REPORT

Meeting: **ICES Annual Science Conference**
Parties: **ICES, scientists, research institutes, stakeholders**
Date: **15-18 September 2026**
Location: **Brest, France**
Rapporteur: **NSAC Secretariat**

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Introduction

The 2026 ICES Annual Science Conference in Brest, France, brought together scientists, early-career professionals, stakeholders, policymakers and partners from around the world. The opening highlighted France's long-standing contribution to ICES and thanked Ifremer, the University of Brest, the European Commission and other local partners for hosting the event. The conference emphasised interdisciplinary collaboration, international exchange and the need to strengthen sustainable ocean management. NSAC was in the panel of the Special Event of DG MARE and ICES discussing future fisheries advice.

Special event of ICES and DG MARE: Fisheries advice toward 2040

The session explored how fisheries advice should evolve toward 2040. Fabrizio Donatella of the European Commission highlighted the ICES–Commission partnership and four challenges: ecosystem complexity, climate change, data and knowledge gaps, and uncertainty. Future advice must **move beyond single-stock assessments** to integrate ecosystem interactions, environmental conditions and shifting species distributions, while becoming more adaptive, forward-looking and **effective at communicating risks** and scenarios.

Clara Ulrich stressed the need to preserve existing strengths while developing new capabilities. Representative **data collection, scientific expertise and robust governance** remain essential, alongside investment in new models, indicators and risk-assessment methods addressing emerging needs, including recreational fisheries and new stocks.

Stakeholder engagement was a recurring priority. Advice must be scientifically credible, understandable and practical. Tamara Talevska emphasised involving stakeholders early, particularly when defining advice requests, since initial questions and assumptions shape outcomes. Trust requires transparent governance, clear processes, sustained engagement, capacity-building and greater integration of social sciences.

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Nathalie Steins advocated viewing marine ecosystems as social-ecological systems, integrating biological and ecological evidence with economic, social and institutional knowledge. **Full-spectrum advice** should assess how management affects livelihoods, who benefits or loses, and the trade-offs between ecological, social and economic objectives. Demonstration advice could illustrate this approach through transparent, evidence-based scenarios. Social and economic research must be recognised as rigorous science, supported by better data collection and funding.

Resilience was another key theme. Management must respect ecosystem limits as climate change increases uncertainty. **Management Strategy Evaluations (MSEs)** can test options against stakeholder objectives and environmental change, but their resource demands require selective application. Tools such as MSE and FMSY are means, not ends. The overarching goal is sustainable, useful advice that supports healthy, abundant, diverse fish populations with strong age structures, strengthening resilience to future pressures.

Future scientific advice cont.

The session examined how ICES can broaden fisheries advice to address environmental, social and economic complexity while maintaining impartial, evidence-based science. Climate change, biodiversity loss, technological advances and competition for marine space demand more **integrated, ecosystem-based and climate-informed** approaches.

Stakeholder engagement was central. Interviews with over 120 French fisheries stakeholders identified fragmented, inaccessible knowledge; demand for comprehensive socioeconomic analysis; the need to translate broader science into locally relevant advice; and interest in practical experiments, modelling and real-world trials.

The French administration **advocated multi-year, risk-based management scenarios** to reduce uncertainty, support investment and explore alternative risks, opportunities and responses to extreme events. Developing these requires **transparent assumptions**, stakeholder participation and models integrating socioeconomic factors, multispecies interactions and environmental shocks.

The **Nature Restoration Regulation** offers ICES opportunities to provide independent advice on restoration priorities, methods and outcomes. Cooperation with OSPAR and HELCOM could improve coordination and avoid duplication.

Ecosystem-based fisheries management should align with wider environmental policies, integrating compatible indicators and frameworks such as the **Marine Strategy, Water Framework, Habitats and Birds Directives.**

Four strategic priorities emerged: **interdisciplinary capacity, science-policy engagement, ecosystem advice, and innovation and technology**. Recommended actions include regular stakeholder dialogue, integrated ecological and socioeconomic risk assessments, cumulative-impact assessments, ecosystem reference points, improved data integration and electronic collection, participatory modelling, and stronger incorporation of social-ecological systems thinking into future ICES advice.

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Roundtable: Bringing science and policy

The closing discussion emphasised the need for stronger **science–policy dialogue**, interdisciplinary collaboration and links with sectors traditionally outside ICES's core activities. Participants were encouraged to contribute to the development of ICES's future strategy through four broad areas: **interdisciplinary capacity, science–policy engagement, ecosystem advice, and innovation and technology**.

Overall, the conference presented 2040 as a horizon requiring action now. ICES has substantial existing expertise and tools, but future advice will need to integrate ecosystem, social and economic dimensions, strengthen stakeholder participation, improve data and research capacity, communicate uncertainty more effectively, and focus on resilience and practical decision-making.

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Marine Spatial Planning

The session explored how marine spatial planning (MSP) can better integrate science, policy, stakeholders and local contexts. Science should support not only data analysis but also the **co-construction, mediation and implementation** of planning. French MSP combines environmental and socio-economic considerations through multidisciplinary expertise.

Transparency and trust are essential, supported by public consultation, accessible information, environmental assessment and clear legal frameworks. National objectives must align with local planning, while MSP, fisheries, water and environmental policies require coherent coordination.

Socio-economic data remain less systematically collected than environmental data, particularly regarding management costs and impacts. Consistent data across local, national, European and sea-basin scales, alongside improved monitoring and ecosystem-based assessment, are crucial as climate change alters ecosystems and cumulative impacts.

Assessing cumulative impacts remains challenging. GIS can map overlapping activities and ecosystems locally, but knowledge gaps persist around additive and interactive effects. Assessments at sea-basin scale, including offshore wind developments, require improved ecosystem modelling and cross-border cooperation.

Policy fragmentation between fisheries, energy and conservation can obscure interactions and competing objectives, making stronger European and national coordination necessary.

Finally, equity and participation require meaningful stakeholder and citizen involvement, recognition of unequal impacts, and support for affected groups to adapt and build resilience.

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Ecosystem-based Fisheries Management

Extreme environmental conditions are associated with poor recruitment of an estuarine sportfish (Manuel Coffill-Rivera)

The study examined **environmental effects on recruitment**. For spotted sea trout in southeastern US estuaries, researchers combined stock assessment, hydrodynamic modelling, and temperature and salinity indicators. Both variables influenced poor recruitment, with salinity particularly important. Using the "poor recruitment paradigm," the study focused on extreme environmental conditions associated with unusually low recruitment rather than assuming a simple relationship across the full environmental range. The results highlighted the importance of estuary-scale conditions and cautioned against generalizing environmental relationships across broad species distributions.

Linking environmental change to temporal and spatial trends in Pacific Hake maturity at age (Eric Ward)

The study investigated **Pacific hake maturation and temperature** using more than 3,000 observations. Temperature-based models performed better than models relying only on age, season, spatial variation and random temporal effects. Maturation increased with temperature up to a threshold, then appeared to decline at very warm temperatures, although more observations under extreme conditions are needed. Incorporating temperature-driven maturation into the assessment had relatively modest effects on spawning biomass, while within-year variation in maturation had a greater influence. The approach has already been incorporated into the hake assessment.

When environment-recruitment relationships work for the wrong reasons (Matthew Robertson)

The presentation demonstrated that apparent **environmental recruitment relationships can be misleading** if environmental conditions actually affect other processes. Simulations showed that when the environment influenced natural mortality, assessment models could incorrectly identify a significant environmental effect on recruitment. More than 40% of simulations produced evidence supporting an environmental recruitment covariate when no true recruitment relationship existed. State-space models allowing several processes to vary through time performed better, highlighting the need to model mortality and other demographic processes alongside recruitment.

Season matters: uncovering seasonal mechanisms driving European sardine population dynamics using integrated state-space model (Maxime Olmos)

The session also examined **seasonal dynamics in Bay of Biscay sardine**. A seasonal state-space model identified variation in natural mortality, density dependence, temperature effects and zooplankton interactions. Winter temperature influenced mortality of young sardines, while temperature and zooplankton jointly affected summer mortality. Fishing mortality was also higher in winter, consistent with information from fishers. These findings remain exploratory and require further validation. A related assessment incorporating time-varying

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mortality and selectivity improved data fits, reduced retrospective patterns, and revealed changes in mortality and fishing selectivity.

Circulation-driven dispersal and retention affect blue whiting recruitment dynamics in the Northeast Atlantic Ocean (Constanza Cappelli)

The session then considered **environmentally-informed recruitment forecasting**. For Northeast Atlantic blue whiting, wind-stress curl was used as an environmental recruitment index because it influences ocean mixing, upwelling and transport. Combining this index with previous recruitment improved predictions compared with the geometric-mean approach. Agent-based modelling suggested that strong subpolar gyre conditions could favour larval transport and temperature conditions. However, environmental relationships may change under climate variability and therefore require continued monitoring.

Recruitment variability of the Gulf of Riga herring stock: a long-term perspective (Elvita Eglite)

For Gulf of Riga herring, recruitment was highly variable and historical relationships with temperature and food availability weakened following a 1990s ecosystem regime shift. Herring growth rate emerged as a potential integrated indicator of ecosystem conditions and stronger year classes, particularly when combined with early-life environmental conditions. Overall, the session argued for **more ecologically realistic assessments** that incorporate environmental drivers, seasonal variation and multiple time-varying processes. Environmental covariates can improve forecasting, but unstable relationships and uncertain future conditions mean they should be tested carefully. Management Strategy Evaluations could help identify robust management strategies under such uncertainty.

Including human dimensions expertise can improve catch advice for sustainable fisheries management (Andrea Chan)

The study explored how **integrating human dimensions**, including social, economic and behavioural factors, can improve fisheries catch advice and sustainable management. Comparing case studies from ICES and NOAA fisheries, it highlighted the importance of incorporating fishers' local ecological knowledge, fishing behaviour, market conditions and fleet dynamics throughout the assessment process. Human dimensions can improve data collection, CPUE standardisation, stock assessment models, projections and harvest control rules. Successful examples demonstrated the value of collaboration between scientists, economists, fishers and stakeholders, including participatory approaches that incorporate Indigenous knowledge. The presentation also emphasised the need for better data sharing, interdisciplinary research and contextual advice products. Overall, integrating human dimensions can improve understanding of uncertainty, identify social and economic trade-offs, and support more adaptive, inclusive and sustainable fisheries management in a changing environment.

From net to web: a socio-ecological system analysis of brown shrimp fisheries in the Wadden Sea (Tjitske Kooistra)

The presentation examined **Dutch brown shrimp fisheries** in the Wadden Sea, a protected UNESCO World Heritage and Natura 2000 area where bottom trawling creates ecosystem pressures, including bycatch of juvenile fish and potential effects on shrimp stocks and

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reproduction. As part of the Marine SABRES project, the researcher used causal loop diagrams to map the socio-ecological system and support ecosystem-based management. Two models were compared: one developed through expert discussions and interviews, and another generated using an AI language model and published literature. Both identified similar key elements, including fishing intensity, recruitment and production rates. However, lower-confidence AI models produced greater complexity and some different leverage points. Expert-built models offer system-specific knowledge and discussion but require considerable time and resources. AI models are quicker and literature-driven but need expert verification. The presentation concluded that stakeholder discussions are essential for validating models and developing shared understanding.

How valuable is a dolphin? Evidence from the French Bay of Biscay closure (Francois-Charles Wolff)

The study estimates the **economic cost of measures designed to reduce dolphin deaths** from fishing in France. Using a natural experiment created by mandatory four-week fishing closures in 2024 and 2025, the study compares affected and unaffected fish markets. A large dataset covering 34 French fish markets and millions of transactions from 2016–2025 is analysed using difference-in-differences and matrix-completion methods. The results suggest that closures reduced fish-market sales by about €40,000 per market per day. After accounting for value added and wider economic effects, the estimated annual economic loss is approximately €20 million. Using dolphin stranding data and adjustments for unobserved deaths, the study estimates that closures saved around 1,250 dolphins over two years, or roughly 625 per year. This implies an economic cost of approximately €30,000 per dolphin saved. The speaker stresses that this figure alone cannot determine whether closures are worthwhile and suggests comparing alternative conservation measures.

Operationalising ecosystem indicators in the sea urchin fishery in Western Mediterranean Sea: from single species to ecosystem approach to management (Giovanni Romagnoni)

The speaker presented an **ecosystem-based framework for managing sea urchin fisheries**, which face two opposing risks. When predator populations decline, sea urchins can become overabundant, overgraze macroalgae forests, and create barren habitats, reducing biodiversity. Conversely, excessive fishing can drive sea urchin populations below a level needed to sustain the fishery. The speaker proposes adapting traditional fisheries reference-point frameworks by adding an upper biomass threshold to prevent ecosystem collapse from excessive sea urchin abundance. This “excessive biomass” threshold could also apply to other commercially valuable species that can negatively affect ecosystems when overly abundant. Sea urchins provide a useful case because ecosystem degradation is visible and measurable, allowing thresholds to be empirically estimated. In the Mediterranean, two sea urchin species contribute to barren formation, although only one is commercially harvested. The proposed framework incorporates both species and their combined ecological effects, enabling managers to assess fisheries sustainability alongside habitat conservation and develop quantitative, threshold-based ecosystem management advice.

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How Much is too much? Estimating ecosystem-level thresholds of overfishing (Jay Peterson)

The speaker synthesized research on how ecosystem information can be incorporated into U.S. fisheries management. The management process offers several points where ecosystem data can influence catch advice, within legal requirements including the ten national standards and the use of the best available information. Examples include **ecosystem-wide catch caps** in Alaska, **ecosystem status reports** that provide annual context and increasingly forward-looking forecasts, and **stock assessment models** incorporating environmental variables. Risk tables can adjust catch limits according to ecosystem and socioeconomic risks, while multi-species harvest rules account for trade-offs between predators and prey. MSEs explicitly examine trade-offs among fisheries and ecosystem objectives. Dynamic tools such as EcoCast combine satellite data and species-tracking information to identify areas where fishing can reduce protected-species bycatch while maintaining access to target species.

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Climate change

Ecosystem-based harvest rules for a climate-sensitive forage fish species (Maartje Oostdijk)

The study develops **ecosystem-based harvest control rules for capelin** in Iceland using the **Atlantis end-to-end ecosystem model**. Capelin is a climate-sensitive, highly migratory forage fish and an important prey species for commercial fish, whales and seabirds. The model simulates ecological processes, including predation, growth, reproduction and migration, to assess alternative management strategies under different recruitment scenarios. Ecosystem-based rules are compared with a MSY approach, including harvest and escapement strategies. Results indicate that all ecosystem-based rules maintain capelin biomass effectively across recruitment scenarios, even with some stock assessment uncertainty. However, these precautionary approaches substantially reduce catches compared with MSY-based management, highlighting the trade-off between ecosystem protection and fisheries yield under changing environmental conditions.

A climate-informed Management Strategy Evaluation for the stock of common sole in the highly mixed demersal fishery context of the Bay of Biscay (Pierre-Yves Hernvann)

The study evaluates climate-informed management strategies for common sole in the Bay of Biscay, where declining recruitment and biomass may be linked to environmental changes affecting nursery habitats. Using a MSE framework, researchers incorporated relationships between **river discharge, nursery capacity and recruitment** to project future stock productivity. Results suggest that climate-informed management can mitigate declining productivity and improve spawning-stock biomass compared with conventional approaches. One strategy increased biomass by 5–10%, while another achieved improvements of up to 20%, although with greater catch variability. The study also highlights socioeconomic trade-offs, including unequal impacts on fishing fleets, and the challenges of integrating complex ecosystem models into management evaluations.

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How environmental forcing in ecosystem models affects management advice under ecosystem-based fisheries management: a temperature check (Leander Hohne)

This study investigates how **climate change can be incorporated into ecosystem models** to improve fisheries management on Georges Bank in the rapidly warming northeastern US shelf. Using the **multispecies Hydra model**, researchers examined temperature effects on recruitment, growth and maturation across several fish species. Results revealed consistently negative relationships between rising temperatures and recruitment, while growth and maturation responses varied by species. Incorporating projected ocean temperatures into ecosystem simulations produced substantial changes in future stock biomass for some species. Recruitment and growth were the most influential climate-sensitive processes, whereas maturation had relatively limited effects. The findings highlight the importance of climate-informed ecosystem models for improving future stock projections, reference points and fisheries management advice.

Climate, Fisheries and Foodwebs in the North Sea (Robert Thorpe)

This study uses an end-to-end ecosystem model and management strategy evaluation to examine **interactions between seals, fisheries and climate change** in the North Sea. Simulations compared current and projected future climate scenarios, different minimum seal biomass requirements, and alternative harvest control rules across 12 fishing fleet segments. Results indicate that **seal impacts on fisheries yields are relatively modest**, largely because of food-web compensation. However, climate change substantially reduces catches and increases food-web depletion risks, with these effects not mitigated by the management strategies tested. Changes were driven primarily by reduced ecosystem productivity rather than temperature alone. The study highlights the importance of ecosystem-based management while acknowledging model limitations and the need to incorporate broader environmental and socioeconomic considerations.

The impact of reduced data quality on the management of climate vulnerable fish (Alexandra Schneider)

This study used MSE to investigate how climate change and declining data quality affect fisheries management, focusing on Western Gulf of Maine cod. Using the Woods Hole Assessment Model, researchers examined how **observation error and process uncertainty** influence stock assessments and management outcomes. Increased observation error caused spawning-stock biomass to be overestimated, resulting in higher catch advice, greater catch variability and increased overfishing risk. Moderate observation error produced approximately 5% risk of overfishing, reaching nearly 20% in some simulation years. Process error had relatively limited effects, suggesting random effects captured additional uncertainty effectively. The findings highlight the importance of reliable monitoring data and precautionary management, particularly for depleted, climate-vulnerable stocks undergoing rebuilding.

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Discussion on EBFM

Bridging the gap between science and management

The main challenge in ecosystem-based fisheries management (EBFM) is translating scientific knowledge into practical, understandable management decisions. Unlike single-stock management, EBFM lacks a standardized workflow connecting data collection, assessment, advice and decisions. Clearer communication of models, methods and uncertainty, alongside early stakeholder involvement, is essential for building trust.

Rather than rebuilding existing systems entirely, participants recommended building on successful examples, starting with manageable issues such as two-species interactions, and gradually scaling up. Complex models, including Atlantis, must produce interpretable, decision-relevant outputs. Where data are limited, management should remain robust across plausible ecosystem conditions.

EBFM must integrate:

- Social dimensions: stakeholder interests, trust and governance.
- Biological dimensions: species interactions, food webs and productivity.
- Temporal dimensions: seasonal, annual and long-term changes.
- Spatial dimensions: migration, connectivity and differences between management areas.

Models should address practical management questions and suit users' needs and understanding.

Rethinking Maximum Sustainable Yield (MSY)

Traditional MSY reference points focus on individual stocks, often overlooking species interactions, environmental conditions and human behaviour. Fixed annual targets may encourage reactive decisions, while broad target ranges can increase political discretion. MSY also fails to fully capture ecosystem health, social benefits and the distribution of economic gains.

Suggested improvements include:

1. Incorporating uncertainty buffers and ecological indicators.
2. Communicating natural stock fluctuations and uncertainty clearly.
3. Avoiding repeated management changes based on short-term variation before sufficient evidence is available.
4. Exploring multispecies MSY and mixed-fisheries approaches.
5. Broadening performance measures to include ecological, economic and social outcomes.

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Although MSY has a strong scientific foundation, its emphasis on high food production also reflects political commitments. Changing its fundamental objective therefore requires societal and political discussion, not just technical improvements.

Improving data collection and use

Priorities include:

- Assessing existing data quality before collecting more.
- Standardizing methods across datasets and institutions.
- Improving information on primary production and lower trophic levels.
- Targeting stock-specific needs, including life history, migration, connectivity and seasonal variation.
- Ensuring collected data inform assessments and decisions.
- Securing sustained funding for long-term monitoring.

There is no universal data wish list. Priorities should reflect the species, ecosystem, management question and existing knowledge gaps. Management must consider who benefits economically, how revenues are distributed, and how food production, ecosystem health and societal wellbeing should be balanced. Science informs these decisions, but society and policymakers determine the objectives against which success is measured.

Overall priorities

Six priorities emerged:

1. Establish a clear EBFM workflow linking data, modelling, advice, engagement and decisions.
2. Engage stakeholders early through transparent processes and sustained collaboration.
3. Demonstrate incremental successes before scaling up to more complex ecosystem approaches.
4. Manage uncertainty explicitly through robust strategies, buffers and realistic communication.
5. Improve data quality and relevance by addressing critical gaps and supporting actual management needs.
6. Reconsider management objectives to assess whether single-species MSY adequately represents ecosystem sustainability and wider societal benefits.

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Unravelling the seasonality of the biological carbon pump and consequences for carbon sequestration in the ocean (Francisco de Melo Virissimo)

The presentation explored the ocean biological carbon pump, which transfers carbon fixed by phytoplankton from surface waters to the deep ocean, where it can remain for centuries or millennia. Although relatively small compared with the total ocean carbon cycle, this process plays an important role in regulating atmospheric CO_2. Much sinking particulate carbon is remineralized in the mesopelagic zone before reaching deeper waters.

Carbon attenuation has traditionally been described using the Martin curve, which assumes a constant attenuation parameter and relatively stable transfer efficiency. However, observations reveal substantial spatial and temporal variability, producing contrasting estimates of global carbon transfer.

To investigate seasonality, researchers used a time-resolving ocean model incorporating seasonal attenuation while maintaining the same annual average. Results showed increased deep-ocean carbon transfer, with transfer efficiency rising by over 150% in some regions and deep-ocean fluxes increasing by more than 120% compared with constant-attenuation simulations.

Seasonal changes also generated spatial variability without ocean circulation directly causing it, potentially explaining discrepancies between previous studies. The findings emphasize the need to understand seasonal sinking and remineralization processes, consider observation timing, and improve models through targeted experiments and integrated observations to strengthen carbon sequestration estimates and future ocean projections.

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Bycatch mitigation

Mandated does not mean effective: rethinking mitigation in a small-scale fishery (Ana Marcalo)

A Portuguese beach-seine fishery provided evidence on the use of **acoustic deterrent devices ("pingers")** to reduce common dolphin bycatch. Initial interviews and direct observation identified substantial variation among beaches. Of 44 observed hauls, bycatch involved only common dolphins, occurring in about 7% of hauls and mortality in about 5%. Up to 15 dolphins were observed in a single haul. Pilot trials comparing nets with and without pingers indicated approximately **40% lower bycatch rates and 60% lower mortality**, although further trials and monitoring are needed. The project is expanding observations using cameras, passive acoustics and fisher self-reporting, while investigating improved device placement and additional mitigation measures. Stakeholder engagement is central, with fishers working closely with researchers to improve release practices and future legislation.

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An assessment of EcOCast, a dynamic ocean management tool for bycatch avoidance, from the use-end perspective (Rachel Seary)

The **EcoCast** case study examined a **dynamic ocean-management tool** for the California swordfish fishery. EcoCast combines environmental and biological data to identify areas where target catches are more likely and bycatch risks lower. However, adoption has been limited by regulatory changes, concerns about losing fishing opportunities, limited internet access at sea and uncertainty about trusting the tool over fishermen's experience. Preliminary comparisons showed some agreement between EcoCast predictions and fishermen's assessments, although catch outcomes were more variable. The study highlighted the **importance of evaluating decision-support tools with end users** rather than assuming that technically sophisticated tools will automatically be adopted.

Participatory evaluation of Acoustic Deterrent Devices in small-scale net fisheries: opportunities, challenges and lessons for real-world uptake (Alessandra Bielli)

The UK **Clean Catch** programme examined pingers for reducing harbour porpoise bycatch in static nets. Although pingers may reduce bycatch, their wider use raises concerns about underwater noise, possible attraction of predators, lost equipment, batteries, crew safety, costs and regulatory restrictions. The programme therefore stresses that mitigation devices must be effective and suitable for real fishing operations. Finally, presentations on economic and social incentives stressed that **adoption depends** not only on technical feasibility but also **on willingness to change**. Market-based certification, eco-labels and sustainability schemes may provide incentives, but technologies must produce measurable, auditable and verifiable evidence. Barriers include stakeholder heterogeneity, uncertainty over costs and benefits, mistrust, regulatory concerns and fear that transparency about bycatch could result in restrictions or fishery closure.

Evidence-based mitigation options for reducing blue shark bycatch mortality in Mediterranean pelagic longline fisheries (Pierluigi Carbonara)

A study investigated critically endangered blue shark bycatch in the South Adriatic longline fishery using onboard observations, logbooks and landing-site monitoring since 2019. Although catch and effort showed no clear trends, landings declined, and catches mainly involved younger sharks, confirming the area's importance. A tagging programme equipped 45 sharks with pop-up satellite tags. Estimated **post-release survival exceeded 67**% and was strongly linked to capture condition. Experiments found circular and J-hooks had similar catch rates and sizes, but **circular hooks improved shark condition,** potentially increasing survival. Tagging revealed sharks occupied deeper waters during daylight and shallower waters at night, with moon phase influencing depth. Reversing fishing schedules eliminated blue shark catches but reduced target-species catches by over 30%. Overall, hook modifications, catch-and-release practices and adjusted fishing times offer mitigation options, but management must balance shark conservation against impacts on target catches.

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Fishers' experience with he 100mm 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)

The session focused on **moving fisheries bycatch mitigation from experimental trials into practical, routine use**. In the Celtic Sea, a T90 mesh system in French bottom trawls substantially reduced unwanted catches of gurnard, boarfish and juvenile fish, while improving catch quality and reducing sorting time. However, selectivity was too high for some commercially important species, causing potential commercial losses. Adoption was strongest where the gear was low-cost, easy to handle and repairable, and where fishermen could directly observe its benefits. Different fleet segments therefore preferred different gear options.

From co-creation to field results: lessons from the LIFE CIBBRiNA Bycatch Mitigation case studies (Martin Pastoors)

The CIBBRiNA project showed that technical effectiveness alone does not determine whether mitigation measures are adopted. Its PESTEL analysis considered political, economic, social, technological, environmental and legal factors. Co-creation involving fishers, scientists, policymakers and NGOs was highlighted as important for identifying barriers and supporting implementation.

Turning bycatch mitigation into practice: adaptive co-design in a bird-scaring line trial (Emily Roebuck)

The Clean Catch project applied adaptive **co-design to bird-scaring lines** in a North Sea whitefish fishery. Baseline monitoring, remote electronic monitoring, observer trips, self-reporting and feedback from skippers and vessel owners were combined. Cost, effort, operational fit, safety and trust in evidence were identified as key barriers. Continuous communication and a fishery liaison officer helped build trust and adapt the trial. The discussion also highlighted difficulties in demonstrating statistical significance, particularly when bycatch is rare. Testing technologies under varied conditions and building broader evidence may provide stronger support for adoption.

Changing the drag: pathways to innovative fishing gear (Annika Bruger)

The innovation programme aimed to improve the **sustainability of Germany's traditional brown shrimp fishery** by addressing challenges such as high fuel consumption, economic pressure and bycatch. Small mesh sizes result in significant catches of non-target species, particularly juvenile fish, contributing to discards, mortality and biodiversity loss. The programme adopts a bottom-up, collaborative approach, encouraging fishermen to develop practical solutions and prototypes. These are tested under commercial conditions through scientific trials, with results shared through stakeholder workshops. By fostering co-engineering, dialogue and collaboration between fishermen, scientists and policymakers, the programme supports innovation, practical implementation and the long-term sustainability of the fishery.

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The development and implementation of a tunnel Excluder in small-meshed North Sea trawl fisheries (Claus Sparrevohn)

Danish pelagic industry researcher presented the development of a **tunnel excluder designed to improve selectivity and reduce bycatch** in Danish pelagic fisheries. Developed through collaboration between fishermen, net manufacturers and scientists, the device allows unwanted smaller fish to escape while retaining target species. Successful commercial trials in 2018 demonstrated reduced bycatch without compromising Norway pout catches. Following scientific evaluation, the device was approved in 2021 and incorporated into EU regulations in 2022. By 2025, approximately 90% of relevant fishing vessels were using it. Further research explores applications in sand eel fisheries and reducing seal bycatch, highlighting the importance of co-creation and stakeholder collaboration.

Bridging the implementation gap: Best practices to promote the uptake of selectivity measures in EU fisheries (Laurence Fauconnet)

Fauconnet presented a review of **best practices for improving fishing selectivity** and encouraging uptake following the **EU Landing Obligation**. Key success factors include early and continuous collaboration between fishermen, scientists and other stakeholders, building trust and co-creating solutions. Fisher-led initiatives, appropriate financial and non-financial incentives, and locally adapted, practical and simple gear designs can encourage adoption. Testing should combine modelling, fisher-led trials and rigorous scientific assessments under commercial conditions. Effective communication, transparent reporting of positive and negative results, data sharing and understanding species ecology are also essential.

Restoring fished seascapes

What counts as restoration on Working Fishing Grounds? From concepts to practical management (Mark Dickey-Collas)

Marine ecosystem restoration must support biodiversity targets through **measurable outcomes, integrated monitoring, and cross-sector collaboration**. The presentation distinguished natural, productive, and transformed ecosystems, emphasizing that **fishing alters ecosystems but does not automatically constitute degradation**. Degradation involves persistent deterioration beyond agreed ecological thresholds, considering ecosystem condition, duration, and spatial scale.

A Nordic study examined fisheries and restoration through literature reviews and case studies in Finnish coastal lagoons, the Oslofjord, the eastern Baltic, and the Faroe Islands. Findings highlight the need for context-specific definitions, scientific indicators, and adaptive management. Once degradation is established, measures may include **spatial closures, reduced fishing pressure, selective gear, bycatch reduction, and habitat support**.

A decision framework guides assessment, implementation, monitoring, and evaluation. Restoration success requires demonstrated recovery, not merely implementing measures. Early stakeholder engagement, adequate resources, and recognition of socioeconomic costs

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are essential. Fishers and fisheries administrations should contribute throughout restoration, enabling equitable, evidence-based recovery alongside sustainable fishing.

Clarifying marine restoration pathways: disentangling MPAs, nature-based solutions, hybrid approaches and grey infrastructure (Louise C. Flensborg)

Addressing environmental pressures requires ambitious, coordinated restoration strategies. Approaches include Marine Protected Areas (MPAs), Nature-based Solutions (NbS), Nature-Inclusive Design (NID), hybrid ecological-engineering solutions, and conventional grey infrastructure. Although often grouped under sustainability goals, these **interventions differ in objectives, mechanisms, scale, and conservation ambition**. Distinguishing them is essential to ensure genuine ecosystem recovery rather than simply mitigating environmental impacts. The EU-funded TRANSEATION project analyzed 113 peer-reviewed studies to examine how marine restoration and protection measures are defined and implemented. Findings reveal **substantial terminological ambiguity**, particularly when NbS are conflated with MPAs, NID, and hybrid coastal solutions. Restoration scale and monitoring approaches also vary considerably. These inconsistencies **hinder comparisons, weaken evidence-based decision-making, and obscure whether interventions achieve meaningful ecological improvements**. The project emphasizes harmonized definitions, standardized evaluation criteria, and science-based guidance to improve assessment and align marine restoration efforts with effective, measurable conservation outcomes.

Helping nature support humans – the role of discourses in the governance of deep-sea restoration in the European seas (Johanna Sophie Buekert)

Deep-sea ecosystems across Europe are increasingly degraded by human activities. The EU Nature Restoration Regulation targets restoring at least 20% of land and sea by 2030, requiring investment in restoration technologies, implementation, and monitoring. The Horizon Europe REDRESS project supports these ambitions by **developing restoration priorities, addressing neglected habitats, and assessing restoration feasibility and effectiveness**. Researchers investigated governance across five case studies: Dohrn Canyon, the Azores, West of Shetland, the Catalan Margin, and Guilvinec Canyon. Approximately 50 interviews with researchers, NGOs, policymakers, and industry representatives explored the actors, rules, resources, and narratives shaping restoration. Findings show that deep-sea restoration governance is still emerging. Potential ecological and societal benefits may unite stakeholders and raise public awareness, but deep-sea ecosystems remain largely invisible, and their ecosystem services are poorly understood and quantified.

A sea full of measures: EU conservation goals for benthic habitats will require wide-ranging spatial measures (Nicolaus Probst)

The use of marine space by human activities is continuously increasing, resulting in a competition between human use and spatial measures for marine conservation. The EU MSFD and the Nature Restoration Law (NRL) are two important legal means to implement ambitious spatial conservation targets for benthic habitats within the waters of EU member states. This study analysis how the targets of MSFD and NRL are currently met in the German waters of the North Sea and which areas the full implementation of both legislations might require. The current spatial conservation measures, which ban demersal trawling within

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certain zones of designated MPA, are not sufficient to reach the targets of the MSFD and NRL. **Extending the exclusion of demersal trawling to the entire area of the MPAs** would increase the average coverage for all habitat types/groups from 19 % to 73 % except for offshore sand and mud habitats. These could be further protected, when including areas for offshore wind farms, where trawling is also banned. However, to date it is unclear, if and how these (or other human use) areas could be included legally into spatial conservation regimes. Hence a debate on how to better combine human activities with spatial conservation targets is urgently needed to allow for the achievement of the ambitious MSFD and NRL targets in marine waters of EU member states.

Empirical estimates of recovery after cessation of disturbance for benthic invertebrates (Jan Geert Hiddink)

Recovery of benthic invertebrate communities is essential for seabed ecosystem resilience following disturbances such as bottom trawling, aggregate dredging, and potential seabed mining. **Predicting recovery rates** helps guide conservation and balance resource exploitation with habitat protection. This study compiled published time-series data to investigate passive recovery after disturbances or the introduction of new substrates. Researchers analyzed abundance and biomass trajectories across different substrates, species, and communities, fitting logistic growth curves to estimate recovery rates. Results revealed substantial variation across species and environments**. Recovery rates were significantly higher in sediments than on hard substrates**, and declined with increasing water depth and disturbance scale. **Biomass recovered more slowly than abundance**, suggesting that functional ecosystem recovery may lag behind the return of organism numbers. Incorporating habitat type, depth, disturbance scale, and life-history traits, such as maximum lifespan, could improve predictive models of seabed resilience and support more effective marine conservation and management.

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