

**ICES ANNUAL SCIENCE CONFERENCE**  
**15-18 September 2026**  
**Theme session D: Bycatch reduction**

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## **SharkGuard: Commercial Sea Trials of an Induction Charged Shark Deterrent System**

*Robert Enever*

The global abundance of oceanic sharks and rays has declined by nearly three-quarters (71%) over the last 50 years due to overfishing. Accidental capture or ‘bycatch’ is a primary driver of population declines and poses an important challenge for species conservation. There are currently no technological solutions to this problem.

In this work we test a new technology (SharkGuard) designed to overcome the operational challenges of delivering Electronic Pulse Devices (EPD) in a commercial fishery setting, assessing the operational effectiveness and collecting data on the efficacy of the SharkGuard EPDs on both shark bycatch and tuna target catch.

Experiments were conducted on 3 commercial tuna longline vessels fishing in the New Caledonian Marine Park over a 35-day period. Operational effectiveness was assessed and bycatch and target catch data were collected for both SharkGuard and control branchlines (n=~45,000 hooks from 4 trips and 40 hauls). The SharkGuard EPDs were positioned in two locations above the baited hooks (40 and 60cm). At 60cm from the hook, SharkGuard EPD had no significant impact (-2.2%) on commercially important fish species (predominantly albacore tuna) and significantly reduced shark bycatch by 46.6% when compared to the control hooks. When positioned closer to the hook (40cm), shark bycatch was significantly reduced by 88.7% but there was also a significant reduction in target catch of -19.4% (likely due to tuna being visually spooked by the close proximity of the EPD to the bait).

Operationally, SharkGuard worked well for the duration of the trials and on all vessels. Depleted SharkGuard EPDs were successfully charged after each haul using the vessel’s power and required minimal input from the crews. Importantly, SharkGuard had a negligible impact on the speed of hauling or shooting operations when compared to their standard hook setting bins.

These findings present us with some new technological challenges to overcome. When the SharkGuard EPD was positioned at 40cm instead of 60cm from the hook, shark bycatch reduction almost doubled (from 47% to 89%). The modelled field strength at the hook is 3.5 times higher with the SharkGuard placed at 40cm vs 60cm, leading to a much higher shark deterrent effect. However, the increase in shark bycatch reduction compromised the tuna catch rates, which may reduce commercial acceptance of the SharkGuard system. To achieve a near 90% reduction in shark bycatch and no impact on target catch, we need to develop the SharkGuard EPD to deliver the same field strength at the hook at 60cm as it does at 40cm. This work demonstrates a step-change in our ability to mitigate shark bycatch in pelagic longline fisheries. These trials of SharkGuard have demonstrated, for the first time in a commercial fishery setting, that shark bycatch can be substantially reduced without impact on target catch or vessel operations; findings that have the global potential to save millions of sharks annually.

### **Game of Trawls: towards a real-time reaction to bycatch events inside fishing trawls**

*Robin Faillettaz*

Trawling is still largely a blind process, driven by fishers' experience and local ecological knowledge. This limits fishers' ability to avoid bycatch and optimize selectivity. The issue is even more complex in the case of Endangered, Threatened, and Protected (ETP) species, due to the sporadic nature of their encounter and the high mortality rate post-capture. Air-breathing ETP species are frequently taken as bycatch in pelagic trawl fisheries and require rapid escapement to get access to the surface, since the bycatch of even a few individuals can have conservation and regulatory consequences for fisheries. Consequently, reducing bycatch of air-breathing species, such as dolphins, requires selective systems that ensure immediate, unobstructed escape, even at the expense of the target catch. Real time detection and response to the presence of these species in the net are key aspects to improve the sustainability of these fishing gears, which contribute substantially to the seafood supply worldwide. The Game of Trawls system transforms blind fishing into a real-time active process, where bycatch species can be released without interrupting fishing operations. It combines acoustic communication, embedded computer vision, and AI, along with actuators that trigger a reversible hatch to release or retain species. The complexity of this innovative system requires several iterations of fine-tuning and performance assessment. We here present the latest results of the AI-based active (i.e. reversible) selectivity system tested *in situ*, along with a 1:3 scale-model prototype of an emergency release system specifically developed in the MarineBeacon project for airbreathing species, for which a larger section of the trawl needs to be opened for their survival. Its operational performance was evaluated in controlled flume tank experiments. When triggered, the system collapses the entire top panel of the trawls last tapered section, creating a rapid, upward-facing escape opening. The system's single trigger point simultaneously actuates two running lines, that when released swiftly create a 3-m long and 1.5-m wide opening, within 4 s at a flow velocity of  $0.9 \text{ m s}^{-1}$ . When matured, this new application of the Game of Trawls system could thus inform on the interaction between ETP species and trawl fisheries while limiting the latter's negative impacts, ultimately providing monitoring data for certification requirements and meeting the consumers' demand for sustainable seafood.

### **What are the options to reduce unwanted elasmobranch bycatch from flatfish trawl fisheries?**

*Sebastian Uhlmann*

Mitigating unwanted bycatch of elasmobranchs—particularly skates and rays—from demersal flatfish trawls is challenging, because mechanical separation or modified ground gear did not discriminate sufficiently between species or did reduce catches of valuable flatfish. Sensory deterrents, particularly those exploiting elasmobranch electroreception through the ampullae of Lorenzini (AoL), offer an alternative, despite mixed results in previous studies regarding the ability of magnetic or electric stimuli to elicit avoidance behaviour among elasmobranch species.

Based on the results from a motivational lab trial to quantify behavioural responses of thornback ray (*Raja clavata*) when exposed to electromagnetic deterrent devices (SharkBanz® Zeppelin magnet; FishTek® SharkGuard), we are exploring options for technological engineering solutions in accommodating such devices ahead and/or inside a trawl configuration to deter entry into a trawl and/or facilitate underwater escape.

Some field trials are planned (possibly using a modified KingGrid) for a catch comparison comparing a conventional vs a bycatch reduction device. With the completion of these trials, it is envisioned to gauge whether available bycatch reduction devices can be successfully tuned to deter unwanted elasmobranch species and identify any barriers for uptake to future proof a bycatch-prone fishery.

### **Influence of Artificial Illumination on Catch Efficiency and Size Structure of *Pagellus bogaraveo* Under Variable Lunar Conditions**

*Sergio Vitale*

The blackspot seabream (*Pagellus bogaraveo*; hereafter SBR) is a commercially important species targeted by Mediterranean longline fisheries. Adults reproduce throughout the year, with regional peaks during the colder seasons. Juveniles typically inhabit coastal areas, whereas adults occupy the upper continental slope down to approximately 400 m. In recent years, signs of overexploitation have been reported in several regions, and the increasing use of artificial light in both commercial and recreational fisheries has raised concerns regarding the sustainability of current exploitation patterns. In this context, the present study evaluates the effects of artificial light on SBR catch rates. The trial was conducted at the Lipari Island fishing ground (Aeolian Islands, South Tyrrhenian Sea), known as “Secca del Capo” (15.4306°E, 38.0910°N), during the summers of 2022 and 2023. Eight fishing trips were carried out under two lunar phases: full moon (high brightness, HB; 96–100%) and new moon (low brightness, LB; 0–31%). During each trip, four 200-m longlines were alternately deployed in a circular layout around the bank summit at approximately 200 m depth. Two longlines were configured according to traditional SBR fishing practices used by local fishers (control), while the remaining two were equipped with eight green and white LED bulbs (peak wavelengths: 520 and 460 nm, respectively; intensity 3.5 cd) attached to the float line. Catch per unit effort (CPUE;  $n \cdot h^{-1}$ ) was recorded for both SBR and by-catch species (fish and cephalopods). Catches were classified into three categories: Control, LB without LED; Test 1, LB with LED; Test 2, HB without LED. Kruskal–Wallis tests indicated significant differences among treatments ( $p < 0.05$ ). Post hoc Dunn tests revealed significant differences only between control vs. test 2 and test 1 vs. test 2, with test 2 producing the highest SBR CPUE. Length-frequency distributions (LFDs) exhibited a unimodal pattern in test 2 (22–44 cm TL; mode 28 cm TL). Control and test 1 showed similar unimodal distributions (24–32 cm TL; mode 26 cm TL), while the control LFD displayed a more flattened shape (24–40 cm TL). By-catch CPUE was also highest in test 2, whereas no significant differences were detected between control and test 1. Overall, the results indicate that test 2 yielded the highest CPUE for both SBR and by-catch species. Test 1 produced a higher number of smaller individuals, although without statistically significant differences in CPUE relative to the control. In conclusion, artificial light appears to positively influence SBR catches under

low-brightness conditions, supporting its increasing use in the fishery; however, no detectable effect is observed under high-brightness (full-moon) conditions.

### **KingGrid: An innovative design paradigm for rethinking sorting grids**

*Juan Santos*

Sorting grids are commonly used in crustacean trawl fisheries to reduce bycatch by preventing unwanted species from entering the codend. While sorting grids can provide well-defined and efficient catch separation, their implementation in commercial fisheries can be challenging, particularly if the design of the grid is not optimised to address practical constraints. This is the case in the North Sea beam trawl fishery targeting brown shrimp (*Crangon crangon*). In this fishery, fishermen are required to use sorting grids or sieve nets to avoid bycatch. However, the steel grid designs originally implemented in these fisheries did not meet the needs of the fishermen. Consequently sieve-nets became the prevalent technology. In recent years, particularly during the summer season, the use of sieve-nets has become unpractical due to clogging issues linked to increased occurrences of algae and benthos invertebrates. In response to the current need for efficient alternatives to sieve-nets, we reconsidered the potential of sorting grids through an innovative design paradigm – KingGrid - that aims to deliver efficient, problem-focused solutions while addressing the practical challenges that may hinder commercial adoption. The KingGrid is made from polycarbonate, which, combined with its functional design, results in a lightweight, mechanically flexible and robust device. Furthermore, the concept uses a simple modular assembly process, enabling easy repair and bar spacing adjustments according to fishermen preferences and regulatory requirements. Based on such design paradigm, a KingGrid concept has been developed for North Sea brown shrimp fisheries, optimised to facilitate the removal of algae, benthos organisms and debris from the net. Initial investigations on the sorting efficiency of KingGrid configurations with bar spacings ranging from 12 mm to 20 mm, revealed an average catch efficiency for the targeted shrimp of about 90%, regardless of the bar-spacing applied. Furthermore, a direct performance comparison with standard sieve-net showed that using KingGrid can significantly reduce the bycatch of juvenile fish species for which the fishery has no quota. By adopting the KingGrid design paradigm, sorting grids may become a viable technological solution in the brown shrimp fisheries and other trawl fisheries facing similar bycatch and technological implementation challenges. The presentation will discuss this development within the PESTEL framework.

### **Assessing oceanographic and operational impacts on fixed On-Demand gear performance**

*Abigail Costigan*

Since 2017, the North Atlantic right whale (*Eubalaena glacialis*) has been experiencing an Unusual Mortality Event (UME), with entanglement in fixed fishing gear identified as a primary driver of injury and mortality. As restricted areas which prohibit the use of vertical lines are employed to mitigate this risk along the U.S. East Coast, on-demand (ropeless) gear has emerged as a critical innovation to allow fishing access to these areas once more. While this technology is not yet legal for commercial use in the Maine American lobster (*Homarus americanus*) fishery, ongoing experimental trials provide a vital dataset for assessing the viability of this technology. This study leverages State of Maine trial data to evaluate the influence of oceanographic conditions (e.g., wave height, depth) and operational variables (e.g. gear configuration) on gear retrieval success. By employing Generalized Additive Models (GAMs) integrated with high-resolution modeled oceanographic data pertinent to Maine's Lobster Management Zones, we predict the operational precision and reliability of these systems. These

findings offer a data-driven foundation for assessing the scalability of on-demand gear in otherwise untested areas and its potential to harmonize fishery operations with protected species conservation.

### **800 years to fix a net (and counting...)**

*Francisco Flores*

This presentation explores, through specific examples, how the critical intersection between innovation and implementation has evolved throughout history. We often see fisheries regulations as a 20<sup>th</sup>- and 21<sup>st</sup>- century concern, but they have been around for much longer than one might think. We are working in one of the oldest professions known to humankind. Our ancestors designed the first fishing gears more than 20,000 years ago, and as efficiency increased, so did the first concerns about bycatch and overfishing of stocks. After all, with great power comes great responsibility...

For at least 800 years, governments have recognised the impact of human activity on marine resources, and they have tried their best (or not) to preserve stocks for future generations. Intellectuals wondered at the time: “Why can’t fishermen see the long-term consequences of their actions?” “Why don’t they follow the very wise mesh-size regulations by our Emperor Charles V?” In which century would you place complaints like “We should go back to old methods before it’s too late”? Looking at past concerns, innovative technical measures, and attempts to implement regulations gives us valuable and often overlooked insights to avoid repeating the mistakes past generations made. We’ll be bringing back a short review of historical documents, fishing gears and regulations from different historical periods and comparing them to the situations we are more than familiar with in modern times.

### **From Fragmentation to Impact: Coordinated Pathways Towards a Unified Voice on Bycatch Reduction**

*Caecilia Manago*

Bycatch remains a persistent challenge in marine ecosystem protection and restoration. Barriers and obstacles span the full range, from technology, to lack of ecosystem understanding, complex stakeholder interest downstream of the research, and challenging business models and policy landscapes in the fisheries sector.

In this context, fragmented and concurrent research efforts can easily deliver performant niche solutions in parallel, that fail to get traction on uptake, re-use and generating impact. Good solutions, with promising preliminary results can sit on the R&D shelves, as a result of unforseeable bottle necks downstream of the research, that were always beyond the capacity of the research teams.

The oral presentation will focus on a community resource: the Bycatch Triad. Funded and operated by ECO-CATCH, MarineGuardian and Sea4Future Projects between 2025-2030, the Triad aims to provide opportunities for joint trials across EU Regional Seas, mobility to all concurrent bycatch R&D projects, and platforms and pipelines for joint "science-2-policy" actionable advice. The aspirations of the TRIAD are to reduce the fragmentation of concurrent efforts on bycatch R&D, and offer structural assistance for concurrent efforts between 2025-2030, meaningfully co-deliver Bycatch Reduction Technologies (BRT), and offer recommendations with a united message and single voice towards policy.

Examples will focus on past projects where pro-active and agile Knowledge Transfer Frameworks were successfully deployed, as well as better use of existing ICES assets that can consolidate "science-2-policy" community efforts.

### **Mandated does not mean effective: Rethinking mitigation in a small-scale fishery**

*Ana Marçalo*

Bycatch of common dolphins (*Delphinus delphis*) remains a recurrent conservation and management challenge across the Bay of Biscay and Iberian Waters, including Portuguese coastal fisheries, which pose additional risks to the critically endangered Iberian harbour porpoise (*Phocoena phocoena*).

In Portugal, the beach-seine fishery (*arte-xávega*), a traditional coastal method, is a primary focus of concern. Although the use of acoustic deterrent devices (pingers) has been legally mandated since 2020, the lack of a dedicated monitoring program has created a critical information gap regarding bycatch rates and the actual effectiveness of this measure. The persistence of highly visible bycatch events on shore raises fundamental questions about whether current regulations are fit for purpose or require adaptive revision.

The Marine Guardian Horizon project (2025-2029) addresses this gap by evaluating the Portuguese *arte-xávega* through a multi-stage approach. We began with a preliminary assessment using structured interviews covering approximately 50% of the fleet, which confirmed that recent bycatch exclusively involved common dolphins. This diagnostic phase not only identified high-risk areas but also strengthened the collaboration between the fishing community and scientists. Subsequent monitoring of 45 hauls from June to October 2025 established baseline rates: 1.29 sightings, 0.58 bycatch events, and 0.13 mortalities per haul. While fishers report releasing most animals alive through established operational techniques, post-release survival remains an urgent unknown.

To address possible mitigation measures, a pilot trial was conducted between August and November 2025 on three commercial vessels (≈16% of the fleet), testing two pinger models (Future Oceans Netguard, 60–120 kHz; Fishtek Banana, 50–120 kHz). Overall, 16 control hauls (using dummy devices) and 13 hauls using pingers were monitored. Dolphins were sighted during net deployment in both treatments, with higher sighting rates in hauls using pingers, indicating that these devices did not exclude animals from the fishing areas. Bycatch results differed between treatments, with fewer capture events observed while using pingers. Although these results seem promising, pinger use also poses practical limitations, including maintenance demands such as battery replacement, and risks associated with acoustic emissions and potential chemical pollution if devices are lost at sea.

Future work will focus on a multi-layered mitigation framework, combining an optimized single-technology deployment with detailed documentation of mitigation practices used by fishers to ease cetacean release. The integration of complementary monitoring tools (e.g. cameras and passive acoustics devices) will improve understanding of bycatch drivers. This integrative approach aims to support adaptive, evidence-based policies that balance technological mitigation with operational practices and environmental trade-offs.

### **An assessment of EcoCast, a Dynamic Ocean Management tool for bycatch avoidance, from the end-user perspective.**

*Rachel Seary*

Dynamic Ocean Management is a rapidly adaptive strategy for the management of the marine environment under a changing climate. By providing near real-time spatio-temporal information

on environmental, economic, biological or social conditions, Dynamic Ocean Management can be a useful approach for managing human activities such as fishing, where there is a need to both minimize bycatch of protected species and maintain fishing opportunity.

The EcoCast tool (Hazen et al., 2018) was built in collaboration with stakeholders in a California fishery targeting broadbill swordfish, *Xiphias gladius*, to help fishers minimise bycatch of protected species of concern in Southern California. The EcoCast tool uses habitat suitability models and satellite-derived environmental data to predict where broadbill swordfish and three bycatch species (leatherback turtle, blue shark and California sea lion) are likely to be each day. EcoCast provides a novel solution to bycatch reduction, producing daily maps to be used directly by fishers that combine both target and bycatch species habitat, guiding the locations that are 'best to fish' based on both economic and environmental criteria.

This project provided a rare opportunity to evaluate the effectiveness of this Dynamic Ocean Management tool after its development and implementation. We tested the tool's effectiveness from the end-user (social) perspective. Participatory data collection was conducted during fishing trips, with skippers reporting an assessment of pre-set and post-haul fishing conditions for the location, alongside EcoCast projections, based on criteria such as target catch and observations of bycatch species. Comparison of tool projections and skipper evaluations allow us to determine the tools efficacy from the perspective of those using it on the water. Using this information to refine the delivery of tools to support evolving end-user needs will be the next step in reinforcing Dynamic Ocean Management as a more widely used strategy for bycatch avoidance. The use of such tools could promote ecological and socio-economic sustainability under changing environmental and governance landscapes.

### **Participatory evaluation of Acoustic Deterrent Devices in small-scale net fisheries: opportunities, challenges, and lessons for real-world uptake**

*Alessandra Bielli*

Acoustic Deterrent Devices (pingers) are widely proposed as a mitigation tool to reduce cetacean bycatch in static net fisheries, yet results on their real-world performance and the factors influencing uptake are mixed. In 2019, the Clean Catch pinger trial, funded by the UK Department for Environment, Food and Rural Affairs (Defra), was launched in response to requests from fishers in Southwest England seeking practical solutions to cetacean bycatch in small-scale gillnet fisheries.

Cefas and participating fishers collaboratively designed a data collection framework suitable for commercial operations in the Western English Channel and Celtic Sea, through focus groups and one to one conversations. Data were collected using Remote Electronic Monitoring (REM) and a self-reporting mobile application (Clean Catch App) which was co-developed with the fishers. This codesigned approach ensured that the evaluation of pinger usability, compliance and operational performance was grounded in real fishing contexts.

Using this trial as a case study, we examine the interplay of economic, social, technological, environmental and legal factors that shape the adoption of pingers. These include:

- Legal: evolving regulatory framework for cetacean bycatch mitigation and the implications of potential mandatory pinger use;
- Economic: direct and indirect costs to small scale fleets, and the evidence required to justify investment;
- Social: fisher perceptions of pingers, trust in science, and how codesign can strengthen legitimacy and engagement;
- Technological: device reliability, integration with diverse gear types, and the challenges of assessing effectiveness with limited bycatch event data;
- Environmental: unintended effects on target and non-target species.

By highlighting barriers and lessons learned, this case study demonstrates the importance of participatory and transdisciplinary approaches for implementation of pingers. Preliminary findings will be presented where available, alongside reflections on the next steps needed to support scalable, evidence-based bycatch mitigation in small scale net fisheries.

### **Improving monitoring of incidental bycatch of marine mammals, birds and turtles in a purse seine fishery targeting small pelagic fishes via stakeholder engagement**

*Rita Vasconcelos*

Commercial fishing activity in the marine environment sometimes results in the interaction with and incidental bycatch of endangered, threatened and protected (ETP) species of marine mammals, birds and turtles, due to the spatial and temporal overlap between fishing operations and these species, as well as e.g. target and ETP species behaviour. Incidental bycatch is typically monitored by scientific observers at sea, but low observer coverage in many fisheries worldwide limits the accuracy of ETP species bycatch rate estimates since such events are rare for most species. Electronic monitoring is increasingly used but with challenges in industry acceptance, cost and feasibility. Methods such as questionnaires conducted by scientific observers in ports and self-reporting by fishers are sometimes used although not considered as accurate as it relies on voluntary reporting. In this study, the latter two methods are implemented to improve the knowledge on ETP species incidental bycatch rates in the purse seine fishery targeting small pelagic fishes in continental Portugal as part of its undergoing an MSC certification. More precisely, scientific observers carried out questionnaires in fisheries landing ports, to collect information from vessel skippers on their retrospective perception of ETP species bycatch rates and on additional aspects such as previous participation in monitoring activities. Furthermore, a free smartphone application was developed and announced to skippers to allow the self-reporting of ETP species bycatch events, or their absence, at the haul level.

### **Assessing Bycatch Reduction Technologies through Cost–Benefit and Ecosystem-Based Frameworks: Insights from European Case Studies**

*Arantza Murillas-Maza Azti*

Fisheries bycatch remains one of the most persistent challenges in achieving sustainable and ecosystem-based marine resource management, particularly in regions where interactions with marine megafauna — including cetaceans, sea turtles, seabirds, and elasmobranchs — threaten both conservation objectives and fishery viability. Despite decades of regulatory efforts, conventional top-down or command-and-control approaches often fail to generate adequate behavioral change among fishers, especially when mitigation measures reduce short-term profitability or increase operational complexity and costs. As a result, there is increasing interest in incentive-based strategies combined with robust cost–benefit analyses (CBA) to evaluate and promote the uptake of effective bycatch reduction technologies (BRTs). This research, developed within the EU LIFE CIBBRiNA Project, proposes adopting within an economic perspective a multidimensional methodological framework to assess the economic, ecological, and social performance of such technologies under both stock-based and ecosystem-based management scenarios. The framework integrates: (1) direct impacts of mitigation technologies on target species' landings and profitability; (2) trophic and ecological cascading effects estimated through ecosystem modelling tools such as Ecopath with Ecosim (EwE), allowing quantification of net changes in food-web productivity; and (3) the economic valuation of provisioning, cultural, and regulating ecosystem services, including public

willingness to pay for the conservation of endangered and charismatic megafauna species affected by fisheries under a climate change context.

This research applies a CBA methodological framework to multiple case studies across EU, including, among others, Northern gillnets in Baltic Sea, Iceland and Norwegian waters where bycatch species are Grey seal (*Halichoerus grypus*); Harbour seal (*Phoca vitulina*); Harbour porpoise (*Phocoena phocoena*); Alcid seabirds and Eider (*Somateria mollissima*), to be presented during the conference.

Our results show that evaluating BRTs solely through a stock-based provisioning lens systematically underestimates the benefits of bycatch mitigation, particularly when interactions involve long-lived, culturally valued megafauna. Ecosystem-based CBA reveals additional gains derived from trophic functioning, non-use values, and long-term ecosystem resilience.

Conversely, costs to fishers are highly context-specific and depend strongly on mitigation type, regulatory setting, fleet structure, and market incentives.

This integrated framework enables policy-makers and Advisory Councils to identify cost-effective, socially acceptable, and ecologically meaningful mitigation pathways. The approach, which will be applied to multiple case studies within LIFE CIBBRiNA, hope to generate transferable insights across gears, regions, and megafauna conservation.

## **How market-based sustainability schemes reward bycatch-reduction technologies**

*Sandra Ougier*

Fisheries exert considerable pressure on marine species, habitats, and ecosystems, despite substantial scientific knowledge on methods to prevent or mitigate the impact of fishing. Incentivising environmentally-friendly fishing practices with market-based sustainability schemes that may confer market access and price premiums is a key to encourage fishers to adopt lower-impact practices and to ensure long-term management of marine resources. The MSC ecolabel, VALDUVIS, and the GoodFish guide are sustainability assessment and consumer information schemes designed to steer fisheries and seafood supply chains toward more responsible fishing practices. Each scheme benchmarks fisheries' environmental sustainability — using different approaches — based on attributes such as target stock status, ecosystem impacts, monitoring and management practices. Assessment results of individual schemes are signalled to consumers through an ecolabel (MSC), a scoring system (VALDUVIS), or colour-coded recommendations (GoodFish). By making seafood sustainability visible to buyers and consumers that prefer sustainable products, market-based sustainability schemes create incentives for fishers to improve their practices. To strengthen the incentive to adopt gear changes and new data collection tools, it is useful to establish how market-based sustainability schemes reward bycatch mitigation. Here, we investigate how these schemes account for changes in sustainability performance following the adoption of a suite of bycatch-reduction technologies developed in the EU Horizon project ECO-CATCH. We identify which indicators within each sustainability scheme are affected by each specific innovation in bycatch reduction. We then catalogue the type of information required by each scheme to evaluate changes in performance. Our results can inform providers of fisheries monitoring technologies to ensure that data outputs from monitoring tools can readily be used by certification and rating auditors. Moreover, our results can help the fishing industry to understand how particular bycatch mitigation strategies can improve their sustainability scheme scoring and the likelihood of obtaining market recognition.

## **Incentive-Based Approaches to Mitigate Fisheries Bycatch in European Waters: Feasibility and Barriers**

*Benjamin Dudouet*

The persistent issue of fisheries bycatch in European marine water poses significant threats to vulnerable marine species and ecosystems. While traditional command-and-control measures have been widely implemented, their effectiveness is often limited by monitoring and enforcement challenges and resistance from fishing communities. Incentive-based approaches offer a promising alternative, as they foster voluntary compliance and promote more sustainable fishing practice.

This study examines the applicability of incentive-based measures across various case studies in Europe, with a particular focus on innovative management strategies aimed at mitigate fisheries bycatch (e.g. voluntary dynamic spatial management, voluntary use of deterrent devices, real-time reporting).

By analysing technical, environmental, economic, social and institutional barriers, we identify key factors influencing the potential feasibility and success of these measures.

Using a multi-disciplinary framework, we assess the potential of incentives through a typology of 13 incentives types categorized into five groups: financial, fishing opportunities, market access, collective incentives and individual incentives (e.g. tax, rewards, bycatch limits, labelling,..) .

Through stakeholder engagement and empirical analysis, we evaluate the effectiveness of these measures in mitigating bycatches while maintaining the livelihoods of fishing communities. The goal is to understand the dynamics of the social-ecological systems linked to the bycatch issues in order to implement the appropriate, effective, and socially accepted solutions.

The results highlight the need for adaptive policies that integrate environmental, economic and social consideration. By addressing institutional constraints and fostering partnerships among policymakers, scientists and fishers, incentive-based approaches can enhance the sustainability of European fisheries. Anchoring these measures in local structures, whether institutional or associative, further increases their potential for being acceptable, monitored and enforced by ensuring greater contextual relevance and compliance. This study emphasizes the critical role of context-specific solutions, carefully tailored to local conditions, in achieving a balance between ecological conservation and the social-economic sustainability of fishing communities.

### **Evidence-based mitigation options for reducing blue shark bycatch mortality in Mediterranean pelagic longline fisheries**

*Pierluigi Carbonara*

Reducing bycatch mortality of threatened species while maintaining viable fisheries is a central challenge for ecosystem-based fisheries management. In the Mediterranean Sea, the blue shark (*Prionace glauca*) is assessed as Critically Endangered and has been recently listed for strict protection under the UNEP MAP Regional Sea Convention, yet it remains a frequent bycatch species in pelagic longline fisheries targeting swordfish. Management measures increasingly promote live release and gear modification, but their expected conservation gains remain poorly quantified. Here, we provide an operational evaluation of mitigation options based on integrated fishery monitoring, experimental gear trials, satellite telemetry, and predictive modelling conducted in the southern Adriatic Sea (2019–2024).

Fishery-dependent data collected through onboard observation, landing-site monitoring, and fisher logbooks showed stable catch rates but declining landings after 2021, indicating improving compliance with no-retention measures. An experimental comparison of traditional J-hooks and circle hooks demonstrated no significant differences in swordfish catch-per-unit-effort or size structure, ensuring economic neutrality. However, circle hooks significantly improved blue shark capture conditions, with 71.5% of individuals released in healthy condition compared to 22.6% using J-hooks.

Post-release survival was quantified using 45 pop-up satellite archival tags, yielding an overall survival estimate of 77%, with most mortality occurring within four days. Capture condition and body size were key predictors of survival probability. Random Forest modelling identified soak time as the primary operational driver of capture condition, followed by environmental variables (sea-surface temperature, chlorophyll-a, dissolved oxygen).

Vertical movement analyses revealed predictable diel depth shifts and lunar-driven deepening prior to and during full moon phases. These behavioural patterns identify temporal and depth-based mitigation windows that could reduce spatio-temporal overlap between fishing gear and shark habitat without reducing target catch.

By integrating capture-condition frequencies with survival estimates, we project that approximately 68% of incidentally captured blue sharks could survive if released promptly under optimized fishing practices. Our results provide quantitative support for three management levers: adoption of circle hooks, reduction of soak time, and behaviour-informed adjustment of fishing depth and timing. This study delivers a transferable, evidence-based framework to evaluate and implement mitigation measures that balance conservation objectives with fishery performance in pelagic longline systems.

### **A promising by-catch reduction device in the deep-water red shrimp fishery**

*Michele Luca Geraci*

Most Mediterranean fish stocks are overexploited due to high fishing efforts and poor exploitation patterns. Demersal trawl fisheries are considered to have the greatest environmental impact because of the large quantities of unwanted fish that are routinely discarded at sea. One of the most productive areas for demersal resources in the Mediterranean is the Strait of Sicily (Central Mediterranean), which is mainly exploited by trawl fisheries. A large fleet of around 785 trawlers from Italy, Malta and Tunisia exploit shared resources in international waters. The deep-water red shrimp (DWRS) fishery, targeting *Aristaeomorpha foliacea* and catching *Aristaeus antennatus* as a main commercial by-catch, is one of the area's most representative and profitable trawling typologies. The DWRS fisheries operate using 40 mm square meshes in the codends, which also retain small individuals of low commercial value. There are concerns about the capability of these resources to withstand increasing fishing pressure, as well as the absence of a minimum conservation reference size. Against this backdrop, this study aims to mitigate the impact of the DWRS on *A. foliacea* and *A. antennatus* juveniles by testing a bycatch reduction device (BRD), specifically a T90 codend with 90° rotated diamond meshes. In autumn 2022, a three-day selectivity survey involving two trawlers was conducted as part of a paired gear experiment. One trawler used commercial gear (40 mm square mesh) as a control, while the other used a 50 mm T90 codend for the test. Each vessel carried out four hauls per day, for a total of 24 hauls over the course of the survey. In the present study, we compared the catch per unit effort (CPUE) of *A. foliacea* and *A. antennatus*, expressed as kg per hour, as well as the revenue and size structure, for the control and T90 codend groups. The results showed that the CPUE of both species was slightly higher for the T90 codend, although the Mann–Whitney test did not detect any significant differences ( $p$  value > 0.05). A preliminary economic analysis based on the overall CPUE and the local market value of

both species indicated that the revenues of the BRD were higher than those of the control. The size structure analysis revealed that the T90 codend reduced the catch of juveniles (below the size at first reproduction reported in the area) and slightly increased adult catches of both species, but the Kolmogorov–Smirnov test again did not detect significant differences. In conclusion, while further studies should be conducted in the future to evaluate the performance of the T90 codend in different areas and seasons, the investigated gear appears promising in reducing the catch of juveniles while maintaining economic viability and mitigating the potential overfishing of these vulnerable seafood resources.

### **PearlNet: The long way from concept to implementation**

*Andrea Milanelli*

Odontocete bycatch, especially in bottom-set nets, represents a significant threat to these species worldwide. To mitigate this problem, an innovative net design has been developed: the PearlNet (PN). The PN follows the same configuration as standard nets but includes small plastic spheres attached to the netting that act as acoustic reflectors to enhance detectability. Although the PN has been evaluated in the Baltic and Black Sea with respect to target-species catch efficiency and handling time, a key question remains: Does the PN reduce odontocete bycatch? To date, only one trial in Turkey has assessed bycatch effects and, although the results suggested a reduction in harbour porpoise (*Phocoena phocoena*) bycatch, it was not statistically significant. To address this question, we tested the PN in a commercial gillnet fishery in Iceland, a region with historically high harbor porpoise bycatch. Recognizing that fisheries differ in machinery, environmental conditions, and target species, we also evaluated PN performance in terms of cod (*Gadus morhua*) catch efficiency and handling time. Our results indicate that the PN reduces harbor porpoise bycatch while maintaining handling times and catch efficiency of target species comparable to standard nets. The presentation will discuss the development, testing and implementation of the PearlNet, covering the different dimensions of the PESTEL framework. Additionally, it will address the challenges of gear development for outcomes with low observed incidence in short-term study, such as the incidental bycatch of odontocete species.

### **New legal gears in the Baltic – a bumpy road**

*Daniel Stepputtis*

The poor state of cod stocks in the Baltic Sea since at least 2019 has required urgent solutions to reduce cod bycatch in the bottom trawl fishery. Only under these conditions can flatfish fisheries continue without hindering the recovery of cod stocks. Baltic gear technologists have developed and proposed technical solutions (two codends and the ROOFLESS-device) to achieve this goal in the short term. The presentation will look at the technical aspects and selectivity of the proposed selection devices, and will also review the challenging path from the finalisation of the solutions in 2020 until the mandatory legalisation in April 2025.

### **PETS bycatch programs (FEAMPA ARP, LIFE EMM and OBSCAMe+): fostering collaboration with fishers to test BRTs and evaluate their effectiveness through robust methods**

*Chloé Merrien*

Reducing bycatch of protected, endangered, and threatened species (PETS) – including marine mammals, seabirds, marine turtles, elasmobranchs and diadromous fish – in French fisheries constitutes the central objective of three major programs currently led by the French

Biodiversity Agency (OFB). The OBSCAMe+ program aims to improve the quantification and characterization of bycatch events through Remote Electronic Monitoring (REM) systems aboard commercial fishing vessels operating in the Bay of Biscay (BoB). The LIFE EMM project (Marine Mobile Species) targets to reduce the primary anthropogenic causes of mortality of 23 marine species in Metropolitan France. The FEAMPA ARP project (FRA – Fisheries Risk Analysis) aims to conclude on risks induced by professional fishing gears on species and habitats of community interest at both biogeographic scale and smaller high-risk areas. It further aims to propose mitigation measures by the end of 2026 in metropolitan French waters.

Within this framework, FEAMPA ARP and LIFE EMM will evaluate the effectiveness of different BRTs respectively through REM and onboard observers, in collaboration with voluntary fishers. The programs will non-exhaustively test LEDs, acoustically visible headlines, and scary bird devices. BRT data will be collected on approximately a dozen netters, trawlers and longliners for the FEAMPA ARP (REM) and approximately 70 vessels for the LIFE EMM (observers). The OBSCAMe+ program, the first program in France using REM, is integrated into the ministerial action plan for reduction of small cetacean bycatch in the BoB, currently equipping 100 netters (and 15 trawlers) on a mandatory basis. It started as a voluntary program but is now mandatory for a list of representative vessels. It will contribute to the robust evaluation of the effectiveness of BRTs.

We present an overview of the three programs which address the important challenge of reducing PETS bycatch in French fisheries. Those programs are interconnected and mutualized. We explore the different methods used, regulatory frameworks, and incentives, to encourage mobilization of fishers.

### **Bycatch in the Icelandic lump sucker fishery – history, mitigation, and management**

*Gudjon Sigurdsson*

The Icelandic lump sucker (*Cyclopterus lumpus*) fishery is a small-scale gillnet fishery conducted in the spring and summer in Icelandic coastal waters which received MSC (Marine Stewardship Council) certification in 2014. While small-scale, the fishery provides valuable employment and economic stimulant to fragile coastal communities from where the fishery is conducted. Observations in 2010-2015 suggested high bycatch rate of several sensitive marine mammal and seabird populations, such as the harbour seal (*Phoca vitulina*) and black guillemot (*Cepphus grylle*). Given the sensitive conservation status of these populations, the observed bycatch rates highlighted that the fishery could be hindering the recovery of them, leading to a suspension of the MSC certificate. Follow up research confirmed the high bycatch rates, which led to some management changes and attempted co-management by involving the fishing industry in selecting spatial closures. Although the attempted co-management was not successful due to the industry mostly selecting areas where no fishing took place, the resulting discord and awareness that followed brought down the bycatch rates to the point a MSC certificate was reissued. Furthermore, new gear regulations and changes to the management system, with the introduction of an ITQ (Individual Transferable Quotas) system (previously an effort-controlled fishery), offers fishers more flexibility to alter their fishing patterns to reduce bycatch. Ongoing research and monitoring aims to assess the effectiveness of these changes in reducing bycatch rates in the near future.

### **Fisher's experience with the 100 mm T90 mesh selective device in the Celtic Sea: high voluntary adoption in the monkfish and ray fisheries versus low uptake in the gadoid fisheries.**

*Marianne Robert*

Reducing unwanted catches remains a key challenge for most European demersal trawl fisheries to improve fishing practices and ensure long-term yield. In the Celtic Sea, a recent assessment of the absolute selectivity of the standard 100-mm diamond mesh codend and extension highlighted limited intra- and interspecific size selectivity. Several research programmes have investigated alternative gear configurations to enhance selectivity in the region. This study reports on the voluntary implementation of a 100-mm T90 mesh extension and codend as a bycatch reduction device (BRD) after scientific trials conducted under commercial conditions on twin trawlers. We demonstrated a marked reduction in catches of pelagic and schooling species, notably boarfish, for which these fisheries have strict quota restrictions. Owing to its low cost and ease of implementation, the device was rapidly and voluntarily adopted by vessels targeting monkfish and rays. A 2022 industry survey indicated that 13 vessels had implemented this gear modification. However, the 100-mm T90 configuration proved overly selective for roundfish species such as whiting and haddock, thereby constraining its uptake across other demersal trawl segments. Nevertheless, the mechanical characteristics of T90 mesh indicate potential to enhance multispecies selectivity, particularly for species subject to high discard rates, including gurnard and lesser-spotted dogfish. Experimental evidence suggests that reducing T90 mesh size to 80 mm may better align L50 values with the commercial sizes of gadoids. Indeed, successful voluntary uptake of an 80-mm T90 configuration has been documented on four vessels targeting finfish in the North Bay of Biscay. In the Celtic Sea, however, regulatory constraints currently hinder the implementation of an 80-mm T90 configuration. A shift towards a results-based management approach, rather than strict minimum mesh size regulation, could facilitate further testing of such BRDs in whitefish fisheries and promote the broader uptake of effective selectivity measures in the Celtic Sea.

## **From Co-creation to Field Results: Lessons from the LIFE CIBBRiNA Bycatch Mitigation Case Studies**

*Martin Pastoors*

The LIFE CIBBRiNA project (2023–2029) implements bycatch mitigation trials across eight case studies covering gillnet, longline, pelagic trawl, and bottom trawl fisheries in thirteen European countries, focussed on endangered, threatened, and protected (ETP) species including marine mammals, sharks, rays and skates, seabirds and marine turtles.

Bycatch monitoring and mitigation technologies that are tested include pearl nets to avoid bycatch of cetaceans in gillnet fisheries, acoustic and electromagnetic deterrent devices of various types in both passive and active gears, bird scaring lines in UK longline fisheries, escape panels in pelagic trawl fisheries. Monitoring of the trials takes place with observers, remote electronic monitoring and self-reporting in different fisheries. Results are mixed but instructive: pearl nets show promise for reducing harbour porpoise bycatch in gillnet fisheries; bird scaring lines and offal disposal reduce seabird interactions under certain conditions in longline fisheries; and pinger trials reveal important context-dependent results, including potential ‘dinner bell’ effects for seals and bottlenose dolphins. A recurring challenge, for example in one of the gillnet case studies, is that mitigation trials can be conducted across hundreds of fishing sets without recording a single bycatch event either with or without the mitigation measure being deployed.

CIBBRiNA's co-creation model, in which fishers are active partners rather than research subjects, consistently underpins the trial design. Trust, transparency around data use, and timely feedback to participants are preconditions for sustained engagement, not afterthoughts. The co-creation model also lead to the raising of depredation of target species by e.g.

bottlenose dolphins as a cross-cutting issue across multiple case studies. Addressing depredation concerns alongside conservation objectives has proven an important entry point for engaging the fishing industry, turning a shared problem into a shared motivation for participating in trials.

These lessons speak directly to the PESTEL framework (Political, Economic, Social, Technological, Environmental, Legal) that this session adopts to examine how innovation translates into real-world adoption: bycatch reduction technologies cannot be evaluated in isolation from the broader context in which they are deployed.

### **Turning bycatch mitigation into practice: adaptive co-design in a bird-scaring line trial**

*Emily Roebuck*

Bycatch remains a significant threat to sensitive marine species, including seabirds, cetaceans and elasmobranchs, despite the availability of bycatch reduction technologies (BRTs). Although many BRTs have demonstrated technical effectiveness, uptake within fisheries is often limited by operational, economic, social and governance challenges. Clean Catch seeks to address this implementation gap through a fishermen-led, co-designed approach to bycatch monitoring and mitigation in a North Sea trawl fishery, centred on a trial of bird-scaring lines (BSLs) to reduce seabird interactions and bycatch.

Vessel owners and skippers were involved from the outset, helping shape trial objectives and methods to ensure they reflected real fishing practices. Monitoring approaches were co-developed to balance scientific robustness with practicality at sea, combining remote electronic monitoring (REM) with skipper self-reporting to document seabird interactions with fishing gear, particularly warp cables, alongside observations of other sensitive species bycatch. Periodic questionnaires capture participant motivations, concerns and experiences throughout the trial, allowing the approach to evolve through an adaptive co-design process that brings together industry knowledge with physical and social science evidence.

Following an initial three-month baseline monitoring phase, bird-scaring lines were introduced using configurations developed jointly with participating skippers and vessel owners. Information gathered throughout the trial, including insights from observer trips, was shared with participants in an accessible and appropriate format, supporting informed decisions about trial progression and providing clarity around roles, expectations and data use. Rather than viewing implementation as a fixed endpoint, Clean Catch adopts an adaptive learning approach based on ongoing communication, knowledge exchange and adjustments informed by participant feedback to maintain engagement and operational feasibility.

This trial shows how a co-designed approach, supported by ongoing communication, structured feedback and shared decision-making, can help address persistent barriers to BRT uptake by aligning mitigation measures with industry motivations and working practices. The approach offers transferable lessons for translating bycatch mitigation technologies from trials into practical, scalable solutions that support ecosystem-based fisheries management.

### **Changing the drag: Pathways to innovative fishing gear**

*Annika Brüger*

The German fishery for brown shrimp (*Crangon crangon*) is facing a set of interlinked ecological, technical and economic pressures that make further innovation in fishing gear and practices unavoidable. The most pressing challenge is the persistent bycatch of non-targeted species and juvenile individuals, which continues to raise concerns regarding ecosystem impacts, stock sustainability and increasing regulatory pressure on the fishery. The beam trawl gears used,

equipped with very small mesh sizes, inherently limit selectivity and make the effective exclusion of smaller organisms particularly difficult.

Alongside this central ecological issue, the comparatively high fuel consumption of the fleet creates additional pressure. It places growing economic burden on fishing operations while also contributing to environmental impacts through emissions and seabed disturbance. Together, these challenges underline the urgent need for technological and operational innovation that improves selectivity while simultaneously enhancing energy efficiency.

To address these interconnected issues the “Innovation program for shrimp fishery”, imposed by the advisory board for shrimp fishery in Schleswig Holstein, Germany, brings together fishers, scientists and stakeholders in a collaborative development process. Through this co-design approach, practical solutions are tested under real fishing conditions, ensuring that innovations respond not only to ecological objectives but also to operational realities and economic constraints. By embedding the fishers as “end users” directly in the innovation process, the programme operates at the critical intersection between technological development and implementation, where many promising solutions otherwise fail.

In this sense, the programme functions as a foundational building block for long-term change. By jointly developing and validating workable ideas with the sector, it creates the conditions necessary for broader uptake beyond pilot trials. Its participatory design, iterative testing structure and integration of multiple stakeholder perspectives provide a transferable model that can facilitate implementation under varying regulatory, technical and socio-economic conditions. This increases the likelihood that effective bycatch reduction and energy efficiency measures move beyond experimentation and become embedded in routine fishing practice.

### **The development and implementation of a tunnel Excluder in small-meshed North Sea trawl fisheries**

*Claus Sparrevohn*

A challenge often encountered in small-meshed trawling for forage fish is bycatch of adult and juvenile non-target species. To mitigate this, top-down regulation with multiple regulatory and technical measures has been implemented for many of the fisheries taken place in the North Sea, but with varying success.

A bottom-up driven process where fishers and trawl manufacturers started developing an Excluder tunnel was started in 2015. The project setup was such that most of the development of the gear and testing lay within the responsibility of the fishery and net manufacturers, while the scientific proofs of concept and documentation was done by DTU Aqua. The tunnel Excluder has proven successful and is now being used voluntarily by most of the vessels in North Sea fisheries for Norway pout (*Trisopterus esmarkii*), sandeel (*Ammodytes* spp.) and sprat (*Sprattus sprattus*).

The journey from ideas to final implementation in EU legislation and broad acceptance within the fishery has not been without bumps. In this presentation we tell the story focusing on aspects fundamental for the successful implementation of the gear, such as target species efficiency, motivation within the fishery and a bottom-up industry driven process with a strong consortium.

### **Bridging the Implementation Gap: Best Practices to Promote the Uptake of Selectivity Measures in EU Fisheries**

*Laurence Fauconnet*

The implementation of the EU Landing Obligation (LO) created a strong incentive to improve selectivity in EU fisheries. To assess progress and remaining challenges, an overview of the current state of play in selectivity developments in the wake of the LO was requested by the European Parliament, along with the identification of best practices from projects that have successfully improved selectivity and could be replicated across Member States. The review of existing selectivity measures and recent research revealed a clear pattern: while extensive experimental and technical work has been conducted over the past decade to test gear modifications and other selectivity measures, their uptake in commercial fisheries has often lagged behind. This implementation gap highlights persistent technical, economic, and social barriers. Best practices were identified through a literature review and an analysis of EU and national initiatives. The most consistent driver of successful uptake was close collaboration with fishers, grounded in trust, transparency, and long-term engagement. Bottom-up initiatives proved particularly effective in fostering ownership and innovation, provided that appropriate incentives were in place. While financial incentives can support adoption, enhancing the public image and recognition of fishers engaging in selective practices also emerged as a powerful lever. Successful initiatives typically developed solutions tailored to local fisheries and operational realities, emphasizing practicality and “fisher-friendly” designs. Striking the right balance between simplicity and technical sophistication was also key to promoting adoption. Strategic testing pathways - screening promising measures, conducting rigorous validation under commercial conditions, and ensuring wide and accessible communication of results - helped accelerate both regulatory acceptance and industry uptake. Finally, advancing knowledge on species behaviour, gear-species interactions, and ecosystem processes, combined with international data sharing and integrated evaluation frameworks, strengthened the evidence base for effective selectivity improvements. These findings highlight that technological innovation alone is insufficient: overcoming barriers to implementation requires co-development, targeted incentives, effective communication, and integration of ecological, technical, and socio-economic dimensions.