REPORT
NSAC/EAPO Symposium on Innovative Fishing
Precision-fishing: re-imagining bottom-trawling through innovation

Date: **7 March 2024**
Time: **10:00 – 16:30 CET**
Location: **Sofitel Brussels Europe**
Moderator: **Mogens Schou**
Rapporteurs: **Kateryna Urbanovych, Tamara Talevska, NSAC**

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1 Welcome and introductions

Kenn Skau Fischer, Chair of the NSAC, welcomed participants to the symposium. He acknowledged the rich programme with insightful presentations tabled for the day, and noted that success ensues from genuine participation and engagement of the people working with and affected by the legislation. The number of participants registered for the event reflected the interest of the industry and stakeholders in research, innovation, and decision-making.

Mogens Schou, moderator, thanked participants for attending and remarked that selectivity determines the use of resources, with targeting being the main issue. "***How to ensure that the most selective gear is used with the highest catch of the right fish and the least impact on seabed?***" There are crucial issues to be resolved in fishing and management, and the symposium aimed to explore the opportunities for achieving low-impact and selective fishing. Participants were to hear views on technologies proposed and discuss problems as well as solutions. The final deliverable of the event is the NSAC/EAPO policy recommendation/advice to the European Commission and EU Member States.

2 Keynote address by Eoin Mac Aoidh, Deputy Head of Unit D3 at DG MARE

Eoin Mac Aoidh emphasized innovation as essential for resilience and survival, especially in view of impending climate change and resulting policy shifts.

The Commission is currently working on the second report on the implementation of Technical Measures Regulation (TMR), the focus of which is precisely on innovation. The received consultation replies and participation in the STECF meeting will feed into the report. Mac Aoidh commended the commitment of stakeholders to taking part in such exercises.

Following the adoption of the EU Biodiversity strategy in 2020, the Marine Action Plan was announced, sparking discussions on the future of bottom-trawling. Rather than imposing a blanket ban, the Commission initiated a Joint Special Group on Marine Action Plan for ongoing dialogue between environmental and fisheries departments. Workshops on eel and financing the Marine Action Plan are planned, alongside continued engagement in the Energy Transition Partnership, the Fishers of the Future study, and a plan to kick-off the evaluation of the Landing Obligation (LO) in 2025.

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Mac Aoidh highlighted that the **Marine Action Plan is generating momentum** by both expanding the pool of innovative solutions for sustainability, as well as to promoting practical solutions aboard vessels. Innovation and new technologies will enhance selectivity, protect vulnerable species, reduce fuel usage, and improve economic viability. However, the health of seas cannot be taken for granted, with ecosystems showing signs of degradation. **Collaboration between technical experts, Advisory Councils, and the scientific community** is crucial in addressing these challenges.

He concluded by saying that ICES advice on innovative gear already shows all the available gears delivered by innovation. ICES was requested by DG MARE to catalogue what is available and also to understand why it is available. He assured that the Commission will be listening and taking up the proposed solutions. He wished everyone an interesting and productive seminar.

3 Lessons learned from pulse fishing ban

Nathalie Steins (Wageningen University & Research) provided a short summary of the introduction of **pulse fishing** in the Netherlands as an alternative to traditional beam trawling for common sole. Pulse trawling used electrical stimulus instead of heavy tickler chains to startle common sole and other flatfish from the seabed. Initially used under a derogation from the Common Fisheries Policy (CFP), pulse trawling showed promising results in terms of reduced discards, seabed disturbance, fuel consumption, and CO2 emissions. The gear had a high technological readiness level and in a couple of years it was taken up by most of the Dutch flatfish fleet. Despite extensive research supporting its ecological benefits, pulse fishing was ultimately banned.

Steins confronted the audience with a pointed inquiry: ‘*How did it come to be that years of research and millions of euros in public and private expenditure in pulse fishing were washed down the drain? And why was the decision-making process under the CFP, which is meant to be science-based, so severely compromised?*’

The lengthy development process of this new gear, which began in the 1970s, highlights the **complexities involved in innovation** within fisheries management.

The pulse method was initially deployed on a research vessel. Once proven feasible, one Dutch commercial vessel was equipped with the pulse trawl and financially supported to lift

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the gear to practical technological readiness level. As five more vessels employed the gear, knowledge-sharing among them boosted its technological readiness level for practical application. This development took place in the context of a shared vision for sustainable flatfish fisheries in the Netherlands, developed by the Dutch government, some NGOs, and the fishing industry. However, the vision was not shared beyond the Dutch landscape.

In the next stage, as the EU imposed a 5% fleet derogation limit for pulse fishing in the North Sea, the Dutch government, driven by economic pressures in its beam-trawl fleet, sought more licenses once this limit was reached. The shift to pulse trawling proved profitable for vessels, contrasting with those using traditional bottom trawls. However, this sparked concerns among neighbouring countries. At the time, the NSAC was involved, later starting its own Pulse Focus Group. With 76 vessels fishing with pulse in the North Sea, it became evident that that the involvement of international stakeholders was unavoidable, though the Dutch government initially pushed pulse as a solution to Dutch issues. Despite efforts to engage stakeholders in the innovation process through **International Dialogues** centered on research questions and the approach for a new multi-year research programme on the ecological impacts of pulse fishing, the **ban on pulse fishing** occurred, with hindsight suggesting earlier engagement was needed.

The ban of pulse trawling resulted from a series of events. In 2016, French NGO Bloom started a campaign against pulse trawling, which gained momentum with support from other NGOs and small-scale fishers who felt disadvantaged by the technology. In the end, the anti-pulse campaign dominated the narrative. Despite a forthcoming ICES advice, the European Parliament, decided the fate of pulse fishing on the basis of a simple campaign message: “no to the electrocution of fish and the desertification of the ocean”.

The pulse trawling innovation process was influenced by various factors covering political, economic, social, technological, environmental, and legal dimensions, as outlined in the PESTEL framework. While these aspects were considered in the pulse case, they were mostly internalized and focused on the Dutch context. Despite success in technological readiness and uptake, the **failure to address broader social and economic impacts beyond direct stakeholders** led to its downfall.

Gear and net innovation have been found to often face challenges in uptake by fishers. This reluctance is mainly caused by a mix of social, policy, and science-related factors. Many of these aspects are related to the **ability** of fishers to make the change, with concerns like catch

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loss and bureaucratic hurdles hindering adaptation. Other aspects relate to fishers' **willingness** to use proven gears voluntarily, which is influenced by peer perception, policy decisions, and lack of fishers' involvement in management and research. While policy and science typically focus on fishers' ability to change, addressing willingness factors is essential for successful gear innovation and other changes in fisheries.

In summary, key lessons learned include:

- Involving fishers in gear innovations from the **bottom up** speeds up practical application and increases wider gear support.
- **Compensating** fishers for **revenue loss** due to gear innovation should be prioritized, making sure this is allowed in the EMFAF and other programmes.
- Consideration of **political, economic, social, technological, environmental, and legal** factors is crucial in gear innovation process and in assessing fishers' ability and willingness to engage.
- Fishers' willingness to innovate should equally regarded as their ability. **Intrinsic motivation** to change is key.

Gear innovations can be defined as transformative, involving a large change, and disruptive, bearing initial costs but with high eventual benefits. The pulse is one of these examples. Such innovations present several key lessons including:

- Establishing an **independent oversight committee** once a gear moves beyond proof of concept is essential.
- Conducting a **social impact analysis** of transformative or disruptive innovation helping identify affected groups as well as intended and unintended social impacts.
- **Co-producing knowledge** with stakeholders to map environmental, social, and economic impacts is critical. Once areas requiring additional research are identified, a programme should be built on a list of knowledge sources, with an adaptive approach based on evolving insights. Particularly relevant here is the **liaison with relevant Advisory Councils and Member State Groups**.
- Defining and maintaining **limits**, such as the number of vessels or areas for experimentation, is crucial during research programs.

Overall, **caution** is needed in gear innovation. Shared understanding and co-production of knowledge through the process does not automatically guarantee a successful science-based

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introduction of innovations, as political decision-making process is also influenced by lobbies, political interests, and potential court cases.

Pim **Visser** (PO Noordelijke Visserijalliantie) emphasized the importance of acknowledging that innovative gears differ from the old gear they replace. He underscored the need for fisheries management to adapt to the unique characteristics of new gear, rather than simply replicating management approaches used for previous gear types.

4 ICES Advice on innovative gears

Antonello Sala, Chair of ICES WKING 2 and Research Director at the National Research Council, presented ICES' recent advice on innovative gears.

Sala's experience in gear innovation goes back to the 90s, focusing on replacing old Mediterranean trawl designs with new ones using high-strength materials to improve fuel efficiency. Collaborative efforts with the industry have also led to advancements in otter board design. Currently, Sala coordinates the DECARBONYT project, aimed at improving trawl design in the Mediterranean. While innovations are available, their implementation faces significant barriers,highlighting the necessary efforts to involve the industry in projects such as DECARBONYT from the start, aiming to develop practical solutions and assist fishers in adopting innovative practices.

The recent ICES advice stems from a EU request for advice on innovative gears for potential use in EU waters and their impacts, dating back to 2020. This led to development of a catalogue of such gears per sea basin. In 2023, ICES updated the catalogue, including the gears' objectives, technical specificities, and benefits in terms of selectivity on target and non-target species, and environmental impacts. Additionally, in ready-for-deployment innovations, their level of uptake was assessed, taking into consideration financial needs, user-friendliness, and crew safety. For not implemented innovations, main drivers preventing use were analysed, including behavioural drivers and socio-economic trade-offs, with the aim of indicating ways forward for implementation.

The request from DG MARE aligns with Article 31 of the TMR, which mandates a triennial report submission by the Commission with input from ICES on the progress and impacts of innovative gears. Bodies such as NSAC play a key role in proposing alternatives to current gear baselines.

During the Innovative Gear workshop (WKING), *innovation* was defined as any new ideas, creative thoughts, new imaginations in the form of technology or method with *successful innovation* allowing for a better solution than existing options. Innovations can be categorized as incremental, transformative, distributive, or failed in terms of their evolution dynamics. In the context of fishing gear, *innovative* gear differs significantly from the baseline defined by EU regulations or commonly used gear in a specific sea basin.

Innovations were defined for each of the 6 EU sea basins as per the EU TMR. **The ecological performance** of innovations was evaluated based on catch efficiency, selectivity, and ecosystem impact. Innovations were also categorized by their **performance improvement** into incremental, transformative, disruptive, no effect, or negative. Likewise, the **level** of **technological complexity** was defined as either minimal, medium, or significant, based on the degree of change required compared to existing baselines. Additionally, the **Technology Readiness Level** (TRL) was assessed as low, moderate, or high, aligning with EU-defined TRLs.

A matrix was developed based on ecological performance and TRL (Figure 1), with another matrix added in 2023 focusing on economic evaluation, assessing capital cost of innovation investment and **return on investment** (ROI) (Figure 2).

Performance	Technology readiness level: Low	Moderate	High
Disruptive	Probably worth considering	Highly promising	Unicorn "no brainer"
Transformative	May be worth considering	Some potential	Very promising
Incremental	Not worth considering	Probably not worth considering	Possibly worth considering
No effect	Not worth considering	Not worth considering	Not worth considering
Negative	Negative outcomes	Negative outcomes	Negative outcomes

Figure 1: Ecological performance and TRL matrix.

Return on Investment (ROI)	Capital cost: High	Moderate	Low
Significant	Promising	Highly promising	Unicorn "no brainer"
Substantial	May be worth considering	Promising	Highly promising
Minor	Probably not worth considering/Refine	May be worth considering	Promising
Negative	Discard / Seek alternatives	Discard / Seek alternatives	Discard / Seek alternatives

Figure 2: capital cost of innovation investment and ROI matrix

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The latest report implemented the PESTEL framework, evaluating six umbrella factors' influence on the adoption of innovative fishing gear.

Information is collected in factsheets with the gear's description, development area, TRL, complexity level, ecological and economic performance, and PESTEL assessment.

In total, three matrices were developed, scoring catch efficiency, selectivity, and impact improvement based on TRL. **Most innovative gears** (80%) showed p**ositive effects on catch efficiency and selectivity**, with 80% of these having high technological readiness. Sixty-four percent of innovative gears **reduced impact on the marine ecosystem**, with 77% having high technological readiness. Nearly 80% of innovative gears had **high technological readiness**, with only 4% classified as low. Forty-eight percent of innovative gears were found to have low capital costs, with over 78% of these showing positive ROI, making them viable replacements for current gears.

The ICES study identified **four intrinsic motivations for fishers to adopt new technologies**: (i) increasing revenue through higher catch quantity or (ii) value, (iii) reducing fishing costs, and (iv) improving onboard comfort and safety. Despite rational recognition of the need for change in fishers, emotional resistance may hinder it.

In the ICES report, the PESTEL framework was applied to six case studies, indicating that innovations reducing environmental impact and fishing costs or improving catch efficiency are more likely to be adopted. One case study, the **dual cod-end gear**, examined in both Irish Nephrops and Mediterranean demersal trawl fisheries, pointed to the presence of economic incentives for adoption due to reduced sorting time and improved catch quality. However, the gear presented technological challenges, and legal barriers impeded adoption in both regions.

In conclusion, a large portion of gear innovations appear ready for industry uptake, though the level of uptake and main influencing factors remain unclear. ICES recommends systematic use of the PESTEL framework to evaluate barriers and opportunities for innovative fishing gear. Alternative methods like fisher interviews or fleet-wide surveys are needed to better understand uptake dynamics.

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5 Project presentations on innovative gear and main takeaways on project application, funding, innovation process, and uptake

5.1 Real-time catch monitoring in demersal trawl fisheries

Ludvig Ahm Krag from DTU Aqua presented on real-time catch monitoring in demersal trawl fisheries.

As bottom-trawling faces evolving conditions and expectations, including ambitious management goals, consumer expectations, and sustainability concerns, a **transformation** towards efficiency, precision, and transparency is essential. Traditional optimization methods are not enough, and a new selective fishing gear alone won't be sufficient. To address this challenge, DTU Aqua developed a real-time trawl camera and an AI-based automatic image processing system to **provide fishers with knowledgeable catch information without altering trawler performance**. This technology shifts trawling from a blind to an informed process, enabling skippers to obtain quantitative catch insights.

Once integrated, the camera records and showcases fish composition. To provide quantitative data for skippers, AI processes the acquired data, detecting and identifying each species and capturing length, weight, and distribution information. This data can be converted into prices for fishers.

In conclusion, such real-time decision tool can **boost fishing precision and efficiency**, **reduce bycatch and habitat impact**, **lower CO2 emissions**, and **improve transparency** if data is shared (i.e. in sustainable labelling). Commercially available hardware and ongoing software development across Europe enable demersal trawling adaptation to current and future demands. The main bottleneck of the technology is the lack of a clear vision from managers and industry for the next 5 to 10 years. Transition efforts are crucial.

5.2 Gentle and effective fishing with new and innovative trawl gear

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Bård Wathne Tveiten (SINTEF Ocean) presented the Semi-Circle Spreading Gear (SCSG) concept, developed collaboratively across Europe.

The SCSG concept involves semi-circular high-density polyethylene sections that spread during towing to **enhance efficiency, reduce fuel consumption, and minimize seabed disturbance**. While the existing solution, the rockhopper gear, allows for effective lifting of trawl nets, the SCSG allows fish to escape after spreading. Full-scale trials on research vessels in the Arctic from 2013 to 2025 demonstrated good performance, stability during towing, easiness of passing bottom obstacles, and improved catch composition compared to conventional gear. However, material wear emerged as an issue needing attention in commercial product development.

Although the technology showed good performance, it required market demand. With recent calls for environmentally friendly and energy-efficient solutions, commercial vessel trials began in November 2023. Key findings include a 20-40% increase in catch, enhanced catch efficiency, shorter towing times, lower fuel consumption, reduced gear weight, and minimized seabed impact. Despite positive progress, the type of material used and its wear are a concern. Collaborative efforts with the Arctic University of Norway, SINTEF Ocean, Institute of Marine Research, and the Norwegian Directorate of Fisheries are underway to assess seabed impacts. Overall, the technology marks a significant step towards sustainable practices that balance ecological impacts with fishing efficiency.

5.3 Decision Support Tool for Optimizing Catches in Bottom Trawling

Elsa Cuende (AZTI) presented a Spanish tool for optimizing bottom trawling catches.

When addressing how to improve bottom trawl sustainability and efficiency, two main strategies are considered. The first involves developing innovations in fishing gear selectivity. While various gears, devices to improve fish escape, codend modifications, and mesh orientations have been tested and developed, results are varied, particularly in highly mixed fisheries.

The second strategy focuses on optimizing fishing effort allocation, with AZTI developing a **catch prediction tool to assist fishers in decision-making**. Utilizing modelling data and predictions, this tool aims to **enhance catch efficiency** by avoiding high-probability bycatch areas. Predictions, in the form of maps, are then delivered to fishers via a user-friendly tool.

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Currently under development, the tool provides species occurrence data over different time periods and locations, as well as predictions of catch and discard probabilities. It is based on catch data collected through the European Data Collection Framework and can be integrated with any database, allowing for continual updating as new data becomes available.

In this process, several bottlenecks and limitations have been identified. Firstly, the quality of baseline data influences the tool's predictive accuracy. Secondly, achieving complete elimination of unwanted catches was not achieved due to the inherent challenges of mixed fisheries. Additionally, there may be limited engagement, particularly when considering alternative uses of the tool beyond its original intent.

Moving forward, making use of data collected for control and policymaking purposes can enhance both scientific understanding and industry benefits. Statistical tools may overcome data limitations, but reliability decreases with poorer data quality. Addressing the second bottleneck, complementary gear modifications can help reduce unwanted species catches.

Overall, the decision support tool aids in avoiding unwanted catches and complying with the LO. Despite potential disincentives due to LO penalties, the fishing industry has shown interest in testing and implementing the tool onboard.

5.4 KingGrid: an innovative design paradigm for rethinking sorting grids

Juan Santos from the Thünen Institute introduced the KingGrid project, which addresses issues in beam trawl fisheries, particularly targeting Brown shrimp in the North Sea.

Despite sieve nets being fisher-approved and easy-to-use technology for bycatch reduction in the fishery, the presence of suspended materials like seagrass is causing significant catch losses due to net clogging. This is currently a common issue in German fisheries due to rising density of suspended materials in the water.

Upon examining existing technologies, the **grid system** emerged as a promising alternative for reducing bycatch in beam trawl shrimp fisheries. The grid allows for easy access and cleaning if clogged, enabling fishing to continue uninterrupted. However, previously developed grids were heavy, rigid, lacked problem-driven design, and had fixed selectivity, rendering them unsuitable for fisheries. Thus, a redesign of the technology was necessary.

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In 2023, the KingGrid was developed as a solution to address the limitations of traditional grid systems. The KingGrid utilizes polycarbonate plastic instead of steel, making it lighter and more flexible, thus improving robustness and handling on vessels. Its modular design requires minimal skills for assembly and repair, while also allowing for easy adjustment to meet selectivity requirements.

Following testing in clean conditions in 2023, the KingGrid outperformed traditional sieve nets. Subsequent trials on commercial vessels led to high demand, with units quickly selling out. Some fishers have been observed to combine the KingGrid with other technologies to enhance fishing outcomes.

The success of the KingGrid underscores the **potential of quick innovations to address immediate fisheries challenges**, highlighting the importance of **adapting existing technologies to current needs**.

6 Interactive breakout session: political, economic, scientific, technical, environmental, and legal shortcomings

The first breakout session aimed to identify innovation shortcomings and challenges, while the second focussed on solutions. Participants were to categorize identified shortcomings using the PESTEL model categories. Three main relevant shortcomings were presented by the groups' rapporteurs, with all other suggestions collected in Annexes A and B.

6.1 Results from first breakout session

The main challenges of innovation identified by the six breakout groups are summarized as follows:

- **Political**: Slow and layered decision-making process.
- **Economic**: High investment combined with uncertainty, leading to low technology uptake; lack of profitability; unaddressed economic losses in application of new technologies; lack of clarity on sustainable fishing financial model ("who pays for sustainable fish?").
- **Social**: Lack of motivation and fear of the unknown; lack of trust due to targeted management and negative public opinion; insufficient incentives for adopting new

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technologies (i.e. Remote Electronic Monitoring (REM)); limited flexibility in operational changes; generational divides; fishers' scepticism towards science (black box, lack of feedback) and policy (top-down approach); challenges with generational renewal.

- **Technological**: Limited commercial trials; lack of vessels with technical capacity for independent trial verification; inflexible regulations hindering gear efficiency improvements; lack of innovation tailored to fishers' needs in different areas (one size does not fit all).
- **Legal**: Inefficient control hampering trials of new gears; strict legal provisions limiting technology introduction; lack of flexibility in legal frameworks (i.e. TMR) limiting gear modernisation, legislation lagging behind innovation; restricted use of innovative gear due to the Landing Obligation; demanding scientific evidence and the evaluation on STECF, limiting bureaucracy.
- **Environmental**: Lack of clear classification for bottom impact; lack of robust scientific trials.

7 Modular Harvest System trials in the Dutch mixed demersal beam trawl fishery – improving fish quality and survival of discarded bycatch

Pieke Molenaar (Wageningen University & Research) presented the Modular Harvest System (MHS) technology, initially developed in New Zealand (NZ) and currently being studied and trialled in the Netherlands.

The MHS system targets the tickler chain beam trawl fishery, a mixed fishery with target species of sole and plaice, yielding substantial bycatch of undersized plaice. Studies conducted on conventional beam trawl operations revealed low survival rates for discarded undersized plaice, when monitoring in captivity (15 days). The state of the fish greatly influences its survival, with poor-condition fish exhibiting lower survival rates. Conversely, fish in good condition may have a 60% survival rate. To improve survival rates and potentially allow for CFP exemptions, the condition of the fish must be enhanced, also contributing to product quality improvement.

The MHS technology addresses this issue by replacing the lengthener and cod-end of the trawl, reducing water flow in the gear during trawling and to allow fish to be lifted in a bag of water. The system comprises modular components adaptable to fishery requirements, including a cone module and retention modules shaped based on the desired escape of undersized target species. The MHS opening, designed according to fish width and thickness measurements, achieves a 62% retention rate at sole MRCS. The Netherlands' adaptation of the MHS is smaller compared to the NZ one, to suit mixed fisheries' needs, showcasing the technology's adaptability.

The conventional cod-end catches animals and fish in a turbulent manner, causing damage and scale loss, while the MHS cod-end provides a gentler environment where fish can remain for several hours. This modification **improves** the **condition and survival of undersized fish,** and **increases** the **marketable catch** due to better fish quality.

With MHS, undersized plaice showed improved condition with maintained mucus layer and scales, resulting in a 30% increase in survivability. Further improvements in onboard catch processing could enhance survival rates. Although catches of sole appeared slightly lower, recent trials demonstrated a 40% increase in sole landings with MHS, with no significant differences observed for other species. Regarding **discards**, there was an overall 15% **reduction**, primarily in brittle stars and crabs, although there was a concurrent increase in bycatch of undersized sole.

In summary, MHS significantly enhances fish condition and discard survival, leading to improved product quality. Despite having similar selectivity to conventional trawls, MHS promotes higher survival rates, thereby reducing fishery mortality for undersized fish. Future research on MHS will focus on species-specific selectivity based on shape and behaviour, with the technology currently at Technology Readiness Level 7 for beam trawl fishery.

Next steps involve conducting longer-term experiments to assess endurance and performance on various fishing grounds. Additionally, efforts will be made to improve onboard catch processing, legalize the technology for use in EU and UK waters, implement species-specific selectivity measures, and explore its application in other fisheries such as otter trawl and flyshoot.

Martin **Pastoors** (MPFF) questioned why a larger hole was not attempted to avoid catching undersized sole. Molenaar explained that such a solution would allow larger individuals to escape as well.

Fischer inquired about the process needed to legalize the technology, whether it would require a change in the TMR or a separate regulation. Molenaar clarified that since the TMR

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is based on mesh size in the cod-end, and MHS does not use mesh, it necessitates a reconsideration of regulatory frameworks. Furthermore, even if MHS is legalized in Europe, it must also be legalized in UK waters, where 60% of the fishery occurs, as well as in Norway.

Santos asked about the mechanism behind the observed 15% reduction in discards and whether discussions with fishery modelers regarding fish population dynamics had occurred. Molenaar mentioned that discussions with stock assessment modelers will take place in the future. Regarding discard reduction, it appears that fish escape through the trawls bottom panel when it’s slightly lifted due to the floating properties of the MHS. Further refinement of the trawl's design could potentially reduce discards further.

Michael **Park** (SWFPA) inquired about the basic costs of the technology. Molenaar explained that MHS is currently not commercially produced in Europe and must be imported from New Zealand, making it expensive. However, once production is established in Europe on a larger scale, costs are expected to decrease. Additionally, MHS's durability means it does not need frequent replacement compared to shrinking mesh in traditional netting, providing a long-term cost benefit.

Patrick **Murphy** (Irish South and West Fish PO) inquired about the stability of the board when it is lifted up and MHS’ effect on fuel consumption.

Molenaar explained that since this fishery can handle catches of 3-4 tons in one trawl, the MSH was designed to contain an equivalent of 2000 kg of water. Regarding fuel consumption, no changes were observed compared to conventional gear in the Dutch case.

8 SafetyNet Technologies: Precision fishing

Tom Rossiter (SafetyNet Technologies) presented precision fishing opportunities and challenges in the UK.

Precision fishing may vary in its definition depending on the perspective. To a fisher, it might mean catching what's necessary, avoiding what's not, and doing so with maximum efficiency.

The current state of the UK fishing sector post-Brexit presents challenges. Recently, the UK Gear Forum, of which the SafetyNet Technologies is part of, commissioned Cefas to conduct a survey on the current adoption status of precision fishing innovations and best practices.

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The findings revealed several obstacles: a lack of incentives, regulatory barriers (real or perceived), financial constraints hindering innovation adoption, insufficient information sharing within the fishing industry, and the inflexibility of solutions.

In the UK, the focus is currently towards **enhancing vessel efficiency and reducing CO2 emissions**, with innovations such as electric-powered inshore vessels being trialed. Efforts are also directed towards vessel design optimization and sharing accessible information with fishers. Automation in fishing vessels is emerging as a significant trend, resembling factory-like operations.

Regarding **gear selectivity**, the UK Gear Forum facilitates information exchange among various stakeholders, including researchers and fishers' organizations. While initiatives like the Fishing Gear database exist, they require updating. Fishers' motivation to obtain **MSC certification** has been driving innovation projects, along with recent developments such as Smart Trawl technology for reducing unwanted bycatch. Innovation in traps and baits is also gaining attention. Nevertheless, the lack of clear policy on innovation hampers fishing businesses.

Several projects are underway to **enhance gear efficiency and reduce environmental impact** in the UK fisheries sector. The Sumwing project, scheduled for trials in April 2024, aims to test a new design tailored for UK beam trawls. Additionally, industry-led research is improving Scallop Dredges to reduce seabed impact and increase durability. The Katchi project is developing demersal trawl technology without trawl doors, incorporating hydrodynamic blocks for movement. Efforts are also focused on semi-pelagic doors, with potential for significant fuel savings and CO2 emissions reductions. Finally, in collaboration with the University of Ulster, another project monitoring the impact of fishing gear, particularly nephrons trawl, on the seabed is starting in Spring 2024.

SafetyNet Technologies is also involved in projects to improve catch welfare, addressing concerns raised by NGOs regarding the environmental impact of fishing. Specifically, Crustacean Compassion, a UK-based environmental NGO, has been advocating against consuming crustaceans due to concerns about the environmental impact of fisheries. Similarly, Open Seas has been lobbying against the negative effects of bottom trawling. Given that these messages are persistent, **fishers** have to **prioritize addressing** these **concerns through** their **actions** wherever feasible. In view of this, initiatives like the Nephrops tailing

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project aim to automate processes to alleviate repetitive tasks for fishers and enhance catch quality.

The current UK fisheries policy is complex, with each of the four countries responsible for fisheries management, although collaboration is underway. Progress towards **co-management** is taking place, albeit currently in a consultative and cooperative manner. However, this approach presents challenges, with 43 Fisheries Management Plans requiring consultation and collaboration, involving significant effort from fishers.

SafetyNet Technologies is advancing **precision technologies** through the development of cameras, lights, and sensors (depth, temperature, light intensity, turbidity, etc.) to be implemented on board, enhancing operational and ecological efficiency while providing fishers with accurate information.

Murphy suggested developing a campaign for fishers as a response to environmental NGO messaging.

Rossiter agreed, highlighting how TV programs have been effective in this regard, but more efforts are needed to counter the prevailing perception that fishers are guilty until proven innocent. Additionally, it's crucial for fishers to receive **recognition for their efforts in implementing innovations** to reduce impacts and improve efficiency.

Visser pointed out the challenge of bringing facts into emotional discussions, especially in fisheries where emotions often dominate.

Stephen **Davies** (DG MARE) asked about involving fishers in deciding which innovations to pursue and the direction to take.

In response, Rossiter emphasized the importance of **communication, listening, and trialing innovations** while allowing room for mistakes. He stressed the need for an iterative process that involves fishers in determining what is most likely to succeed and getting them excited about the project.

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9 Innovative modified nets in Nephrops fishery: dual cod-end and coverless trawl

Lois Flounders (MarFishEco) presented ongoing research on innovative modified nets in the Nephrops fishery.

The Nephrops fishery in the UK is economically significant, valued at £125 million in exports in 2022, second only to the salmon industry, with a majority of exports going to the EU. With increasing pressure for sustainability from NGOs, the UK industry is striving to enhance sustainability practices.

The Gear Trials Partnership Project (GTPP), funded by DEFRA, consists of two parts.Part A focuses on the design process, consolidating existing data and developing rigorous and iterative gear modifications in collaboration with the industry. A landscape review was conducted to consolidate data from previous gear trials (44 trials reviewed), identifying viable solutions to reduce bycatch and assess the economic and ecological effectiveness of gear modifications. However, past trials lacked robustness and industry involvement from the outset, hindering implementation and driving management decisions.

Following a landscape review, four engagement sessions were held with UK Nephrops skippers to generate industry-driven research ideas and co-design modified nets. Subsequently, collaboration with industry, gear technologists, governmental fisheries agencies, and seafood industry experts refined the research plan for trials. Afterwards, a presentation deck to collect feedback from 18 UK fisheries producers organizations was circulated, refining trials plan based on sector selectivity issues across geographic ranges.

Next, a detailed research proposal was submitted, leading to Part B of the GTPP project. This ongoing phase aims to robustly trial and evaluate the performance of two promising Nephrops fishery gear modifications: the **dual cod-end** and **coverless trawl**. Multi-season and multi-location trials onboard commercial trawlers over two years will scientifically validate industry claims about these gears, examining their ecological sustainability and socio-economic implications. The project aims to **drive positive policy and management changes in the Nephrops fishery through industry-science collaboration and robust scientific data**. Methods and approaches used in the GTPP will be shared with UK administration to facilitate positive change.

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The dual cod-end features a larger diamond mesh size in the top cod-end and a smaller size mesh in the bottom cod-end. It aims to separate Nephrops from fish bycatch using an inclined square mesh panel, improving catch quality, reducing sorting time, and minimizing juvenile bycatch.

The coverless trawl targets a reduction in fish bycatch, primarily whiting and haddock, while enhancing fuel efficiency. The top panel is cut back to align the headline and footrope lengths, allowing fish to escape ahead of the footrope. Additionally, a square mesh panel offers a secondary escape route for fish bycatch.

Onboard, **ecological data** collection includes fish condition assessments and environmental data sampling. Two cameras, a GoPro above the sorting table and an SNTech CatchCam, monitor catch and fish behaviour. **Socioeconomic data**, both quantitative and qualitative, are also being gathered to understand historic management relations and industry needs for net rollout.

Expected outcomes include:

1. **Reduced bycatch and increased selectivity** in both the dual cod-end and coverless trawl compared to standard gear, dependent on net type, trial locations, and seasons. The dual cod-end shows effective separation of Nephrops from commercial-sized fish, while the coverless trawl shows further reduction of whitefish catch.
2. **Reduced cod-end bulk and increased separation** in modified nets improve catch quality, potentially increasing market value and discard survivability.

Results will be shared with the industry to foster cooperation and enhance result quality. Incentivization avenues will be explored to highlight economic and overall benefits across the supply chain. Dissemination methods will include gear animations, a documentary, infographics, news reports, and policy briefs. Final dissemination workshops will involve industry and government to discuss findings and practical implementation steps.

Murphy asked if outcomes implemented in the UK would also be required by other fleets. Flounders explained that project trials will conclude in February 2025, with results delivered to the UK government in March. Development depends on ongoing campaign pressure and its impact on driving change.

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Steins asked if ongoing conversations with fishers from trial vessels are occurring. Flounders confirmed, noting fishers' willing cooperation.

10 Bottom-trawling of tomorrow: precision-fishing and real-time management driven by high quality real-time data as a viable alternative to prohibition – a case of co-management in Belgium

Hans Polet (ILVO) took the floor with a poignant statement: *'Fishers fear the future, and feel a lack of certainty. Unless social issues are solved, no progress will be made*.'

In Belgium, significant steps have been made in resolving social issues within the fisheries sector over the past 15 years. Government entities, policymakers, managers, administrators, fishers, scientists, and NGOs have unified behind a **roadmap for a more sustainable and profitable future for fishers**. This unity is determined by a different approach to collaboration among stakeholders.

Amidst the complexity of the fishing industry, returning to basics is advocated. A fishery without rules is not viable, requiring an appropriate management system. On the contrary, a fishery without control and enforcement could be considered.

A healthy ecosystem, robust fish stocks, and sound seafloor and habitat are essential for operations. Fishers should have autonomy to fish in the manner they deem most suitable for economic viability, efficiency, and adaptability. However, comprehensive data on fish mortality from each vessel is imperative to evaluate ecosystem health. Complete transparency in data sharing – including catch details, gear impact on the seafloor, and fish survival – is essential. This data is valuable for both fishers and scientists, enabling **more efficient fishing, identification of favourable fish concentrations, and assessment of acceptable mortality rates** and thresholds. Throughout this process, maintaining social cohesion is vital, with openness being essential, only achieved through trust.

Polet raised concerns about the future direction of the CFP, noting a lack of self-criticism and unresolved issues faced by fishers. He highlighted small progress since the last review in 2013 and growing mistrust between fishers, scientists, and policymakers.

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Conversely, he underlined the collaborative success of the Belgian fishing sector, illustrated by a covenant signed in 2011 by the government, fisher's producer organizations, an NGO and administrators promoting sustainability. This partnership produced a roadmap, the Vistraject, supported by all stakeholders. Notably, a system tool with 11 sustainability indicators to estimate fishery's sustainability was established, linking to a labelling program (Visserij Verduurzaamt). One of the indicators involves data, rewarding fishers with **an additional sustainability score if they provide data to scientists**. Currently, 38 Belgian fishing vessels provide real-time confidential data (scale data, fuel consumption, GPS data, etc.) to science, enhancing efficiency and allowing for better quota management. Data collection is facilitated through the Vistools project, utilizing onboard concentrators connected to a cloud for continuous real-time access by scientists.

Cameras installed in the fish auction continuously gather data to train the ILVO device system, which can now detect 19 different aspects. ILVO is also developing systems to be implemented on vessels for analysing and sorting catches, with the cooperation of willing fishers.

Additionally, ILVO is exploring **environmental DNA** (eDNA) analysis, which involves extracting DNA from a liter of water to understand species composition and biomass in an area. This complements catch data by providing a broader perspective. A device for automated eDNA sampling onboard vessels is currently under development, set to be employed on vessels in April.

All gathered data feeds into the Digital Twin, integrating with Copernicus and EMODnet data to provide valuable information to skippers, managers, and scientists. While existing tools enhance sustainability and efficiency, there is potential for more comprehensive data utilization. Access to data from each individual fishing vessel could enable **reliable stock assessments, real-time catch predictions, discard risk assessments, eDNA hotspot detection, real-time incentives, and ecosystem-based approaches**.

All this facilitates precision fishing, defined by Costello et al. (2016) as the use of advanced tools and technologies to optimise fishing operations and management.

Having a fishery without control and enforcement is feasible, and, though requiring further technological development, progress in this direction is evident. This is especially the case if open-minded individuals are willing to pursue positive change.

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For vessels with persistent high mortality rates, efforts will initially focus on improving performance, followed by restrictions such as limited days at sea if necessary. Continued non-compliance may result in exclusion from the system.

Although **data collection technology** determines costs, its implementation **drastically reduces expenses for control and enforcement**. Moreover, it encourages cooperation among stakeholders and promotes ecosystem health. Key discussions revolve around acceptable mortality rates, while the innovation in management, driven by data, enables targeted and effective measures, avoiding broad regulations.

In conclusion, the current state of fisheries management often overlooks the social dimension, fostering industry mistrust. **Establishing trust and demonstrating the value of data encourages fishers to share information**, enabling precision fishing and the development of a digital fishery twin. This forms a sound basis for **alternative management strategies** with minimum control and enforcement.

Regarding regional implementation of such strategy, **Visser** sought further details given the EU's diverse sea basins and social networks. Polet emphasized that trust-building and collaboration, as well as a less top-down approach to management, are needed across the whole EU.

Ursula Krampe from DG MARE inquired about the number of cameras on Belgian vessels and best practices for sharing confidential data. Polet clarified that 38 vessels are currently providing detailed data sets, including fish weights, fuel consumption, and vessel positions. While cameras are not installed on vessels, they are utilized in auctions to collect images for AI training. The implementation of technology onboard poses challenges, requiring collaboration with fishers for successful integration.

Steins expressed concerns about the challenges of implementing cameras for catch registration in the Netherlands, citing technical challenges and fishers' reluctance due to privacy issues and perceived surveillance. This mirrors challenges discussed in the European Parliament regarding the use of CCTV cameras for rule enforcement, making it difficult to involve fishers in initiatives like Fully Documented Fisheries (FDF).

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Polet confirmed that Belgium encounters similar obstacles, with fishers showing openness but remaining cautious due to privacy concerns.

Rachel Tiller (SINTEF Ocean) inquired about the focus of the camera technology in fisheries, particularly whether it caters to small-scale or large-scale operations.

Polet clarified that the interest lies mainly in monitoring the conveyor belt process, with less emphasis on observing fishers' activities onboard, as the primary focus is on assessing the mortality caused by fishing activities rather than monitoring fishing practices themselves.

Visser mentioned the Dutch participation in FDF but highlighted concerns about negative perceptions surrounding onboard cameras. He sought strategies to emphasize the positive aspects of this technology.

Polet stressed the importance of engaging with policymakers and understanding their challenges in reducing discards. Collaboration and exchange of ideas are essential for achieving sustainable fishing goals.

Schou emphasized the challenge of cultural change within diverse EU communities and suggested considering economic incentives to facilitate this shift.

11 Second breakout session: the necessary pre-requisites for innovative nature-friendly fishing (regulatory, technical, scientific, social, outreach & communications)

The second breakout session focussed on brainstorming solutions for innovative fishing. Similar to the first breakout session, participants utilized the PESTEL framework to guide their discussions.

11.1 Results from second breakout session

The rapporteurs from the six groups presented the three main identified ways forward for innovative fishing, categorized under the PESTEL framework as follows:

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- **Political**: Reform or revise the CFP to adapt to the new policy context; employ a pragmatic management approach involving Member States in uptake; embrace co-management respecting diverse cultures and histories; change Art 15 on the Landing Obligation to an Account Obligation; conduct a structural analysis of strengths & weaknesses of the EU fisheries innovation system for tailored solutions.
- **Economic**: better promotion of EMFAF by Member States and European Institutions; address financial instability due to quota changes from varying scientific advice.
- **Social**: Foster trust in new technology's value for fishers; involve fishers in knowledge exchange; implement the socio-economic pillar of the CFP for increased stakeholder dialogue; increase transparency through digitalization; focus on generational renewal and crew education.
- **Technological**: Provide working space for operational flexibility; allow free choice of gear in Remote Electronic Monitoring (REM), ensure accurate catch data input for scientific advice; create a record of used gears with assessment of performance; use real-time data for decision-making; ensure technical capacity on vessels for independent trial verification.
- **Legal**: Adopt a results-based legal system focusing on regulation of output instead of gears; implement flexible and adaptive legislation for technology adoption; implement results-based approach at the fleet level with from the help of monitoring tools.
- **Environment**: Showcase environmental gains of innovations through improved target species catch, reduced fishing time, lighter gear, and long-term cost savings.

12 Wrap-up & recommendations

Before closing the event, the moderator invited brief comments from the audience.

Laowe de Boer (Ekofish Group) urged reflection on the future of fisheries. He emphasized the importance of encouraging pride in being a fisher and engaging the new generation. Addressing crew shortages, he stressed the need for stability and a clear framework, allowing fishers to showcase their work.

Visser conveyed appreciation for the event, highlighting the value of sharing innovative fishing practices. He suggested a re-establishment of an innovation network to prevent duplication of efforts and maintain momentum.

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13 Closing remarks

Esben Sverdrup-Jensen (EAPO President) emphasized the importance of maintaining the momentum and noted the need for the right mindset to drive opportunities and solutions forward. He discussed the challenges of the TMR reform, noting its aim for simplification which ultimately wasn't achieved. In view of this, he highlighted the importance of collaboration between the industry and scientific community, citing examples of successful dialogue regarding new technologies like CCTV. He further stressed the significance of economic viability and stability in fostering innovation within the fishing community. Finally, he acknowledged the potential of the seafood industry but cautioned against losing sight of core principles.

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ANNEX A

Breakout session 1:

Challenges

Political:

- Lack of motivation among MS to implement LO / lack of incentives to set target and selectivity indicators
- Landing obligation a political decision with no impact assessment
- Lack of consideration of negative effects of political decisions on decarbonisation, reduced bottom contact, environmental impact etc. on fisheries.
- Lack of robust science for policy decision-making/management
- Public debate tends to be polarised
- Arguments based on science vs arguments based on protection of national fisheries
- Complex bureaucracy (restrictive Technical Measures Regulation)
- Lack of (political) trust
- High administrative burden
- Rigidity of the system
- Lack of critical thinking/self-criticism ("If it doesn't work, it needs to be questioned")

Economic:

- Lack of economic returns/ROI
- High investments/costs in new gear
- Lack of compensation for revenue loss in the investment/uptake of new gear
- Costs and uncertainty in the effectiveness of innovative gear
- Financial losses due to uptake of new gear that is less catch effective
- Lack of funding
- Lack of incentives
- Failed business model of selective fishing – selective means less catch

Social:

- Lack of stakeholder engagement in all stages of development of new gear and projects

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- Path dependency, change in culture towards more openness to innovation takes years/generations
- Top-down approach to innovation followed by reluctance to follow rules/adopt measures
- Fishers' scepticism of science and policy (black-box, lack of feedback)
- Lack of generational renewal
- Lack of trust in policies
- Lack of trust in fishers by society (negative public opinion)
- Fear of the unknown
- Peer pressure "What will my colleagues say?"
- Lack of effective communication leading to mistrust/dislike of marine management
- Lack of motivation of the crew
- Mistrust of the public against fishers "Fishermen cheat" leading to scientific and bureaucratic control
- Distrust by the fishers that their input is used positively (i.e. by control agency)
- Lack of acceptance of harvesting food from the wild with side effects
- Negative NGO campaigns trump positive communication

Technological:

- Potential reduction in catches with new gears due to overriding environmental concerns
- Innovations not tailored to fishers in different areas
- Fishers not involved in technical design
- Gear innovation driven by immediate needs can be counter-productive
- Ambiguity of science, "Science not speaking black on white"
- Data harmonisation and standardisation
- Lack of uptake of innovative gear

Environmental:

- Environmental considerations more pronounced in research/project applications
- Classify bottom impact – define what is a problem?

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Legal:

- In EU, there are co-decision and regionalisation processes, both of which demand establishment of scientific evidence (i.e. STECF evaluation), which is time consuming and renders procedures slow
- Conundrum of layering legal provisions, which are very specific and apply to large part of the sector (complexity instead of simplification)
- LO not realistic, does not make sense for mixed fisheries
- Legal consequences of the discard ban/LO
- Lack of legal certainty
- Lack of stakeholder engagement in drafting legislation
- Legislation too prescriptive (i.e. Technical Measures Regulation)
- Challenges with renewal of fleets: barriers, energy transition)
- Lack of harmonisation in decision-making
- Issue of "One-size-fits-all" approach
- Anticipated ban on trawling does not allows to take risks
- The way LO is implemented hampers the use of new gears
- Legal effect of technology uptake
- EU-UK and EU-NO disputes / lack of harmonisation
- Gear approval following innovation is slow
- Rigidity of the system – if it does not work, it needs to be questioned and changed
- Making unworkable policy work through repression is doomed to fail
- Legislation lags behind innovation
- Inappropriate legal framework to allow for innovation in fisheries

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ANNEX B

Breakout session 2:

<u>Solutions:</u>

Political:

- Explore and embrace co-management (see Belgian example, but there are other ways, the need to adapt to cultural and historical differences)
- Ensure a feedback loop – let fishers know about further steps/consequences in setting policies
- Adopt a fleet-based and regional approach
- Ensure more regionalisation
- Adopt a bottom-up approach
- Reform the CFP with elements to allow adoption of new gear
- Develop a vision of the sector/fishers in the EU seas
- Present structured analysis of strengths and weaknesses of EU fisheries innovation system to tailor legal and political solutions
- Ensure stability of TACs and quotas
- Manage through rebuilding plans rather than catches
- Replace 'landing obligation' with 'information obligation'
- Adapt regulation to reality and not reality to regulation
- Better consideration of fishers' perspective
- Pragmatic approach to management with sufficient human resources (also in policymaking)
- Creation of a permanent committee composed with Member States (local) authorities + stakeholders + scientists (national, STECF, ICES)

Economic:

- Reconsider resource allocation and incentives
- Create economic stability through investments

Social:

- Develop with fishers to ensure uptake

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- Bring fishers together in a Fishers Conference
- Involve the crew
- Improve the dialogue between stakeholders
- Provide incentives and communicate benefits of the uptake of new gear
- Change the narrative on cameras and AI: technologies that help with reporting/documenting/data collection, instead of control
- Measures to foster trust between different actors
- Foster trust through transparency and digitalisation
- Create a generational turning point by new paradigms in schools (on transparency, digitalisation, equality etc.)

Technological:

- Create a catalogue of gears, barcoded with assessment of performance
- Fishers develop and choose their own gear (free choice of gear i.e. as incentive for REM)
- Create a knowledge database to build trust. Consider reviving innovation network: http://www.eftp.eu/
- Adapt the market to technological innovation
- Ensure the collection of real-time data for better decision-making
- Bottom-up, proactive innovations and development
- Less fishing days vs. Increasing the mesh size
- Trials must be carried out to meet commercial realities
- Ensure working space to introduce flexibilities in operations/technological change??
- Vessels need technical capacity (data collection via REM) to verify results of trials independently
- Need for rigorous catch data for robust scientific advice

Environmental:

- Accept, in some areas, impacts of bottom-trawling
- Ensure better understanding of the functioning of the ocean and nature
- Ensure effective predator management for more efficient fishing (catching same amounts shorter time)

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Legal:

- Adaptive/responsive and transparent legislative system (but: trade-offs, transparent system is slow)
- Results/objectives-based legal system as opposed to means-based. Instead of regulating gear, regulate output
- Think about trade-offs: flexibility vs. Monitoring
- Flexible legislation framework to encourage the adoption of new technologies
- Ensure access to innovative technologies/gears
- Implement the socio-economic pillar of the CFP
- Delete Article 15 on the Landing Obligation and establish “Information Obligation”
- Adapt the regulation to reality and not reality to regulation
- Provisionally accept new gear and establish results-based analysis assessing selectivity, impact on the environment, socio-economic impact and carbon footprint
- Work on a joint recommendation and a delegated act that can only enter into force after the results-based analysis.
- Adopt case by case approach to determine whether an innovation can apply without the joint recommendation/delegated act
- Reform CFP or develop a specific legislation on innovation in fisheries that is flexible, addressing selectivity, impact on marine ecosystems, socio-economic impact and energy transition
- Better inclusion of stakeholders in the drafting of legislation

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