org) was developed during the 2020-2023 term. Funds for hosting maintenance going forward may be covered by FAO. Apart from these costs, there are no additional resource requirements for the WGFTFB beyond the secretariat support for group organisation. There are no financial commitments required for membership or participation in the annual meetings.
Linkages to ACOM and groups under ACOM	Linkages to advisory groups as required.
Linkages to other committees or groups	There is a very close working relationship with other groups of EOSG, e.g. WGFAST, DSTSG, and HAPISG.
Linkages to other organizations	The WG is jointly sponsored by the FAO.

Annex 3: Agenda of the meeting (incl. side events)

The world fisheries, as we know is facing various developmental and sustainability challenges. The issues in the marine fisheries sector range from depleted fish stocks, habitat destruction coupled with pollution and climate change, fish loss and wastage and other issues such as by-catch and ghost fishing. This calls for adopting sustainable practices including improved fishing and post-harvest techniques. The choice of technology that we make is very important as it may affect the ecological outcomes but also the social, economic outcomes and human well-being.

The small-scale fisheries in India in particular and the South and Southeast Asia in general, are mostly marginal and vulnerable. Their choice of technology or lack of it has led to the state of fisheries that we see today. The time to ponder and take action is NOW.

This International Symposium hopes to provide a platform for structuring actionable agenda, identifying research and capacity building needs and forging partnerships between and among researchers, academia, industry and the policy makers for a sustainable fisheries future.

Event Summary

<table>
<tr><th></th><th>ICES / FAO WGFTFB & International Symposium</th><th>Side Events
Panel Discussions</th><th colspan="3">Networking Opportunities</th></tr>
<tr><th></th><th>WATER FRONT HALL</th><th>ANCHOR HALL</th><th>MARINA HALL</th><th colspan="2">BESIDES WATER FRONT HALL</th></tr>
<tr><td>13 Feb</td><td>Inauguration
Plenum presentations:
• Active gears
Working Group Meeting</td><td></td><td>Bilateral Meetings</td><td rowspan="2">Waves of Art
(BOBP Social Art Initiative)
Participatory Sketching Event on Fishing Technology</td><td rowspan="5">Industry Expo / Booths:
Display of Products, Innovations and Programmes by Industry/ Institutes</td></tr>
<tr><td>14 Feb</td><td>Plenum Presentations:
• Passive gears
• Indicator
• ALDFG</td><td>Development of a Marine Fisheries Research Network for BOB Region
Artificial Reefs and Sea Ranching: Experience Sharing (Marina Hall)</td><td></td></tr>
<tr><td>15 Feb</td><td>Plenum Presentations:
• ALDFG • Behavior
Topic Group Meetings
1-3 [1 - Water Front Main Hall; 2 Anchor Hall 1; 3 Anchor Hall 2]</td><td></td><td rowspan="3">Bilateral Meetings
(For private network meetings among the participants)</td><td rowspan="3"></td></tr>
<tr><td>16 Feb</td><td>Plenum Presentations
• Energy
• General
Field trip</td><td>Future Proofing the Small Scale Fisheries (SSF)</td></tr>
<tr><td>17 Feb</td><td>Plenum Presentation:
• General
• Gear Design
Working Group Meeting
Valedictory Session</td><td>Greening the Fisheries Sector in the Bay of Bengal Region
Innovations and Solutions for Fish Harvest Sector</td></tr>
</table>

ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB23)

and

Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries

The 23rd meeting of the International Council for the Exploration of the Sea (ICES)-FAO Joint Working Group on Fishing Technology and Fish Behavior (ICES-FAO WGFTFB) is being organized alongside the International Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries being hosted by Department of Fisheries, Government of India.

The primary objective of the ICES-FAO WGFTFB is the incorporation of fishing technology issues and expertise into management advice including, inter alia, the impacts of fishing on the environment (e.g. by-catch, unaccounted fishing mortality, habitat impacts, energy use, greenhouse gas emission).

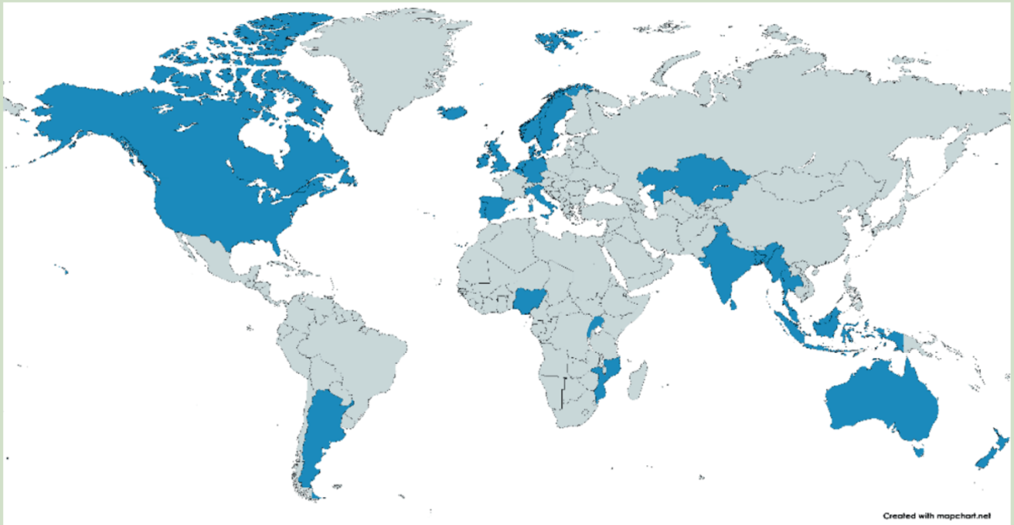
Objectives

The objectives of the International Symposium are to:

- Provide a forum for global synthesis of scientific knowledge;
- Identify appropriate technologies for a blue transformation of the SSF;
- Discuss and review innovations in various domains of fishing technologies; and
- Evaluate the options for optimizing energy use and reduce GHG emissions.

The participants include scientists, researchers, officials, policy makers, diplomats, industry, entrepreneurs, and students.

About 250 participants from about 30 countries are attending this event.



Geographical spread of the participants

Overall Programme for the WGFTFB / International Symposium

Date	Agenda*	Details
February 13, 2023	**Inauguration**	
	Plenum presentations: Active gears [12]	Various aspects of trawl such as selectivity, gear modifications, by-catch and also on seine fisheries
	WGFTFB Administration	Working Group Meeting among the WGFTFB members
February 14, 2023	**Plenum Presentations:** Passive gear [18]	Catch efficiency, gear modifications, selectivity, and sustainability of fisheries by different passive gears.
	Plenum presentations: Indicators [03]	Trawl selectivity, predicting discard survival and addressing the by-catch issues in fisheries.
	Plenum presentations: ALDFG (Ghost Gears) [07]	Gear marking, Global and regional status of ALDFG, and gear modification to curb ghost fishing, etc.
February 15, 2023	Plenum presentations: ALDFG (Ghost Gears) (Continues)	Gear marking, Global and regional status of ALDFG, and gear modification to curb ghost fishing, etc.
	Plenum presentations: Behavior [02]	Responses of fish during fishing.
	Topic Group Meetings [16]	Discussion on PASSIVE GEARS; ALDFG; INDICATORS will be held in three breakout groups, with respective experts.
February 16, 2023	**Plenum presentations:** Energy [08]	Alternate technologies for energy conservation, reducing GHG emission, etc.
	Plenum presentations: General [10]	Innovations and advancement in fishing technologies
	Field trips	Options to visit Technology or Research Institutions, a processing plant, a city visit and a Backwater Boat trip.
February 17, 2023	**Plenum Presentation:** General (continues)	Innovations and advancement in fishing technologies
	Plenum Presentation: Gear Design [12]	Impact of fishing gears, experimental gear design, advancements in gear accessories, real time by-catch detection, etc.
	WGFTFB Administration	Working Group Meeting among the WGFTFB members
	Valedictory session	

*Numbers of presentations in parentheses

In addition, 50 posters will be displayed in two batches of 25 each in the Symposium Venue.

SIDE EVENTS

Parallel to the main presentations being held in **Marina Hall** during 13-17 Feb 2023, thematic discussions will be held in ANCHOR HALL on selected themes on the 14th, 16th & 17th Feb 2023.

HD-BOBP Dialogue on

DEVELOPMENT OF A REGIONAL MARINE FISHERIES RESEARCH PLATFORM FOR THE BAY OF BENGAL REGION

14 February 2023
0900 - 1700

Brainstorming Session on

STRATEGIES FOR DEPLOYING ARTIFICIAL REEFS AND SEA RANCHING IN SOUTH ASIA: LEARNING FROM THE EXPERIENCES

14 February 2023
1400 - 1700

Panel Discussion on

FUTURE PROOFING SMALL SCALE FISHERIES (SSF): INNOVATIONS IN FISHING TO ENHANCE CONTRIBUTION OF SSF TO FOOD SECURITY

16 February 2023
0900 - 1300

Panel Discussion on

GREENING THE FISHERIES SECTOR IN BAY OF BENGAL OPPORTUNITIES AND STRATEGIES

17 February 2023
0900 - 1300

Industry - Stakeholder Interaction on

INNOVATIONS AND SOLUTIONS FOR FISH HARVEST SECTOR

17 February 2023
0900 - 1300

1 SIDE EVENT

Centre for Humanitarian Dialogue

BOBP

HD-BOBP Dialogue on

Development of a Regional Marine Fisheries Research Platform for the Bay of Bengal Region

14 February 2023 | 0900 - 1700

Context

The key challenges of Bay of Bengal region include changing climate, marine pollution, overfishing and habitat degradation. The transboundary nature of these issues require countries in the region to come together and plan collaborative actions. Fisheries is a key sector in the national Blue Economy strategy of the rim countries. These issues and opportunities are gaining attention from the R&D institutions in the region, but a regional platform for marine scientific research is not in place.

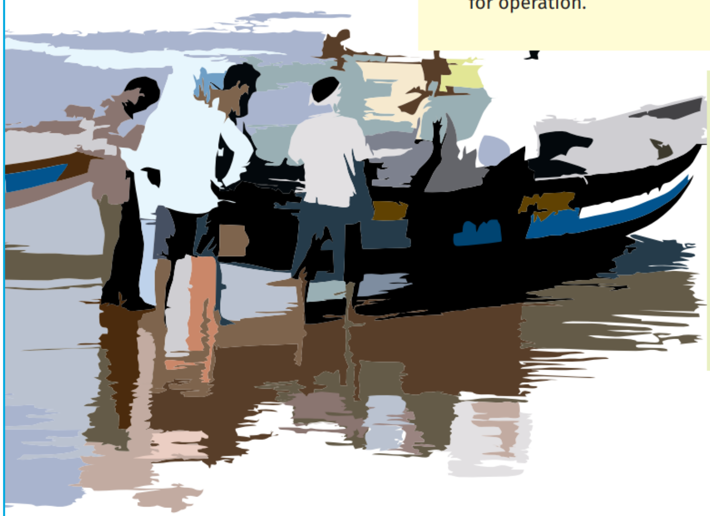
The Event

The event will have coordinated country presentations from delegates from India, Bangladesh, Indonesia, Maldives, Malaysia, Myanmar, Sri Lanka, and Thailand.

The participants will deliberate on the following points: Need for collaboration, potential areas, potential institutes, and existing framework for facilitating collaboration and expected outcome and application.

There shall be a moderated group activity to elucidate opinions on the following points:

- Functional arrangement of networking platform - Potential organisational set-up for creating the platform (is it necessary to have a central coordinating body or can be a bilateral/multilateral arrangement between countries addressing common themes)
- Seeking government support-Likelihood of governments accepting and extending support to the platform and strategies thereof.
- Financial arrangements: Innovative models for operation.



Participants

The participants include academicians and scientists from more than 20 organizations from the BOB rim countries, apart from the mission heads and senior policy makers from the Governments of countries in South Asia.

2 SIDE EVENT

Brainstorming Session on

Strategies for Deploying Artificial Reefs and Sea Ranching in South Asia: Learning from the Experiences

14 February 2023 | 1400 - 1700

Context

The increasing global concern over the threats to sustainable marine fisheries, actions towards mitigating the negative effects of natural and anthropogenic impacts on the coastal and marine ecosystems, are gaining momentum.

Artificial reefs (AR) are effective area-based conservation measures (OECMs) for in situ conservation of biodiversity, to promote habitat recovery and to enhance reef-dependent resources. Sea ranching involves introducing juveniles into the natural water body, where they are allowed to grow and harvested later possibly after maturity. It is a widely adopted practice in many countries, especially for conserving species such as salmon, sea cucumber, pearl oyster, blue crab and shrimps, many grouper species, flat fishes, sea bream, etc.

The Event

This side event is intended to discuss various dimensions and past experiences related to artificial reefs and their impact in the Indian context, emerging challenges and enabling policies that are necessary for further development in artificial reefs.

It will also deliberate upon suitable size of release, area specifications, species-specific favorable seasons, ranching techniques and economics of sea ranching so as to enable successful ranching programs in future.

Participants

The event hosted in hybrid mode will be attended by experts from reputed institutes in India, Greece, USA, Japan and France, apart from the researchers / policy makers from the BOB rim countries.

3 SIDE EVENT

Panel Discussion on

Future Proofing Small Scale Fisheries (SSF): Innovations in Fishing to Enhance Contribution of Ssf to Food Security

16 February 2023 | 0900 - 1300

Context

Small-scale fisheries across the Bay of Bengal region are a major component of the region's food system.

A large part of the rural economy of the Bay depends on fisheries. However, the SSF in the Bay of Bengal is facing a number of issues of growing magnitude, including overfishing, climate change impacts, and a sluggish and scattered input and output market structure. Therefore, to retain fishers in the small scale fisheries and to sustain their contribution to the overall fishery, there is an urgent need to ensure enhanced organizational focus towards innovations with regard to craft and gear modifications; handling and post-harvest; safety of fishers and access to advanced communication and information technologies, with specific focus to the SSF.

The Event

The Event will bring together different organizations working on SSF to discuss and promote various innovations which can result in sustainable SSF.

Speakers will share their experiences from the region on:

- Existing socio-economic and environmental challenges for the development of the SSF
- New innovations in the SSF sector (both marine and inland): Experiences from South Asia
- Developing and promoting strategies towards the application of innovative technologies
- Sea safety, social protection, onboard fish handling, engine optimization, etc.

Participants

The participants include ICES-FAO and regional experts, representatives from various industries, government, academia and research institutions.

4 SIDE EVENT

National Maritime Foundation

Panel Discussion on

Greening the Fisheries Sector in Bay of Bengal Opportunities and Strategies

17 February 2023 | 0900 - 1300

Context

Carbon emission from the marine capture fisheries is increasing over time. With growing importance of value addition and better price realization, the environmental cost has increased following wider use of refrigeration and other freezing techniques. A holistic policy and management solution is required to address the problem, from a pure technology perspective and therefore the challenge is, what can be done to reduce carbon emission from the marine fisheries sector without adversely affecting the benefits.

The Event

The event aims to identify and promote opportunities to encourage green fishing in the Bay of Bengal Region. Expert speakers will share experiences on the research and development initiatives related to de-carbonization, innovations in engines, alternative energy, green fishing activities, and green infrastructure & technology.

The deliberation will take stock of the energy efficient fishing practices in different countries and explore opportunities for collaboration among countries and stakeholders for development of green fishing technologies.

Participants

Senior officials from various countries, academia and research institutes from regional and international organizations will attend the event.

5 SIDE EVENT

Industry - Stakeholder Interaction on
Innovations and Solutions for Fish Harvest Sector

17 February 2023 | 0900 - 1300

Context

The Industry Expo will showcase innovations and technologies in fish harvest sector. The booths in the expo will provide immense opportunity for industry stakeholders to display and exchange technological ideas to the prospective end users, industry stakeholders, experts in the field and senior officials from world over.

The Event

The broad objective of this session is to provide opportunities for showcasing emerging technologies from the global and Indian industry majors, exchanging ideas, and developing leads for academia-industry collaborations. It will include presentation on various topics such as:

- Innovations in fishing technologies
- Fisheries engineering
- Communication & Sea safety
- Digital Technologies

Participants

The participants would include ICES-FAO experts, representatives from various industries, government officials and research institutions.

Field trips

February 16, 2023 (2 pm – 6 pm)

Participants can select the package of their choice to visit

Option 1

ICAR-CIFT & Processing Plant

Central Institute of Fisheries technology (ICAR-CIFT) is the major national center in the country where research in all disciplines relating to fishing technology and fish processing is undertaken.

Kochi is one among the top five fish export centers in India. There are several state-of-the-art fish processing plants in Kochi. CIFT will coordinate a visit to one of the plants.

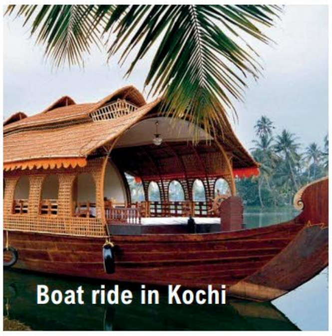
Option 2

ICAR-CMFRI & City Ride

Central Institute of Marine Fisheries Institute (ICAR-CMFRI) is the leading tropical marine fisheries research institute in the region.

The Institute's multidisciplinary approach to research in marine capture and culture fisheries has won recognition as a premier institute comparable to any well-established marine laboratory in the world.

Option 3



Kochi backwater tour will allow to enjoy unmatched beauty of nature, and enable one to get a glimpse of the busy city life.

Kochi backwaters is blessed with rich aquatic life.

The point where Arabian Sea and Vembanad Lake meets is a splendid sight.

WAVES of Art... Series 3

As a part of the Social Art Initiative of BOBP-IGO, a special sketching event will be held during 13-14 Feb 2023 at the Venue, adjacent to the Marina Hall, wherein art enthusiants and Symposium particiopants will get to sketch on the theme of fishing technology.

ICES CIEM

DEPARTMENT OF FISHERIES

Food and Agriculture Organization of the United Nations

ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB23)

and

Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries

13-17 February 2023 | Taj Gateway Hotel, Kochi, India

Symposium Organizing Committee

Chief Patron
Shri Jatindra Nath Swain, IAS
Secretary
Department of Fisheries, Govt. of India

Patrons
Dr. J. Balaji, IAS
Joint Secretary
Department of Fisheries, Govt. of India
Mr. Sagar Mehra
Joint Secretary
Department of Fisheries, Govt. of India
Dr. J.K. Jena
Deputy Director General (Fisheries)
Indian Council of Agricultural Research (ICAR)
Ministry of Agriculture and Farmers Welfare

Convener
Dr. A Gopalakrishnan
Director, ICAR-CMFRI

Co-conveners
Dr. George Ninan
Director, ICAR-CIFT
Dr. Ravishankar C.N.
Vice-Chancellor, ICAR-CIFE
Dr. G. Sugumar
Vice-Chancellor, TNJFU
Dr. Rosalind George
Vice-Chancellor, KUFOS
Dr. R. Jeyabaskaran
Director General, FSI
Mr. A.K. Choudhury
Director, CIFNET

Organizing Secretaries
Dr. P. Krishnan
Director, BOBP-IGO, Chennai
Dr. L. Narasimha Murthy, ARS
Senior Executive Director, NFDB
Mr. Antony Xavier
Fisheries Development Commissioner
Department of Fisheries, Govt. of India

Working Group Chairs
Daniel Stepputtis
Scientist, Thünen Institute, Germany
Antonello Sala
Senior Fisheries Scientist
National Research Council, Italy
Jon Lansley
Fishery Industry Officer, FAO, Italy

Annex 4: Opening Adress by FAO chair Jon Lansley

Opening Address by: Mr Jon Lansley Fishery Industry Officer, Food and Agriculture Organization of the United Nations (FAO)

Colleagues, Ladies and Gentlemen,
It is a great pleasure and honour to welcome you on behalf of FAO's Fisheries and Aquaculture Division, to the 2023 meeting of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour and Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries.

I would like to begin by expressing my sincere gratitude to the Government of India. In particular the Bay of Bengal Inter-Governmental Organisation (BOBP-IGO), for generously hosting this Working Group meeting and symposium. The interest of India to work with ICES and FAO is very much appreciated, and I am sure all Working Group members share my pleasure to be, not only participating in the first psychical meeting in 3 years, but to be achieving this here in Kochi, Kerala.

The Working Group was given a global mandate in 2002 when FAO accepted the invitation of the ICES to form a joint Working Group. In 2011, ICES and FAO further discussed the purpose and methods of collaboration. It was agreed that FAO would co-chair the annual meeting and host the meeting every third year at a location chosen by FAO. Previous locations chosen by FAO were, Thailand in 2013, Mexico in 2016, and China in 2019.

For FAO, the main objective of this collaboration is to involve more developing countries in the work of this group;

- to promote exchange of information between experts working around the globe on fishing technology innovations, and
- to facilitate technology transfer and uptake of responsible and sustainable fishing technologies and practices, by fishing fleets worldwide.

It is the first time that a WGFTFB meeting has been held in South Asia. It is hoped this will result in increased memberships and ongoing participation from the region. I stress this is a two-way collaboration. The Working Group will benefit just as much from the experience brought in by new regional experts, as new members will benefit from the collaboration with the Working Group. In the short time I have been in Kochi I have been very impressed by the warm welcome and wealth of expertise that National Institutes such as the Central Institute of Fisheries Technology (CIFT), the Central Marine Fisheries Research Institute (CMRF), and the School of Industrial Fisheries have demonstrated.

It hasn't been possible to hold a physical meeting during the last 3 years for reasons associated to COVID-19 travel restrictions, and then the war in Europe. For many reasons this has been a very difficult time, for far too many people. However, during this period advances in fishing technology and related fields has still been achieved, owing to the dedication, and adaptable nature of fishing gear technologists and researchers worldwide, and through the course of this week we will learn about many examples of this.

From the FAO, contributions over the last two years include:

- ongoing support for the implementation of the FAO Voluntary Guidelines on the Marking of Fishing Gear;
- ongoing efforts to address negative environmental impacts caused by abandoned, lost or otherwise discarded fishing gear (ALDFG) and other forms of marine pollution caused by fishing operations; and
- ongoing efforts to prevent and reduce unwanted bycatch.

Details on FAO activities will be provided through the course of this meeting, through a series of presentations from myself and other FAO colleagues.

On behalf of FAO, I would like to express my gratitude especially to Dr P. Krishnan and his team at the the Bay of Bengal Inter-Governmental Organisation (BOBP-IGO), for the organisation of this event. Also to the chair-persons of this ICES-FAO Working group. Dr Antonello Sala and Dr Daniel Stepputtis for the excellent work throughout the past year in preparation of this important event.

Please rest assured that the FAO will do all we can to assist progress of this Working Group. Not just over the next few days, but also into the future.

I wish you a productive Symposium and Working Group meeting.