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EUROFISH MAGAZINE

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SELECTED ARTICLES

ŠVENTOJI PORT PREPARES FOR THE FUTURE

In Lithuania, a Fisheries Local Action Group in Klaipėda town and another in the Šventoji area are taking initiatives in support of coastal fisheries. In Klaipėda a hard surface slipway will help fishers launch their vessels while further up the coast **Šventoji port** is being rebuilt with a concrete slipway, a storage hangar, offices, breakwaters, berths for fishing and other vessels, and a sailing school to make the port attractive to a community of diverse users.

PAGE 29

Training enrolments in Germany's aquaculture sector faces a generational crunch: training enrolments fell about 40% since 2013, higher education shrank to one master's degree, and companies declined to 1,950 in 2024. Remedies include school outreach, FLAG-led local engagement, targeted subsidies like Schleswig-Holstein's €15,000 trainee support, EMFAF financing, and implementing the national aquaculture strategy with lighter regulation to attract and retain farmers.

PAGE 17

Since 2012, **Atlantic blue crab** has spread across Catalonia's Ebro delta, threatening shellfisheries. Catalonia has chosen to monitor the invader and create a consumer market for it which in turn gives fishers an incentive to catch it. The Spanish experience of managing blue crab could provide other Mediterranean countries, that are also suffering from invasion, with a model to be adapted to their circumstances.

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Innovations in fishing gear can improve sustainability by reducing bycatch while maintaining viable catches. Species-specific designs like CODEX and ROOF-LESS nets exploit behavioural differences, while AI-enabled smart trawls show future potential. Success depends on practicality, cost, and widespread adoption.

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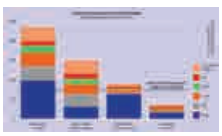

The **OECD–FAO Outlook 2025–2034** projects aquatic animal production rising to 212m tonnes by 2034, led by aquaculture at 118m tonnes or 56% of output. Per-capita consumption edges up to 21.8 kg, with declines in Africa and in Europe. Buoyed by the use of leftovers from processing, fishmeal production is forecast to rise 5.9m tonnes by 2034. Climate risks and El Niño volatility are among the factors that could have an impact on the predictions, however. Read Dr Manfred Klinkhardt's article.

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Whelks, chiefly *Buccinum undatum*, are protein-rich predatory marine snails. They lack a pelagic larval stage, disperse poorly, and are vulnerable to overfishing. Effective management is difficult though several measures including licences, gear limits, and temporal restrictions are in force in different jurisdictions.

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Michelle Boonstra, this edition's guest page interviewee, is manager of the Catch Welfare Platform, a forum for welfare-conscious fishing to improve sustainability and quality. The platform promotes One Welfare, simple yet effective changes on board, and vitality assessments which evaluate fish condition during fishing operations. For greater market acceptance, standards and certification need to be developed that conclusively show that better welfare and higher quality are two sides of the same coin.

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Cover picture courtesy Šventoji Seaport Authority/Aldas Kazlauskas

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GERMANY

Fish international and GASTRO IVENT invite for 2026

From 22 to 24 February, Messe Bremen will once again host both fish international and GASTRO IVENT, offering a unique meeting place for the overlapping target groups of these industries. Visitors will have the opportunity to network with hundreds of national and international exhibitors, uniting the expertise of the fishing, aquaculture, and gastronomy industries under one roof.

As Germany's only trade fair for fish and seafood, fish international will provide an overview of current market and product trends, innovations in processing and packaging, and sustainable aquaculture technologies. From regional producers of aquaculture products to seafood producers from the Fiji Islands, fish international brings together key players within the Blue Economy. Exhibitors include Deutsche See, Transgourmet, Eide Seafood, and Resko, as well as a Pacific Islands delegation participating via the International Trade Centre. Meanwhile, GASTRO IVENT will celebrate Bremen's coffee heritage with a Coffee-Style Area in Hall 7, featuring three national championships organised by the Specialty Coffee Association Germany. Alongside the themes of sustainable supply chains, sensory diversity and new roast profiles, the event will provide a key platform for the hospitality, catering, retail and hotel industries. Together, the two fairs will facilitate the exchange of ideas and practical business opportunities across industry boundaries.

M3BGmbH/Oliver Saul

Fish international will feature fish and seafood producers and processors from within and outside Europe.

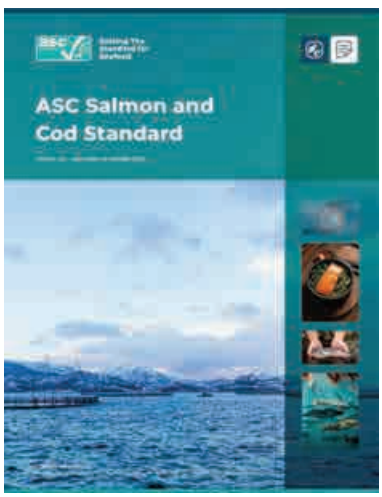
For more information visit https://fishinternational.de/en/

UK

ASC expands certification to include Atlantic cod

The Aquaculture Stewardship Council (ASC) has expanded its certification programme to include Atlantic cod, marking a significant step towards strengthening responsible aquaculture. With quotas for wild-caught cod declining and demand continuing to grow, farmed cod is becoming vital to ensuring a stable and sustainable global supply. Chris Ninnes, CEO of ASC, described the development as a milestone for responsible aquaculture, emphasising that extensive stakeholder input shaped a standard that reflects the realities of cod farming while maintaining high environmental and social benchmarks.

Atlantic cod will initially be certified under a modified ASC Salmon Standard, allowing producers rapid access to certification and a two-year transition period before full integration into the ASC Farm Standard. Because cod and salmon farming share many practices, this approach ensures a smooth adaptation process. The certification covers core sustainability areas, including biodiversity protection, disease management, resource efficiency, and ecosystem impacts. It also upholds strict requirements on water quality, feeding, health management, handling, and humane slaughter to ensure fish welfare. As the cod aquaculture sector evolves, ASC will continue to monitor developments and update its standards to maintain best practice and environmental integrity.



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SCOTLAND

Achieves significant jump in production of Atlantic salmon in 2024

With a total production of 192,000 tonnes of Atlantic salmon in 2024, production levels have increased by around 41,000 tonnes (27%) since 2023. This increase signifies a strong rebound by the Scottish salmon industry, whose production levels have previously decreased significantly two years in a row. The increase was driven by an overall uptick of production levels across all categories—year 0, grilse, pre-salmon, and year 2—but also by an increase in the mean harvest weight of year 0 salmon, grilse and pre-salmon. Scotland is the world´s third largest producer of farmed Atlantic salmon, with salmon making up around 96% of aquaculture production value.

Salmon smolts are kept in cages located in sheltered coastal waters, where they can grow in a controlled environment.

FRANCE

Mussel waste utilisation

Undersized mussels used to be considered waste among mussel farmers, as they were not eligible for sale and often simply discarded. On farms on the coast of Brittany alone, these amount to between 6,000 and 12,000 tonnes, representing around 20% of the overall catch. A pioneering project by the French mussel producer's association Cultimer is transforming the way this by-product is utilised. Based on industrial valorisation processes, the mussel waste is turned into smaller units through biological fermentation, allowing it to be used to generate methane. This, in turn, can be used as a renewable and clean energy resource. Additionally, mussel shells are repurposed as a fertilizer or as animal feed, utilising otherwise discarded materials in a closed-loop system. The project, consisting of mussel producers, local authorities, and scientific researchers, has developed a mobile processing unit that can be deployed on-site. This way, mussel farms can utilise the technology within the existing farm system, further reducing economic strain and environmental harm.

Mussel farms like these are typical for open sea waters in the Normandy area.

ESTONIA

New Estonian law to cap fish sales to 10 kilograms per person

Starting 10 January 2026, Estonia will introduce stricter rules on fish sales and significantly increase fines for violations, as part of a proposed amendment to the Fishing Act. The reform, led by the Ministry of Regional Affairs and Agriculture, aims to align national regulations with the EU's Common Fisheries Policy. Under the bill, individuals without registered sales records will be limited to purchasing ten kilograms of fish per day, down from the current 30 kilograms. For Baltic salmon, the daily limit will be two fish. The ministry stated that while the measure will mainly affect coastal residents who buy directly from fishers, the change will help reduce undocumented sales and improve traceability. Penalties for serious offences will rise sharply, addressing criticism by the European Commission. Individuals could face fines of up to €50,000, and businesses up to €400,000 or five times the illegal profit. Repeat offenders may see penalties doubled. The bill also mandates that fishers report both catches and releases, and that vessels 12 metres or longer be tracked at sea from 2026, expanding to all vessels by 2030.

DENMARK

DNA-testing to increase transparency and fight fraud

A new pilot project by the Danish Veterinary and Food Administration introduces a DNA-tool to test several meat- and fish products for their various contents. This new method is far more effective than previous testing methods that were limited to examine one species at a time. It allows for general testing of a product without demanding suspicion of a specific species being involved. While it´s initial scope is limited to the pilot project, the testing of 54 products revealed that 20 % of tested products showed traces of animals that were not on the ingredient list. This result was especially concerning for the area of fished goods, where tested fish balls contained up to 16 different species. Although this can be explained by a variety of factors, such as traces of multiple species of fish being a result of the food chain, it still indicates a lack of transparency. An accredited laboratory in Portugal also continuously cross-checked the testing to ensure that the method worked and that the results were reliable.

HUNGARY

Hungary to invest over € 50 million to develop aquaculture by 2027

The Hungarian government plans to provide more than HUF 20 billion (EUR 50 million) in funding for aquaculture development by 2027 under the Hungarian Fisheries Operational Programme Plus (MAHOP Plus). Minister of Agriculture István Nagy announced that the Hungarian National Anglers' Association's (MOHOSZ) can receive 100% funding for projects such as creating, restoring and improving habitats and spawning grounds for native fish species, as well as reducing invasive fish populations. This underlines the central role MOHOSZ plays in fisheries management in Hungary. The minister further emphasised the government´s commitment to ensure the long-term sustainability of Hungary´s fish stocks and the continued growth of the angling sector, as showcased with MAHOP Plus.

ITALY

AquaFarm 2026 announces dates and new features

Marking its tenth anniversary, AquaFarm 2026 is set to take place on February 18 and 19 at the Pordenone Exhibition Centre in Italy. The upcoming event will open with a session on the role of aquaculture in conserving and managing both marine and land-based aquatic resources. Water management will present a central theme, addressing the need for adaptive measures regarding climate and environmental change. Other topics include invasive species and anthropogenic pollution, as well as the need to relocate farms due to warming surface waters. The High Seas Treaty's regulatory framework will be discussed, as will its identification of fish farming as a key tool for the conservation and management of the world's fish stocks, which are threatened by indiscriminate and illegal industrial fishing practices. The event will also explore non-monoculture developments in aquaculture such as integrated multi-trophic and regenerative farming, as well as emerging technologies like robotics, AI, and precision feeding. AlgaeFarm will focus on microalgae, while NovelFarm will cover innovative crops and the rise of controlled-environment mushroom farming in Italy. AquaFishery, a new thematic area, will address small-scale and professional fishing, promoting sustainable practices and innovation in marine and inland water supply chains. This initiative will provide a platform for industry players to discuss challenges and solutions, fostering collaboration and growth in the fishing sector.

AquaFarm 2026 will feature a new thematic area, AquaFishery, alongside AlgaeFarm (microalgae) and NovelFarm (innovative crops and farming techniques).

Eurofish joins forces with 7 EU-funded projects at Aquaculture Europe 2025

Aquaculture Europe 2025 took place in Palacio de Congresos de Valencia, Spain, from 22 to 25 September, bringing together the global aquaculture community under the theme "Aquaculture for Everyone - Invest in Your Planet." The event welcomed 3,115 participants from 97 countries, demonstrating the international scope of aquaculture and its critical role in global food security. Among the attendees were 381 students, highlighting the sector's focus on fostering the next generation of aquaculture professionals, researchers, and innovators.

Pupils from primary schools interacted with scientists as one of several activities designed to foster interest in science in general and aquaculture in particular.

Over the four-day event, participants engaged with 1,254 abstracts, including 597 oral presentations and 571 e-posters. The trade show featured 155 booths representing industry players, research organisations, and startups presenting innovative technologies and services. Eurofish International Organisation coordinated a joint exhibition space with seven EU-funded projects dedicated to innovation, transparency, and sustainability in aquaculture: VeriFish, FishEUTrust Project, SAFE (SmartAqua4FuturE), EUMOFA, Mr.Goodfish 3.0, INNOAQUA, and Baltic MUPPETS

Aquaculture offers solutions to different challenges

The conference opened with a lecture by Dr Carlos Duarte, Ibn Sina Distinguished Professor at King Abdullah University of Science and Technology, Saudi Arabia, on "Regenerative Aquaculture to Reconcile Human and Planetary Health." Dr. Duarte emphasised aquaculture's potential to simultaneously address human nutrition, economic growth, cultural heritage, and ecosystem restoration. Despite its promise, only a small fraction of research focuses on regenerative aquaculture, highlighting opportunities for innovation. Plenary 2 featured Dr Elisabetta Giuffra (INRAE, Paris-Saclay University, AgroParisTech), who showed how functional genomics drives advances in breeding, health, and resilience in aquatic species, while shaping future research priorities and improving production efficiency,

animal welfare, and sustainability. Plenary 3 included Joan Riera (Kantar Worldpanel) whose analysis of Eurobarometer data revealed declining seafood consumption across Europe, with Spain as a notable exception. Causes include inflation, convenience preferences, and changing dietary patterns. He suggested older consumers and families with older children may drive future demand, offering growth potential for the sector.

Student engagement and hackathon

Student participation remained central to AE2025. The Student Hackathon on September 24 challenged students to develop solutions for real-world problems. The hackathon promoted teamwork, creativity, and innovative problem-solving that resulted in cash prizes for winning teams. One of the highlights of Plenary 1 was the Student Spotlight Award, celebrating the exceptional research and talent of the next generation of aquaculture professionals. From 163 abstracts submitted, three finalists were selected after pre-selection by the EAS Board and final evaluation by AE2025 programme co-chairs, Diego Mendiola, and Martin Føre.

On Thursday, 25 September, the Spanish Technological Platform for Fisheries and Aquaculture (PTEPA) welcomed 90 local primary school pupils, and with the Spanish Ministry of Agriculture, Fisheries and Food, and the Biodiversity Foundation, organised activities to promote scientific vocations and fish consumption. Pupils explored aquaculture and sustainability and participated in a scientific treasure hunt to meet researchers and learn about their work, inspiring future interest in aquaculture and science.

Javier Ojeda González-Posada awarded honorary life membership at EAS

At the Aquaculture Europe 2025 event in Valencia, Spain, the European Aquaculture Society (EAS) awarded its highest honour, the Honorary Life Membership, to Javier Ojeda González-Posada for his outstanding contributions to European aquaculture. Javier Ojeda, the 17th recipient, has played a vital role in strengthening producer organisations, promoting aquaculture's benefits, and improving public understanding of the sector. As General Secretary of the Federation of European Aquaculture Producers (FEAP) and former Chair of the Aquaculture Advisory Council (AAC), he has been an influential voice at European and international levels. In Spain, he developed APROMAR into a model producers' organisation and served key roles in the Spanish Economic and Social Council and the Aquaculture Technology Platform (PTEPA). His long-term engagement with EAS, including his role on the AE2025 Steering Committee, reflects his dedication to advancing sustainable and responsible aquaculture across Europe.

Javier Ojeda (left) with EAS President 2024-2026 Marc Vandeputte

An event that ticks many boxes

AE2025 reinforced the vital role of aquaculture in global food security and its capacity to deliver sustainable and innovative solutions. It showcased the sector's ability to meet growing demand while addressing environmental and societal challenges. The conference also demonstrated the value of student engagement, cross-sector collaboration, and research dissemination in shaping the future of aquaculture. The aquaculture community can now look forward to Aquaculture Europe 2026 in Ljubljana, Slovenia, from 29 September to 1 October 2026.

Ana Visković,
European Aquaculture Society

Conxemar–FAO–MAPA congress equates aquatic food with food security

On 6 October, experts and stakeholders from around the world and from across the fisheries and aquaculture sector gathered in Vigo for the XIII Conxemar–FAO–MAPA congress to discuss global challenges in aquatic food.

At the thirteenth edition of the Conxemar-FAO-MAPA congress, Manuel Barange, FAO Assistant Director-General and Director of the Fisheries and Aquaculture Division in his keynote address pointed to the way aquaculture has emerged as a driver of growth and a reliable source of protein, while Alberto Prieto, Chief Coordinator at Fundación Fish Nation, in the other keynote speech emphasised that climate change, unequal access to resources, and ocean governance must be integrated to meet today's realities.

The conclusions from the Conxemar-FAO-MAPA conference included a call for more cross border collaboration between certification bodies, the seafood industry, and regulators, to increase the sustainability of seafood.

Industry collaboration with regulatory and certification bodies vital for sustainability

Among the conclusions from four round-table discussions—on consumers, innovation, social impacts, and sustainable growth—was that scaling seafood sustainability will require aligned benchmarks and stronger collaboration among businesses, certification bodies, and regulators across borders. The congress concluded with an inspirational talk by Dr Dayna Baumeister, co-founder of the Biomimicry Institute, who demonstrated how nature and marine ecosystems can inform practical solutions to sector challenges, drawing on real-world examples, including from the renewable energy field. Isabel Artime García, Spain's Secretary-General for Fisheries, used her closing remarks to underscore cooperation, traceability, responsible consumption, and the ocean's central role in global food security.

The 26th edition of Conxemar, an event for the frozen seafood sector, followed the conference. Altogether, 812 exhibitors from 46 countries filled 37,000 m² of exhibition space—42 more than in the previous edition—and the fair closed with a new record of 30,405 visitors, representing growth of more than 12 percent year on year. The event organiser, the Spanish Association of Wholesalers, Importers, Exporters, and Processors of Fisheries and Aquaculture Products (Conxemar), represents 230 companies which generate an annual turnover of EUR12 billion

and sustain more than 20.000 jobs. The opening was led by the Minister of Agriculture, Fisheries, and Food, Luis Planas; the Mayor of Vigo, Abel Caballero; and Galicia's Regional Minister of the Sea, Marta Villaverde, joined by representatives of FAO, the Xunta de Galicia, the Vigo Free Trade Zone, and Eloy García, Conxemar's President.

Sessions on trade reveal the challenges of global supply chains

Across three days, the programme combined culinary showcases, presentations, technical sessions, and business meetings. A double session on the second afternoon featured an EUMOFA talk on EU fish consumption. Discussions addressed declining seafood consumption among younger Europeans (particularly those aged 18–35), the EU's increasing reliance on imports, and how price, convenience, and taste influence purchasing decisions. A subsequent session involving FAO-GLOBEFISH, Conxemar and the FISHINFONetwork (INFOFISH, Asia–Pacific; INFOPESCA, Latin America and the Caribbean; INFOSAMAK, Arab countries and the MENA region; INFOPECHE, Africa; and Eurofish, Central and Eastern Europe) connected diverse regional perspectives with the European market outlook, providing a comprehensive overview of global seafood trade flows and emerging challenges. On the final day, organised educational visits brought groups of students to the exhibition halls to learn about career pathways in fisheries, aquaculture, and the broader seafood value chain. Guided by their lecturers and hosts, students engaged with exhibitors, explored processing innovations, and heard first-hand about skills in demand—an initiative designed to connect future talent with real industry needs. With its diverse programme of events Conxemar again illustrated its importance as a platform for the frozen seafood sector in Europe and beyond.

Francesca Barazzetta,
francesca@eurofish.dk

Blue bioeconomy in focus at WEFTA 2025 in Gdańsk

The 2025 event reflected WEFTA's long-standing mission—to link research excellence with practical innovation across the seafood value chain.

This year's WEFTA conference was opened by Dr Olga Szulecka, WEFTA Chair and representative of the National Marine Fisheries Research Institute (MIR-PIB, Poland). She highlighted the importance of international collaboration in addressing resource efficiency, food safety, and circular bioeconomy goals.

Prospects & Sustainable Seafood Processing Opportunities

The first session focused on how the seafood industry is redefining efficiency through data-driven processing and total raw material utilisation.

Strong participation at WEFTA

From 13 to 17 October 2025, Gdańsk became Europe's centre of scientific discussion on the future of fisheries, aquaculture, and seafood processing. The 53rd Annual Conference of the West European Fish Technologists Association (WEFTA) gathered more than eighty researchers and industry representatives from across the EU, Norway, Iceland, the Faroe Islands, and Japan. Eurofish has been a member of WEFTA since 2024, further strengthening the bridge between scientific research and industry dissemination in the European seafood sector.

The next WEFTA Conference will take place in October 2026 in Reykjavík, Iceland, continuing this dialogue on science-driven innovation for a resilient and competitive European seafood sector.

Dr Grethe Hyldig (Technical University of Denmark), keynote speaker and recipient of the WEFTA Award 2024, illustrated how instrumental sensory evaluation and real-time texture mapping are modern quality assurance. Researchers demonstrated hyperspectral and multispectral imaging as tools for assessing freshness and texture non-destructively, enabling predictive quality control directly on the processing line. Other studies presented methods supporting the transition toward zero-waste processing in shellfish and algae. Dr Joanna Szlinder-Richert (MIR-PIB, Poland) outlined methods to cut water use and recover nutrients from effluents.

The second session explored how innovation in fisheries and aquaculture can secure sustainable raw-material supply in the face of climate change and environmental pressures. Studies showcased environmental DNA and RNA monitoring supported by droplet digital PCR—a technology capable of quantifying fish biomass in near real time without active sampling. Such methods could transform pelagic stock assessments and reduce survey costs. Speakers also discussed diversification of biological resources. Examples included valorising Baltic stickleback as a local source of high-quality oil rich in EPA and DHA, and innovative "dry-bleeding" systems for salmon processing that recover protein from blood while cutting water consumption.

Next-generation seafood combines food with nutraceutical properties

The third session highlighted seafood's shift from commodity protein to functional, high-value foods. Research covered fermentation of pelagic species, extraction of haemoproteins and omega-3-rich fractions, and marine-based functional beverages enriched with bioavailable micronutrients from microalgae. These advances point to "blue health foods," where the boundary between food and nutraceutical blurs. A notable topic was bacteriophage technology to enhance safety and extend shelf life. A phage cocktail targeting Norway lobster (*Nephrops norvegicus*) adds two to three days beyond the typical 3–5, reducing rejections and waste without chemical preservatives and representing a potential game changer for high-value shellfish markets. Further work showed how bioactive peptides from marine species, macroalgal extracts rich in vitamin B12 and long-chain omega-3s, and protein isolates can support products tailored to cardiovascular health and immune system support.

Seafood safety and authenticity

Ensuring safety and trust along increasingly complex supply chains dominated the fourth session. The integration of molecular diagnostics, digital traceability, and predictive modelling is reshaping how seafood safety is managed. Presentations demonstrated how rapid PCR and sequencing, combined with genotypic mapping of contamination sources, can shift the industry from reactive testing to proactive risk prevention. Novel biopreservation strategies were also discussed, particularly the use of lactic-acid bacteria and bacteriophages to inhibit *Listeria monocytogenes* in ready-to-eat salmon. Agnieszka Nona-Mołdawa (bioMérieux, Poland) introduced digital hygiene-mapping tools that integrate laboratory and environmental data, offering processors a dynamic picture of microbial risks. Overall, the session underscored that the ability to interpret and act on data in real time is becoming a defining capability for modern seafood companies.

Eighty researchers and industry representatives from across Europe and Japan gathered for WEFTA 2025.

Prof. Joanna Szlinder-Richert, NMFRI, presents her evaluation of wastewater from Polish fish facilities.

Seafood market, consumption and consumer behaviour

The final session examined how consumer perceptions and purchasing dynamics influence the development of emerging seafood sectors in Europe, particularly for freshwater aquaculture. Research demonstrated that consumer purchasing decisions are increasingly shaped not only by price and availability, but by values such as freshness, product origin, environmental responsibility and local economic impact. Studies on carp revealed a growing interest in short food supply chains, where direct relationships between producers and consumers support trust, transparency and perceived product quality. Although consumers associate carp sold through local channels with superior freshness and authenticity, a lack of convenience and limited product availability remain barriers to wider adoption—indicating a gap between declared willingness to buy locally and actual purchasing behaviours.

Equally significant were findings related to the market potential of African catfish in Central and Eastern Europe. Despite relatively low consumer awareness of the species, survey results across four countries confirmed strong purchase intent when product characteristics—such as mild taste, high protein content and favourable omega fatty acid profile—are clearly communicated. African catfish produced in recirculating aquaculture systems (RAS) was positively viewed in the context of sustainability, provided that its market positioning highlights innovation, culinary versatility and competitive pricing compared with salmon. The session emphasised that scientific innovation in production must be accompanied by equally innovative marketing strategies to successfully convert consumer curiosity into repeat purchasing.

Participants could choose between technical and cultural study tours

The conference concluded with two study tours: an *Aquaculture & Processing Tour* featuring Poland's state-of-the-art recirculating trout farm K2 and MOWI's salmon plant in Duninowo; and a *Regional Tour* exploring the cultural and historical heritage of the Żuławy region and Malbork Castle. WEFTA 2025 confirmed that Europe's seafood community is determined to transform science into smarter processing, cleaner production, and healthier food.

DanFish draws record crowds and industry leaders to Aalborg

DanFish International this year featured one conference on recirculation aquaculture systems (NordicRAS), another on vessels and the green transition, and an exhibition dedicated to the aquaculture sector (DanAqua).

From 7 to 9 October, DanFish International at Aalborg Congress & Culture Center (AKKC) welcomed a wave of visitors from no fewer than 49 different countries. While AKKC reported a rise in visitor numbers, both exhibitors and attendees continued to highlight the exhibition as "the place to be" for the industry. This year, the director of AKKC, the organiser behind DanFish, has even more reason to be proud. In addition to overwhelmingly positive feedback from both exhibitors and visitors, he can also report a significant increase in attendance.

After COVID, we experienced a slight decline in visitor numbers at DanFish, which we saw as a natural consequence of global events. That's why we are especially pleased to announce that the trend has turned. This year, we saw a 7% increase in attendance, welcoming a total of 13,708 visitors from 49 different countries, says Nicolaj Holm, CEO of AKKC. According to Mr Holm, several new initiatives at this year's exhibition contributed to the growth, including the NordicRas conference and the associated DanAqua exhibition focusing on aquaculture, as well as Danish

Nicolaj Holm, AKKC CEO; Mayor Lasse Frimand Jensen; Sebastian Schwarz, Danish Export CEO; and Lars Rønnov, AKKC CCO

Maritime's conference, *Future Propulsion and Green Transition*.

Greenland minister makes a point of visiting DanFish

The importance of DanFish International for the fishing industry has also been underlined by the participation of several prominent figures. Among them was Peter Borg, Greenland's Minister for Fisheries, Hunting, Agriculture and Self-Sufficiency, who prioritised time to attend the exhibition. I'm here because DanFish is an important exhibition—and it has been for many years. It's also an event that Greenlandic stakeholders greatly value. It's a tradition for them to attend, to discover new products, new partnerships, and even shipyards to build new vessels. That's why it's essential for me, as the minister responsible for the sector, to be here as well, Mr Borg said. The fishing industry is Greenland's largest and most important industry, making DanFish a natural meeting place for many exhibitors and visitors from Greenland.

Deals are made on the exhibition floor

Figures from this year's exhibition show that 66% of attendees have purchasing power or influence purchasing decisions within their companies. While exhibitors use DanFish to showcase the latest innovations, maintain relationships, and build networks that can lead to future deals, many transactions are also concluded directly at the exhibition.

And in the fishing industry, these are far from small deals. Aalborg-based company Beritech finalised the sale of its fully electric shrimp cooker to a Norwegian customer for DKK 650,000 during the exhibition. "We're thrilled whenever we sell new machines, and it's fantastic to see customers recognize that Denmark is a specialist in cold-water shrimp. They want our equipment and value our expertise" says Christian Nielsen, Project Manager at Beritech. The shrimp cooker features electric heating elements and an electric actuator, making it among the innovative solutions shaping the future of the fishing industry. This marks the fourth sale of this model in 2025.

This year's show was the 29th edition of DanFish International, and both exhibitors and visitors can already save the date for 12–14 October 2027, when Aalborg will once again transform into the global hub of the fishing industry.

The difficulty of recruiting young talent for German aquaculture

The German aquaculture sector struggles to attract young people with the interest and training to become fish farmers. Ways to counter this exist, but they demand a concerted long-term approach.

Like many other European countries, discussions about a shortage of skilled labour have become a staple of German politics. Certain professions affected by this are often highlighted, with their societal importance named as a key reason why this decline in skilled workers is threatening existing

The challenge of generational renewal in German aquaculture is not insurmountable but calls for changes in the funding and administration of the sector.

industries and ways of living. One profession rarely mentioned or discussed publicly, its slow decline thus invisible, is the traditional fish farmer. With one of the lowest per capita employment levels in the sector across the EU, Germany is already characterised by a smallscale and fragmented aquaculture sector. A generational change is approaching, and concerns are mounting that generations of smallscale producers will retire without anyone to take over their businesses.

The German education system

Germany has an educational system producing internationally renowned and qualified personnel. It offers both vocational training and avenues in higher education. The vocational training to become a fish farmer is a dual system of practice and theory covering the upkeep and management of aquaculture facilities, as well as the proper handling and understanding of aquatic organisms and ecosystems. While this comprehensive approach to producing allround personnel is functional, it leaves limited room for specialisation and makes it harder to incorporate new innovations and technologies emerging in the industry. Nevertheless, the job profile increasingly demands an ever-broader knowledge of control and regulation technology, process engineering, digitisation, marketing and communication, and other relevant fields. Choosing this training still offers a nearguarantee of employment after successful completion, with new graduates often going abroad. Yet the numbers have been declining steadily in recent years: between 2013 and 2023, the number of people in vocational training to become a fish farmer decreased by around 40%, and between 2020 and 2023 alone there was a further decline of about 29%.

Higher education paints a similar picture, defined not only by a decline in student numbers, but also by a reduction in the number of programmes on offer. While programmes specifically for aquaculture were scarce in general, the number dropped from three master's programmes in 2020 to only one in 2025. There are several undergraduate programmes offering modules in aquaculture, or degrees in fisheries sciences, but with no direct pipeline into the aquaculture sector. This is not a problem unique to aquaculture, but one faced by specialised fields in general. Dr Adrian BischoffLang, a researcher at the University of Rostock (home to the only remaining master's degree in aquaculture), explains this as competition to attract as many students as possible to programmes. Universities must ask themselves whether "they really want to offer specialised programmes which attract only a small number of students when attracting as many students as possible is the financially responsible direction". A decrease in enrolment certainly does not help the university's graduate programme in aquaculture, which has averaged around 55% fewer students per year in 2020-2025 than in 2012-2019.

It is, however, not just for lack of educational avenues that young professionals are missing in the aquaculture sector. With the number of companies in the sector at an all-time low—around 1,950 companies in 2024 down from 2,262 in 2020—the underlying trends seem only to intensify. Despite this development, the number of employees in the sector was relatively stable between 2015 and 2023, with around 2,100 employees on average over the nine years. This can be explained by the stratification of the German aquaculture sector into higher and lower volume farms. Although they made up just 21% of all aquaculture companies in 2023, producers with output of over 5,000 kg of fish per year accounted for 91% of farmed fish. Meanwhile, the number of people working in the sector without being officially employed is assumed to be around 3,000, consisting mainly of family members and operations managers. While larger aquaculture companies depend less on this informal workforce, most small-scale farms do and are thus especially exposed to an ageing demographic while lacking young professionals. The industry is stable enough to facilitate continued production but lacks the necessary influx of young and eager professionals to allow meaningful growth and innovation.

Waiting for change

Policymakers are aware of these issues. At the EU level, aquaculture has long been recognised as lagging behind global growth, with Germany particularly affected. The reformed Common Fisheries Policy (CFP) explicitly integrates aquaculture and, together with the European Commission's Strategic Guidelines, sets the orientation for

European aquaculture. Under Article 34 of the CFP, Member States must adopt National Strategic Plans for Aquaculture; Germany's National Strategy Plan Aquaculture (NASTAQ 2021–2030) is the national response. Yet earlier European Parliament initiatives to promote aquaculture saw limited implementation in Germany. Stakeholders cited in NASTAQ 2021–2030 similarly criticise that NASTAQ 2014 already identified core problems in detail and proposed potent solutions, yet the necessary measures were not implemented. In essence, many of the challenges the industry faces must either be addressed holistically, or risk being addressed inadequately.

A multitude of factors influences the weak standing of the profession. Generally, aquaculture does not enjoy the best image with German consumers, which is compounded by limited lobbying by the industry. There is consequently a lack of awareness, both politically and socially, of the challenges faced and the funding and facilitation required by the industry. Given that imports account for 90% of German fish consumption, with salmon, Alaska pollock, and tuna the most popular species, consumers are not innately connected to freshwater aquaculture products. This reflects a broader trend of consumer alienation from the circumstances under which agricultural goods are farmed, harvested, processed, and ultimately offered by wholesalers. This trend is particularly pronounced in the fishery and aquaculture sectors. Another challenge is the poor economic sustainability of many farms, increasing the risks connected with business succession. With high labour and production costs, substantial bureaucracy, and the need for expensive investments in many cases, the threshold to take over or establish a new aquaculture business is often extremely high. Although educational opportunities often lead to successful employment, salaries tend to be at the lower end, especially compared to the physical and temporal intensity of the work. With all this in mind, what are possible measures to address the challenges presented?

Measures to attract and retain talent

Dr BischoffLang emphasises the importance of raising awareness about the context of agricultural and aquaculture production. This includes educating children about the ingredients in fish sticks and chicken nuggets but also improving the image of primary producers and showcasing what constitutes the everyday working life of a (fish) farmer. This goes hand in hand with efforts to promote an image of aquaculture that highlights its social, ecological, and economic importance. Avenues such as communityled local development funding, which brings together relevant local actors, organisations, and citizens, can facilitate interaction and reciprocal understanding, and ultimately raise awareness for the industry. In addition to information campaigns and advertising, these Fisheries Local Action Groups (FLAGs) are effective ways of integrating aquaculture stakeholders into local development processes and regional value chains.

Financial incentives and grants are equally important, both to attract young professionals and to support companies in making investments or scaling their business models. A positive example is the state of Schleswig-Holstein, which in 2025 established a new subsidy for the vocational training programme in fish farming, providing a total of €15,000 in funding for the three-year training programme. The fact that this programme is co-funded by the European Maritime, Fisheries and Aquaculture Fund (EMFAF) showcases that there are financial tools waiting to be utilised. At the same time, no amount of funding can fully compensate for overwhelming bureaucratic demands on aquaculture companies. Due to the federal structure of German aquaculture and fishery regulations, comprehensive change is often halted before it can even be conceived. So, while NASTAQ 2021–2030 seeks to address many challenges by offering solutions like the ones mentioned above, the overarching structural issues must likewise be addressed. If Germany couples focused funding with lighter bureaucracy and stronger outreach, the next generation of fish farmers will have both the reason and the means to take the helm.

Justus M. Dohmen, justus@eurofish.dk

New aquaculture master's

The Institute of Aquaculture and Environmental Safety at the Hungarian University of Agriculture and Life Sciences (MATE) has introduced an innovative master's programme in aquaculture.

Starting in September 2025 a new cutting-edge programme in aquaculture will leverage Hungary's unique geographical advantages, with a specialised focus on freshwater aquaculture. Hungary's well-established tradition in Central European cyprinid pond aquaculture is combined with more intensive farming techniques, including the use of Hungary's rich geothermal water resources for culturing African catfish. This characteristic blend of traditional and modern methods offers students an exceptional practical and theoretical foundation in freshwater fish farming. The master's programme spans three semesters and takes place primarily at MATE's main campus in Gödöllő, Hungary. The curriculum integrates expertise across several scientific disciplines offered by the host institute, such as reproductive physiology, fish nutrition, genetics, environmental science, and toxicology. Additionally, it covers mechanisation procedures pertinent to fish farming and processing, project management, and marketing skills relevant to the aquaculture industry. The training is designed to be hands-on and highly practice-oriented; students gain competence in fish handling, feeding trials, hatchery operations, and scientific laboratory techniques, equipping them with the skills necessary for fieldwork and research.

Practical experience on fish farms an important component

A salient aspect of the programme is its emphasis on real-world exposure. Students regularly participate in field excursions to fish farms and aquaculture-related facilities across Hungary, enabling them to observe and understand diverse aquaculture operations. The Research Center of Fisheries and Aquaculture (HAKI), a collaborative research facility affiliated with the institute, provides ideal conditions for students to gain practical experience with species such as pikeperch and sturgeon—two important freshwater fish species. This direct immersion in farming practices and research translates the theoretical knowledge into applied skills. In its inaugural year, the programme attracted significant interest worldwide. Twelve students, chosen from over 500 applicants, were granted scholarships funded through a partnership between the Food and Agriculture Organization (FAO) and the Hungarian Ministry of Agriculture. This internationally diverse cohort includes individuals from various countries across Asia, Africa, and Europe, such as the Philippines, Bangladesh, Kazakhstan, Georgia, Egypt, Madagascar, Ghana, Kenya, Nigeria, Angola, Uganda, and Algeria. This diversity enriches the learning environment, fostering cross-cultural exchange and broader perspectives on aquaculture challenges and solutions.

Looking ahead, the programme aims to expand its accessibility by leveraging the Stipendium Hungaricum scholarship programme, sponsored by the Government of Hungary. This initiative will potentially enable more international students to benefit from the high-quality education and research opportunities offered by MATE in aquaculture. The programme is taught in English, making it accessible to a global student base. Candidates seeking admission typically hold a bachelor's degree (B.Sc.) or an equivalent qualification in a related scientific field. Credit transfers from previous studies are evaluated for relevancy and equivalency to ensure academic standards. Graduates of the master's programme will find diverse career opportunities including in fish farming enterprises, research institutions, environmental consultancy firms, fisheries management bodies, aquatic product processing industries, and governmental or regulatory agencies focused on agricultural and fisheries development.

To learn more about this programme, please visit https://aquaculture.unimate.hu/master-msc-studies.

Vice-Minister aims for productive and efficient fisheries and aquaculture

Arūnas Jagminas serves as Vice-Minister in the Lithuanian Ministry of Agriculture. He previously served as a member of the Municipal Council of Šilutė, an area close to the Curonian lagoon. As Vice-Minister, he has a vast portfolio of which the development of Lithuanian fisheries and aquaculture is a part. This includes achieving the objectives spelt out in Lithuania's programme for the European Maritime, Fisheries and Aquaculture Fund.

Arūnas Jagminas, Vice-Minister, Lithuanian Ministry of Agriculture

*As a newly appointed member of management in the ministry what are your top three **strategic priorities** for Lithuania's fisheries and aquaculture, and how will you measure success against them?*

The top priorities include sustainable fish resource management, a viable and efficient fishing fleet, economic resilience of coastal communities, and growth of aquaculture production. Success will be measured by well-managed fish stocks, stable sectoral income and employment, and expanding aquaculture output, supported through targeted EMFAF investments in innovation, sustainability, and competitiveness.

*How is the fisheries administration responding to the decline in most of Lithuania's 2025 **Baltic Sea TACs** compared with 2024? What support measures are being implemented for affected fishers, processors, and coastal communities?*

The declining trend in Baltic Sea fishing opportunities has continued for the past five years, creating serious challenges for Lithuania's fishing sector. To

assess the impacts, Klaipėda University carried out a socio-economic survey, which confirmed that further quota reductions would leave the sector with almost no room to operate. The 2025 quota levels represented a critical threshold. However, following intense negotiations with the EU Baltic Sea member states and the European Commission, a political agreement was reached on the 2026 fishing opportunities, bringing significant improvements—the sprat quota increased by 45% and the central Baltic herring quota by 15%. As this was my first year serving as Vice-Minister, I personally witnessed how complex and demanding these processes are, balancing scientific advice, political priorities, and the livelihood of our fishing communities. I firmly believe that this increase in key fishing opportunities for Lithuania will provide much-needed relief for our Baltic Sea fishing sector, offering a more optimistic outlook.

Adding greater value *to the catch as well as* ***diversifying income sources*** *are among the ways of securing livelihoods in coastal communities that depend on fisheries. How are these developments being encouraged? What investments, trade initiatives, or product-innovation programmes do you foresee to strengthen Lithuania's seafood value chain, including for aquaculture species?*

The EMFAF supports initiatives that promote fish processing, marketing, and short supply chains, helping fishers and aquaculture producers gain more from their products. FLAGs are key implementers, fostering innovation, diversification, and stronger community cooperation. Through FLAGs, investments have been directed towards improving infrastructure and competitiveness—for example, the ongoing development of Šventoji port, which is vital for supporting small-scale fisheries and strengthening Lithuania's maritime identity. This important project has also been highlighted in a dedicated article in your journal.

As only small-scale fish processing falls under the EMFAF and the responsibility of the Ministry of Agriculture, our investments are focused on modernising facilities, improving product quality, and supporting innovation in local value-added products, including those from aquaculture. EMFAF support helps processors adopt new technologies, better hygiene standards, and environmentally friendly practices. Larger processing and trade initiatives fall under the Ministry of Economy and Innovation, with whom we cooperate to strengthen export potential.

Generational renewal *in the fishing sector is an issue in many EU countries as young people opt for livelihoods other than fishing. What efforts are being made in Lithuania to attract and retain young people in the sector?*

Generational renewal is indeed a challenge in Lithuania's fishing sector, as in many other EU countries. The current EMFAF programme does not include specific measures directly targeting young fishers, though we recognise the need for such support. Hopefully, in the next programming period, this issue will be addressed together with broader initiatives on generational renewal commonly with agriculture sector. Speaking of the marine fishery, if there is no fish in the sea, no incentives would encourage young people to enter the profession. That is why we are focusing so much on fish stock management and prioritising a scientifically based approach.

What initiatives are being taken in Lithuania regarding ***decarbonisation of the fishing fleet*** *and what has been the response from the fishing industry? Which are the technologies (green fuels, electrification) that show the most promise?*

Firstly, Lithuania is using the EMFAF permanent cessation of fishing activities measure to help balance fleet capacity and fishing effort and ensuring a more sustainable sector structure. However, funding for decarbonisation under the EMFAF is very limited due to very restrictive conditions, which holds back broader progress in this area. The EMFAF support for the replacement or modernisation of fishing vessel engines has so far been unpopular among Lithuanian fishers, but we hope that in the new funding period, with improved conditions, it will become more attractive and effective.

Lithuania's EMFAF programme seeks a 20% aquaculture production increase, however, production has been largely stable in the five years to 2024. What are the ***factors hindering the growth*** *of production and how can they be mitigated?*

First of all, the question is not entirely correct—over the past five to seven years, Lithuania has actually seen strong growth in aquaculture production. For example, production increased by around 30% between 2018 and 2022 The more recent stabilisation of production was largely due to external shocks such as the COVID-19 pandemic and Russia's war in Ukraine, which disrupted supply chains, increased feed and energy prices, and slowed new investments. Even so, maintaining stable production levels under such challenging conditions demonstrates the sector's resilience. We continue to work closely with the aquaculture sector and expect further growth in the coming years, supported by EMFAF measures that provide input for modernisation, innovation, and improved competitiveness.

The programme also suggests at least 25% ***renewable energy in aquaculture****. Is this target on track to being met? What incentives are on offer to encourage fish farmers to switch to renewable energy?*

Many aquaculture enterprises have actively taken advantage of the available support to invest in renewable energy solutions — such as solar panels and others. These investments have helped reduce production costs, lower

carbon emissions, and improve the overall sustainability of the sector. As a result, the 25% renewable energy goal in aquaculture is within reach.

Carp remains the main farmed species, with growing roles for African catfish, rainbow trout, sturgeon, and eel. Is the ministry involved in ***promotion campaigns*** *to increase the awareness and consumption of farmed fish? How is the success of such initiatives measured?*

Yes, the Ministry actively participates in promotion campaigns for local, sustainably farmed aquaculture species, not focusing solely on carp but promoting the entire range of Lithuanian farmed fish, including African catfish, rainbow trout, sturgeon, and eel. These include articles in local magazines and short films introducing Lithuanian fish farmers and their products. We also have a programme running for more than five years, called "Farmed in the EU" (*Išauginta ES*), where schoolchildren visit aquaculture farms to learn about fish species and sustainable production. In addition, Lithuania contributes to a broader EU communication campaign, highlighted in the last annual speech by Commissioner Costas Kadis as one of the EU's most successful promotional initiatives. These actions have produced tangible results — fish consumption in Lithuania has been growing steadily, increasing by around 15% over the past few years, which is one of the key indicators of success.

Electronic monitoring and better data utilisation *are frequently cited as among the ways towards more sustainable fisheries. Will Lithuania expand REM (onboard cameras), and traceability tools across fishing segments, and how can fishers be incentivised to participate in such programmes?*

We are among the first EU countries to transpose the new EU Fisheries Control Regulation into national law—by amending the Law on Fisheries of the Republic of Lithuania and the Code of Administrative Offences. When I took office as Vice-Minister, I became actively involved in the negotiation process of these legislative documents, so it is very positive that we managed to finalise and adopt them in such a short time. These amendments were signed by the President in June. The main amendments introduced stricter control provisions, updated definitions of infringements, introduced certain simplifications for fishing operators, and revised penalties and liability rules to ensure full compliance with EU control standards. Lithuania actively promotes the use of electronic monitoring and digital tools in fisheries.

We have also made notable progress in digitalisation, including the mobile app "e-Laimikis" for recreational fishers and pilot REM projects with Baltic fishing companies, meaning that many of these initiatives are already being implemented well before they become obligatory.

VMU's Aquaculture Centre equips students with potent fish farming skills

Founded in 2015 within the Vytautas Magnus University (VMU) Agriculture Academy, the Aquaculture Centre is a facility for applied aquaculture research and advanced training.

From the outset, VMU's Aquaculture Centre has combined a strong laboratory infrastructure with industry projects, positioning itself as a bridge between science, skills, and the needs of a fast-evolving sector, says Alvydas Žibas, the head of the centre. Its facilities include a complex of closed recirculating aquaculture systems (RAS) for fish breeding and grow-out, analytical equipment, and pilot plants that enable trials across a spectrum of technologies, species, and production intensities. This infrastructure underpins both research and hands-on teaching for university programmes in fisheries, aquaculture

Alvydas Žibas, head of the Aquaculture Centre, Vytautas Magnus University

technology, and allied water engineering disciplines.

The centre's remit covers a wide range of research themes, many of them at the cutting edge of Europe's transition to a circular, low-carbon bioeconomy. Important lines of work include innovative technological solutions in aquaculture; RAS design and components; productivity gains in pond aquaculture; feed trials; biofloc systems; wastewater treatment and sludge valorisation; and biotechnology for fish and microbial systems. These efforts are supported by projects with farms and technology partners to create a mechanism for testing and improving laboratory work by implementation in the field.

From laboratory to regulation and market

According to Mr Žibas, a defining feature of the centre is its habit of turning research into concrete outputs for the sector—normative guidance, feasibility studies, and deployable technologies. In 2023, after carrying out the research staff prepared a report with recommendations for the development of technological norms for fish farming in aquaculture ponds and closed systems. On the strength of this work, Lithuania's Minister of Agriculture approved Technological Norms for fish farming in both ponds and closed systems. For farms and regulators alike, these norms establish practical, legal reference points for the main parameters for various fish growth stages for different species of farmed fish.

Alongside influencing policy, the centre routinely undertakes assignments that provide useful information for the commercial aquaculture sector. Examples include a 2018 feasibility study that helped secure a permit for industrial whiteleg shrimp (*Litopenaeus vannamei*) production in RAS, a technology assessment for wastewater decontamination at a catfish farm, and evaluations of membrane filtration in RAS. These studies demonstrate a practical approach to problem-solving—from licensing support to process optimisation—often in areas where European operators are still building capacity (warm-water shrimp, for instance). The centre also acts as an incubator for new production models. Working with a university spin-off, UAB Aquaculture co-owned by Mantas Brazauskas, a PhD student, it is advancing a multi-year R&D effort to develop biofloc-based technology for African catfish (*Clarias gariepinus*)—elevating a prototype system from Technology Readiness Level TRL-6 to TRL-8. By targeting TRL-8, the team is explicitly engineering for near-market deployment, not just proof of concept.

Education that aligns with climate and digital transitions

The centre's research is tightly coupled with VMU's study programmes, ensuring that graduates leave with both theoretical knowledge and practical proficiency. Last year it renewed a bachelor's programme in water engineering (in Lithuanian) that includes aquaculture-related subjects (e.g. aquaculture biotechnology). It supports laboratory work, field projects, and dissertation research across programmes, including the Aquamatics double-diploma Master's. This programme blends natural and engineering sciences to train environmental engineers who can model hydrological processes, monitor water quality, and design climate-resilient solutions across the water economy, including fisheries and aquaculture. The curriculum—taught in English and offered in cooperation with partners—covers digital modelling, wastewater technologies, aquatic biology, and Innovative Technological Solutions in Aquaculture, among other modules.

Mr Žibas highlights that the Aquamatics programme confers a Master of Science in Engineering, with clearly defined ECTS content across hydrology, GIS, climate crisis management, fisheries and aquaculture, and thesis work. In parallel, it seeks to address skills shortages, strengthen applied research links, and meet climate and digitisation imperatives in water sectors across Lithuania and the EU.

DiBluCa, distance learning designed by a network of European universities

At the heart of the centre's recent international engagement is DiBluCa – The Digital Blue Carrier for a Post-Carbon Future, an Erasmus+ project led by VMU. DiBluCa's aim is to strengthen higher education in aquaculture and fisheries by modernising curricula to reflect the benefits of increasing digitalisation as well as the threats from climate change. The programme emphasises robust e-learning, remote assessment, and cross-border knowledge sharing. DiBluCa is structured in four stages—design, localisation, and curriculum and learning materials modification—with outputs that include a comprehensive handbook (in English), an interactive e-book available in English and all partner languages, video files, and a user-friendly e-learning platform for self-paced learning and best-practice dissemination. The project anticipates transnational workshops, an international conference, and multiplier events providing students with opportunities to build networks across research and industry communities. VMU leads a partnership spanning Turkey (Balıkesir University), Ukraine (Odesa National Technical University, ONUT), Greece (University of Thessaly), and Croatia (University of Dubrovnik), ensuring geographic and aquaculture-system diversity.

Mr Žibas describes the DiBluCa learning environment as open, attractive to younger audiences, and multilingual, with digital books, slide decks, best-practice videos, case studies from different regions, and a pathway to certification under exploration. The material is intended for master's students, working professionals, and public-sector staff. Some five hundred learners have registered from the countries of the participating universities

One of the recirculation aquaculture systems at the Aquaculture Centre

furthering DiBluCa's goal of upskilling technical staff and expanding career opportunities across the blue economy. In practice, DiBluCa also complements the Aquamatics master's. Where Aquamatics trains environmental engineers with strong digital and analytical skills, DiBluCa supplies modular learning for students wishing to focus on fisheries or aquaculture. Combining the two programmes equips students with skills that are useful in several work contexts.

Among the centre's work is the development of biofloc approaches for warm-water species, with a current focus on African catfish. Using knowhow from earlier shrimp (*L. vannamei*) biofloc trials Mantas Brazauskas and Mr Žibas designed freshwater systems that minimise water exchange, cut pumping energy, and convert dissolved nitrogen into microbial biomass that becomes supplementary feed. In the lab and in partnership with farms, the centre is testing variants ranging from pure biofloc to semi-biofloc configurations, supplied with sensors and moving toward IoT-enabled control.

Outreach and pipeline development

A sustainable aquaculture sector needs a pipeline of talent. The centre actively engages schools—around 500 pupils annually—through laboratory visits that explain systems and species, and promote Lithuanian farmed fish as a healthy, modern food. This engagement was part of the EU's Farmed in the EU programme that was implemented by the Ministry of Agriculture through its Agriculture Agency. The centre also advises prospective investors and collaborates with national and international partners to broaden Lithuania's participation in European research consortia. Across Europe, aquaculture enrolments are under pressure, yet industry demand—especially for digital and RAS skills—continues to rise. As the centre continues to develop sustainable water-use innovations suitable for Lithuanian conditions and beyond, it is making tangible contributions to sector competitiveness, environmental performance, and workforce renewal. In short, it is exactly the kind of applied, outward-facing institution Europe needs to succeed in its blue and green transitions.

Biofloc systems to produce African catfish

At Mantas Brazauskas' African catfish farm near Kaunas, biofloc technology is being deployed at industrial scale. In essence, biofloc converts a RAS challenge—accumulating nitrogenous wastes—into a resource by cultivating dense communities of heterotrophic bacteria and micro-organisms. These microbial flocs assimilate ammonia and nitrite in the presence of a carbon source, forming suspended aggregates that both stabilise water quality and provide supplementary nutrition for the fish. In practice, Mr Brazauskas says, this means fewer large pumps and filters, far less lifting of water, and the possibility of near-zero water exchange for months, all of which reduce operating costs and water footprints when the system is stable. The production results are impressive. Mr Brazauskas can grow the fish at a density of 500 kg/m^3 and can reach an FCR of ~0.85 (i.e. producing one kilo of fish flesh from 0.85 kilo of feed), implying that a portion of growth comes from the bacteria. The farm's experience suggests that, with the right process control, *Clarias gariepinus* can thrive in floc-rich water. Stabilisation is the challenge; keeping the microbes in balance demands frequent sensing, careful C:N management, and trained staff who can interpret trends and intervene early. The team is moving toward IoT-enabled monitoring and exploring AI-assisted decision rules, but, as Mr Brazauskas emphasises, full automation requires in-built redundancy, trustworthy sensors, and robust fallback procedures to avoid cascading failures from bad data. Commercialisation has started modestly at 2–3 tonnes per month with product currently channelled to smokers for better prices—while a processing line is being considered to capture more value.

Mantas Brazauskas has his work cut out as he prepares for his PhD while simultaneously running a farm producing African catfish.

The Marine Research Institute collects data for the EU Data Collection Framework

The European Union's Data Collection Framework (DCF) is the daily work of counting fish, sampling fish from nets and trawls, conducting scientific surveys and speaking to fishers and anglers to collect the data that forms the basis of fisheries policy decisions in the EU.

In a period when Baltic cod stocks have collapsed and commercial fishing for salmon faces sweeping restrictions, data about stocks have a massive influence on commercial fishers' livelihoods as well as on the recreational activities of anglers. The legal foundation of the DCF is Council Regulation (EC) No 199/2008 and Regulation (EU) 2017/1004 which aligned data collection with the Common Fisheries Policy reform and introduced Regional Coordination Groups (RCGs). The latter regulation also recognises that recreational fisheries must be measured when they affect stocks, which is crucial in the Baltic.

In Lithuania the Marine Research Institute at Klaipėda University is a key part of this system. Antanas Kontautas and colleagues conduct scientific surveys, undertake biological sampling for the commercial fleet, cooperate with fishers on coastal monitoring, and support trials that reduce impacts on birds and other protected fauna. The team works with gillnetters and trap-net users in the in the Baltic Sea and Curonian lagoon coastal areas, gathering catch data, lengths, and other biological information that feed directly into international assessments. Mr Kontautas underlines the importance of this collaboration and notes how fishermen have hosted gear trials and helped deploy monitoring equipment. This practical cooperation is the only way to maintain sampling effort even when fleets shrink or restrictions enter into force.

How standardised sampling guides decisions for the commercial fleet

Lithuania exemplifies the benefits of the DCF. Cod offers a good example. Targeted fishing has been halted for years, yet the expected recovery has not materialised. During both coastal and offshore monitoring, many small cod are caught: around 24–28 cm in the sea by trawls and 30–33 cm in the coastal area by monitoring nets. Very few larger cod are found, and they are in very poor condition. The mismatch underscores the influence of multifaceted pressures—environmental, ecological, and climatic—that reach far beyond the effects of fishing mortality alone, and only science can provide the answers. DCF sampling documents poor condition in many fish and recurring reports of prey scarcity for adult cod have been issued. Without standardised length and condition data taken year after year, it would be impossible to tell whether small inshore pulses are real recruitment signals or short-lived blips.

Antanas Kontautas, Head of the Fisheries Data Collection Programme implemented by the Marine Research Institute of Klaipėda University

Nutrient inputs add another layer. Mr Kontautas points to nitrogen and phosphorus from agriculture and municipal sources as persistent drivers of eutrophication. These pressures shape plankton dynamics and the availability of prey for juvenile fish, with knock-on effects up the food web. The DCF cannot fix water quality on its own, yet it

provides the biological and fishery indicators that show whether nutrient management is improving outcomes in the sea. When smelt in the Curonian Lagoon crashed in a recent spring, the programme's time series helped distinguish a cyclical trough from a structural fall. The following year the stock rebounded, a pattern that would have been easy to misread without consistent data.

Pelagic species offer another example. Sprat has seen better recent catches and a more stable stock status than many demersal species, while herring has shown weakness in parts of the Baltic. Acoustic surveys at sea and port sampling on land turn landings into the length and age structures that inform advice. Under the DCF these large-scale surveys are set out in an EU multiannual programme that lists mandatory campaigns and thresholds. This common survey calendar ensures that Lithuanian sampling integrates with neighbouring efforts, so indices are comparable from the Gulf of Bothnia to the Arkona Basin.

Lithuania's coastal fishery has become more limited. In the open sea, bottom trawling has mostly ceased, but small pelagic trawlers continue operating, primarily for fishmeal production. Socioeconomic data collected under the national work plans, together with the additional survey *"Eco-Social Effects of the Fishery of the Baltic Sea"* conducted by Klaipėda University this year and presented at Baltfish to the EU Baltic Member States and during the meeting between Lithuanian fishers and Charlina Vitcheva, Director, DG MARE, in September in Klaipėda, provide a crucial evidence base for understanding income dynamics, assessing operational costs, and evaluating the real situation of the Baltic Sea fishery in Lithuania. This report would not have been possible without many years of consistent data collection efforts. Reliable DCF effort data ensure fair compensation, distinguish active fishers from inactive licence holders, and support equitable allocation of future fishing opportunities.

Recreational angling counted fairly for shared Baltic stocks

Recreational anglers in Lithuania number many tens of thousands, with estimates that rise into the hundreds of thousands when occasional participants are included. The DCF recognises the impact of anglers by requiring data on recreational catches and effort when a stock could be affected. Lithuania has set out methods for sampling this sector, including targeted data collection for cod, eel, and salmon in the Baltic Sea, inland waters, and the Curonian Lagoon. The national guidance also explains that recreational boats under six metres must be registered.

Regarding salmon, Lithuania permits anglers to retain a single finclipped salmon per fishing day, while requiring release of wild fish. That rule only makes sense if hatchery releases are marked, if surveys can detect marked fish in the catch, and if independent data can separate river returns from sea catches. Estonia's decision to stop sea trout stocking and the subsequent rise in wild returns, described by Mr Kontautas, illustrates how data can shift policy. When the evidence showed natural reproduction responding, emphasis shifted to seatrout habitats and passages rather than continued releases.

Klaipėda University hosts ICES annual conference

The International Council for the Exploration of the Sea (ICES) Annual Science Conference, held from 15 to 18 September 2025 at Klaipėda University in Lithuania, proved to be a compelling gathering of marine scientists, policymakers and early-career researchers. Hosted by Klaipėda University in partnership with the Lithuanian government, the event brought together 571 participants, of whom 497 attended in person at the university campus and 74 joined online via the conference app.

The scientific agenda of the conference covered critical topics facing marine ecosystems today: ecosystem science, human impacts, emerging technologies, and conservation of marine resources. Among the 325 oral presentations and 166 posters, alongside three keynote speeches and multiple networking sessions, the conference succeeded in combining high-level science with regional relevance. Klaipėda University played a crucial role in bridging Baltic-specific issues—such as eutrophication, coastal fisheries and the blue economy—with broader global marine science themes.

The conference delivered a well-balanced mix of technical depth, networking opportunity and regional impact. By placing Klaipėda University at the core of the event, ICES reinforced the value of local leadership within international marine science. For participants interested in Baltic sea-basin dynamics and the integration of national institutes into global forums, the conference achieved a meaningful and productive outcome.

From ports to rivers the framework builds trust and resilience

The DCF ensures that data from across the Baltic is comparable. Thus, a length distribution for sprat from Klaipėda can confidently be compared with one from Gdańsk. Through regional cooperation under the RCG Baltic, which Lithuania chairs from 2024 to 2027, the framework promotes coordinated data collection and shared understanding. In Lithuania, the DCF portal operates as an integrated data management system, providing real-time access to validated datasets and interactive online dashboards that visualise all data collected under the DCF. The DCF is essential for both commercial fishers and recreational anglers, as it provides the harmonised data foundation on which fisheries policies across countries are built. By ensuring consistent and reliable information, it strengthens the prospects for the recovery of cod and salmon stocks and supports long-term planning and sustainability within the Baltic sea fisheries sector. As a strategic measure under the EMFAF in Lithuania, the DCF demonstrates a broad scope and significant impact—extending well beyond its formal mandate to actively foster scientific cooperation through regional coordination, to contribute to policy development, and to strengthen international engagement, including organising and participation in events such as the ICES Annual Science Conference.

Lithuania's coastal fishery at a crossroads—and the local forces shaping its future

Lithuania's 95 km coastline has long hosted a coastal fishery. Today, however, the activity is at a tipping point as quotas of important species have been drastically reduced while the lack of generational change suggests a bleak future. However, local initiatives are fighting the trend.

Among coastal fishers catches of traditional mainstays—cod and salmon—have been cut sharply or prohibited, fishermen are ageing, and younger people seldom see a viable livelihood at sea. Against this sobering backdrop, two initiatives stand out: the work of the Klaipėda Fisheries Local Action Group (FLAG) which operates in Klaipėda town, and the step-by-step reconstruction of Šventoji port under the Šventoji FLAG which is active in the areas of Šventoji and Palanga. Together, they illustrate how local leadership, and targeted public funding (from both EMFF and national sources in the case of the port) can develop infrastructure leading to the creation of new economic opportunities and thus preserve coastal communities.

A fishery squeezed from all sides

The last decade has been unforgiving in the Baltic. Lithuanian coastal fishers who once landed cod and salmon now face blanket closures or near-total constraints for these species,

Andrius Kairys, Chairman, Klaipeda FLAG

Mindaugas Skritulskas, Managing Director, Šventoji port

Vygintas Lekavičius, Seaport Services Administrator, Šventoji port

while the small-scale fleet contends with short, weather-limited seasons and rising running costs. As Andrius Kairys, head of the Klaipėda FLAG, explains, crews are older, maintenance and safety inspections are costly, and margins on available species are tight (sprat and herring often go to fishmeal rather than for human consumption). Regulatory complexity adds to the pressure. In mixed pelagic trawls, sprat and herring are hard to separate; regulations that shut off one species can de facto shut the fishery, yet compensation mechanisms may not recognise that operational reality. Meanwhile, proposals periodically emerge for wider moratoria driven by environmental concerns. With only a handful of industrially important stocks left for the Lithuanian fleet (sprat, herring, and some flatfish), any additional limits on fishing reverberates across the entire value chain.

EU decisions for the Baltic have tightened opportunities for depleted stocks year after year, and the Council's late-October 2025 agreement on total allowable catches (TACs) for 2026 again places catch limits across herring, sprat, cod, salmon, and plaice to balance stock recovery with livelihoods. The headline remains unchanged: continued restraint on cod and salmon, cautious settings elsewhere with a few exceptions (herring in the Central Baltic).

Coastal fishing sees fewer boats, fewer entrants

Inshore fishing in Lithuania is shrinking. Veteran fishers—often 50–55 years old or more—are reluctant to take on new debt or business models with payback stretching beyond a decade, while younger people see long hours, physical hardship, and uncertain earnings. Producer organisations exist, but with small volumes and irregular landings their ability to finance marketing or processing at scale is limited. The result is attrition with fewer active boats each year and the loss of skills and heritage. Opportunities to sell directly can be constrained too. Where hygiene rules prevent sales straight from the boat, a fisherman who lands only once or twice a week must still carry overheads for a stall, electricity, and rent. That model is hard to make work when cod and salmon are off the table and small pelagics are intermittent. Even well-meant plans for onshore refrigeration and kiosks struggle if volumes fluctuate.

One bright spot, though a volatile one, has been round goby. An invasive species that expanded rapidly about a decade ago, it is not managed and catches have provided some income to coastal fishers—yet landings have been trending downwards since their peak in 2016. Herring, sprat, and plaice are the other species that are targeted by coastal fishers.

What a FLAG can do when the fleet is wary

An outcome of the EU's community-led local development model, FLAGs bring together fishers, municipalities, NGOs, and businesses to design and fund projects tailored to local needs. In Klaipėda, the "*Naujoji Klaipėdos žuvininkystės vietos veiklos grupė*" (NKŽVVG) covers the city municipality and is working on a strategy that targets small but catalytic interventions such as public infrastructure for commercial and recreational fishing and tourism; diversification of fishers' income; and climate-aware, innovation-friendly investments. These priorities accurately reflect the fishers' concerns. Mr Kairys says ideas range from a municipally built slipway (to replace unsafe tractor launches across the beach) to micro-investments that help individual fishers buy a fridge van or kit for direct sales, or even a small recreational vessel for angling when fishing

stops. The financing intensity can reach 50–75% depending on the measure and whether the project is deemed innovative—though in practice true "innovation" is difficult in such a narrow, regulated segment. Yet getting projects off the ground is hard. Early calls saw few applications as some fishers plan to retire, while others are uneasy about co-financing. Municipalities hesitate without designs, permits, and precise costings in hand. The FLAG has responded by repeating calls, re-engaging the mayor's office about the slipway, and broadening outreach to find motivated applicants. The structure is in place—18 or so members spanning fishers, NGOs, and public bodies—but mobilising applications remains a challenge.

One project that is set to be implemented is in northern Klaipėda's beach zone, where coastal crews currently back tractors across sand to launch small boats an operation that sometimes causes friction with other users of the beach. The project foresees a hard-surface slipway with organised parking that would be safer, cleaner, and faster to use, and could be shared by commercial fishers, recreational anglers, and kite-surfers. The municipality is the applicant (public land, public interest), but the FLAG is positioned to co-finance and organise.

Šventoji FLAG undertakes comprehensive modernisation of Šventoji port

Thirty kilometres up the coast, the Šventoji port has been undergoing a major renovation under Mindaugas Skritulskas, the managing director, with the help of EMFF and national funds. The second stage of reconstruction has resulted in a slipway with a crane, a gear hangar, and offices for the port authorities. The next phase includes two offshore breakwaters/pier arms to stop the relentless littoral drift that chokes the entrance. Designs set out a 650-metre southern structure (with a 17-metre-wide pedestrian deck) and a 450-metre companion, plus eastern, northern, and western quays inside the basin. When complete, the harbour should accommodate roughly 450–500 berths for yachts, workboats, and inshore fishing vessels. A sailing school for young mariners is also planned which will sit alongside search-and-rescue services and the Būtingė oil terminal's auxiliaries. The port will become a mixed-use hub offering a safe refuge for small craft, a base for artisanal fishing, and a magnet for nautical tourism that can sustain cafés, service trades, and accommodation in season.

Fishers return to Šventoji port after placing their nets in the sea.

The facilities will enable fishers to move between commercial trips, angling charters, and direct-to-consumer sales when quotas or weather tighten. In addition, a permanent sailing school, dockside work, and a living waterfront may help to recruit the next cohort of skippers and marine technicians—far more effectively than classroom campaigns alone. Finally, ports attract complementary investment—boatyards, chandlers, haul-out services, hospitality—that multiplies their impact.

Projects do not have to be big to be effective

FLAGs encourage application aimed at delivering low-ticket diversification tools that fishers will actually use. Refrigerated vans, mobile sales permits, and standardised hygiene packs (scales, insulated boxes, traceability labels) are modest investments but with a potentially significant impact on margins. Where the city restricts quayside sales, a designated, serviced market point near the harbour, open on announced "landing days," can make direct sales practical without locking fishers into year-round stall rents.

Another area of interest is to promote generational change via paid apprenticeships tied to the sailing school and port services. Few young people want to freeze on a small boat for uncertain pay. But many will apprentice

in marina tech, composites, electrics, or outboard maintenance—skills that keep coastal economies viable and provide a bridge to skippering later. A FLAG-funded stipend for 12–18-month apprenticeships with port tenants would be money well spent. By publishing simple dashboards (projects approved, euros committed, jobs affected), the FLAG could help persuade hesitant applicants and municipal partners that calls for projects lead to delivery.

A realistic but hopeful outlook

No single measure will restore what cod, salmon, and bigger pelagic quotas once meant to Lithuania's coast. But multiple small, well-aimed steps can stabilise incomes, reduce risk, and keep the door open for renewal. Both Mr Kairys and Mr Skritulskas are aware of the hurdles that stand in the way of rejuvenating fishing communities—regulation, demographics, the economics of small boats and, above all, the lack of fish. They are equally clear that infrastructure for new circumstances, co-funding, and projects that respect the mixed character of a 21st-century waterfront—commercial, recreational, educational, and civic are the way forward. If authorities and communities finish the job at Šventoji and complete Klaipėda's slipway, Lithuania can ensure that its coastal fishery survives not only the current cycle, but also future ones.

Klaipėda University's Fisheries and Aquaculture Laboratory turns waste into value

From stock assessment to recirculation aquaculture system pilots, the Fisheries and Aquaculture Laboratory at Klaipėda University's Marine Research Institute is building practical solutions for the Baltic region and beyond.

Dr Nerijus Nika, Head of the Fisheries and Aquaculture Laboratory, Marine Research Institute, Klaipėda University

The Fisheries and Aquaculture Laboratory sits within Klaipėda University's Marine Research Institute, a research-intensive hub on the Lithuanian coast. The lab's remit spans from classic fisheries science—collecting biological data, assessing fish ages, and supporting stock assessment for national and EU obligations to applied aquaculture—designing, testing, and teaching about recirculation aquaculture systems (RAS) that reduce waste and use water and energy efficiently.

Facilities are tailored to these goals, says Nerijus Nika, the head of the laboratory. A dedicated specimen age-reading room and wet labs allow the team to process Baltic and inland-water samples, while small RAS units and aquaponic set-ups provide an experimental area for students and researchers. Tank arrays house salmonids, sturgeons, and crayfish, among other species, so that husbandry variables can be trialled under controlled conditions. Because teaching is part of day-to-day research, cohorts of 10–16 students get

direct exposure to the tools and methods used—valuable experience for future jobs on farms, in laboratories, and administrations.

From stock assessment to systems thinking

Researchers sample the Baltic Sea each year, recording length, weight, sex, maturation stage, and health indicators, and preparing otoliths, scales, or spines for age determination, Dr Nika explains. These datasets underpin assessments for pelagic species such as sprat and herring, and brackish water stocks and show students how field biology, laboratory analysis, and computation fit together in modern fisheries science. While the monitoring programme contributes to good policy, the aquaculture programme aims to make production itself cleaner and more efficient by using waste from one process as an input in another.

One way is to expand conventional aquaponics by adding a third trophic level—crustaceans—to the usual fish-and-plant pairing. Work package 3 of the Interreg South Baltic project, AquaLoop, is led by Dr Nika. He conducts trials pairing rainbow trout or Siberian sturgeon with narrow-clawed crayfish and leafy greens, the crayfish unit sits where solids accumulate. The crayfish consume the sludge before the water continues to biofilters and plant growing beds. Early cycles showed a roughly 40–50 per cent reduction in sludge mass passing downstream, a material improvement in the system. However, the researchers also observed slower crustacean growth, a hint that sludge alone lacks the nutrients needed for fast gains.

Students and researchers are also testing defined diets against sludge fractions in crayfish-holding boxes quantifying consumption and growth. The question is not simply whether crayfish can eat sludge, says Dr Nika, but if they can do so efficiently, If the results suggest a reduction in waste disposal costs as well as a new product (the crayfish) it is likely to be of interest to fish farmers. A complementary experiment explores the production on waste streams of insect-larvae as a circular feed ingredient for fish or crayfish.

Blending geothermal brines is more cost efficient than buying salt

Another experiment conducted under the Interreg BSR TETRAS project tackles the cost and practicality of inland saline aquaculture. Whiteleg shrimp and certain marine finfish perform best in brackish or full-strength marine conditions, but making artificial seawater inland can be expensive depending on the mineral salts used. Researchers have therefore been testing a more economical approach using highly mineralised geothermal brines from western Lithuania, diluted and balanced to the target salinity. For shrimp, the laboratory typically targets ~16‰ salinity so protein skimmers work efficiently (at lower salinities they are less efficient). Traditional salt mixes can be a significant expense, whereas tailored blends of commodity mineral salts bring this to much more manageable levels per m^3. When compatible geothermal brine is available, for example, as waste from a powerplant, the economics could improve further. Trials with rainbow trout in freshwater, natural Baltic brackish water (~6‰), and brine-derived brackish media showed similar growth across treatments, but blind taste tests suggested better texture and flavour in brackish water-reared fish. Whiteleg shrimp showed good growth and survival performance in geothermal brine-based saltwater and could be a suitable solution for inland marine aquaculture development.

Another project ProRMAS run with Klaipeda Science and Technology Park focuses on sludge from marine RAS. German partners have grown polychaete worms on sludge from shrimp tanks, converting it into alternative protein biomass which was blended into shrimp feed. The project consortium now plans to test this feed, while the Italian partner will test if the wastewater, which is saline, can be used to grow halophytes, salt-tolerant plants, such as salicornia. If successful, the loop would substitute part of the imported marine ingredients in feed with a coproduct grown on site, simultaneously reducing disposal volumes and closing the nutrient cycle.

Skills that industry needs now

A distinctive strength of the Klaipėda lab is how thoroughly teaching is woven into research. Rather than passively observing, students build and run small systems, track water quality through sedimentation, biofiltration, and plant beds, and keep mass balances for nitrogen and solids. They learn how to plan experiments, document routines, and respond when alarms go off. As the team notes, the region faces a shortage of fish-health and aquaculture skills, so courses emphasise health checks, biosecurity, and the safe handling of live animals. By training students to walk into a plant and keep it stable, Klaipėda University is addressing one of the most pressing bottlenecks to growth in European aquaculture: competent, systems-literate staff.

Aquaculture trials show what is economically feasible

The economics of inland marine RAS are often forbidding. Feed often accounts

Basel grown as part of an aquaponics trial involving fish and crayfish, where the crayfish feed on the sludge from the fish tank.

for around half of operating costs; energy is the other major expense; and salts can also be a significant budgetary post. Experimenting with other sources of salinity may result in reduced costs without compromising performance, but in general such systems are usually only viable with high-value species such as whiteleg shrimp. Trials in Lithuania for this species as well as modelling suggest producers would need at least ~€40/kg to be viable, positioning the product as a premium, ultra-fresh alternative to frozen imports that retail at €12–€16/kg. There are markets where live or harvest-to-order shrimp can command really high price, but these are niche channels and require tight logistics. The results from these trials could show enterprises what they need to calculate in terms of costs and market positioning for a viable business plan.

Three features distinguish research at the laboratory. It prioritises interventions that RAS farms can deploy with existing equipment without needing investments in complex new systems. Claims are tested with replicated trials and when early results are positive (e.g., sludge reduction), the next question is always whether the effect survives contact with economics and scale. Moreover, students graduate with hours spent at the laboratory on pumps, filters, and biosecurity protocols giving both them and their future employers a competitive advantage. The Fisheries and Aquaculture Laboratory's work on recirculation systems and circularity answers a need for systems characterised by low impact on the environment and high product quality. Scaling such systems to commercial levels would enable the aquaculture industry, particularly in Europe, to finally fulfil the promise it has shown for years but has yet to realise.

If you can't beat them, eat them

Round goby (*Neogobius melanostomus*), an invasive Ponto-Caspian fish now widespread in the Baltic, presents both ecological risks and a commercial opportunity. The Interreg Baltic Sea Region project RoundGoby (2023–2026) brings together authorities, researchers, and companies to pilot viable fisheries, gear, and products. Lithuania's Kaunas University of Technology (KTU), together with the processing company Baltijos Konservai, leads the development and upscaling of canned, minced, and spreadable round goby foods.

Dr Raimondas Narkevicius is responsible for KTU's participation in an Interreg project on round goby. Right, Ms Lina Davydonienė, an engineer at the KTU Food Institute

Round goby is the archetype of a successful invader: highly adaptable, fast-reproducing, and now present across most Baltic coastal waters. Its expansion has driven ecological concerns and bycatch challenges, but it also represents a potential blue-economy resource if harvesting and processing can be organised responsibly. The project's first major study synthesises global experience—from the native Black Sea and the North American Great Lakes to the Baltic—setting out both risks (e.g., parasites, contaminants) and market opportunities (e.g., minced meat, canned products, pet food). It concluded that the Baltic Sea Region is largely an untapped market where targeted product development and supply chains could unlock ways of profitably converting an invasive species into a resource. The project's mandate includes helping authorities adapt regulation, trialling appropriate fishing gears, and guiding enterprises in producing suitable food and pet products for local markets.

From lab concept to factory line

KTU's Food Institute leads efforts within the project to develop canned, minced round goby products. In this it partners closely with Baltijos Konservai, a processing company in Klaipeda, to move promising recipes from lab autoclaves to industrial canning. One of the constraints is that round goby is very lean (≈1–2% fat), which can make heat-processed products dry, crumbly, and bland unless the formulation compensates for fat loss and texture breakdown. In early trials, KTU established that adding an appropriate vegetable oil (sunflower oil performed best) improved mouthfeel and flavour; versions with ulva seaweed were also prototyped for added healthfulness. When taste panellists liked the flavour but not the texture of whole-piece packs, KTU switched to minced and spreadable formats, where delicate flesh becomes an asset rather than a drawback. These are now being prepared for upscaling at Baltijos Konservai.

KTU's samples were prepared at a pilot-scale in-house canning to iterate quickly and deliver factory-ready processing protocols, while acknowledging that full industrial runs are essential for precise temperature–time controls, filling behaviour, and consistency. This lab-to-plant pathway is a good example of collaboration between scientists and industry to create commercially viable products. Although round goby is edible and widely consumed in its native range, Baltic products must comply with EU food safety regulations. In KTU's work, Lithuanian investigations found no heavy-metal presence that exceed safety thresholds in local goby. Tests included dioxin screening (initially via Polish labs) which showed results within regulatory limits. Dr Narkevicius explains that these were single-trial checks and that expanded, comparative analyses by partners in Latvia and Denmark are part of the project plan.

The project's testing of fishing gears in Sweden and Denmark is designed to build a stable supply for processors such as Baltijos Konservai. Ready-to-eat round goby products are still rare in Baltic retail. One canned product is sold in parts of the region, which is why the analysis broadened to other small white-fish categories for inspiration. In taste trials fried round goby scored highest with consumers while canned whole-piece goby was penalised for fragile texture that breaks into flakes—precisely the problem KTU addressed by moving to minced and spread formats where texture is controlled by binding agents and fats.

Processing constraints—and the opportunity in mince

Round goby presents atypical processing challenges. Manual filleting is troublesome due to small size and strong bones; machine filleting solutions adapted from herring and sprat do not transfer well. Industry consultations with producers of processing equipment show that heading and gutting can be mechanised, but industrial-scale filleting remains problematic, so producing minced meat after heading and gutting is currently the most promising route. This validates KTU's strategy to focus on minced, canned, and spreadable products rather than chasing a fillet market. Round goby availability is seasonal and spatially variable with aggregations in some areas such as the northern part of the Lithuanian coast. Cans with their long shelf life emerge as the logical preservation method to smoothen fluctuations in raw material availability and ensure year-round supply.

KTU has tested freeze-drying, fermenting, and smoking (e.g., sausages). These underscore the fat limitation once more, without added fat, dried or fermented goby can be too hard and dry. While these are not target deliverables for the current pilot, the trials broaden the options available for future, higher-value variants if fat systems compatible with curing can be identified. Parallel efforts in the consortium include pet-snack development, where consumer tests suggest dogs are the primary opportunity, and culinary pilots in Sweden to increase consumer awareness via dishes such as fish fingers and burgers. KTU's food-technology know-how complements these by delivering the long-life formats necessary for retailers and export.

KTU's Food Institute links science, industry, and supermarket shelf

There are several aspects to the RoundGoby project including fishing gears, regulatory guidance, consumer acceptance, and business models. KTU's Food Institute provides the process and product engineering that turns a predatory invasive species into foods that the regional market can stock and consumers can trust. KTU's pilot directly answers the project's central challenge: making it technically feasible and commercially attractive create products for human consumption from a pest. If successful, the Baltic gains a new, climate-smart, circular protein; coastal communities gain a new product line; and the ecosystem gains a modest lever to rebalance food webs—a practical materialisation of the project's motto: *If you can't beat them, eat them*

At the Food Institute, laboratories are accredited to the ISO 17025 standard demonstrating their competence.

Representatives from the Catalonian administration, the Croatian and Italian delegations that visited to see how blue crab was managed in Spain, and from Eurofish.

Blue crab in the Ebro delta evolves from threat to resource

The arrival of the Atlantic blue crab in the Ebro (Ebre) delta has transformed one of Spain's most important coastal wetlands into a testbed for invasive-species governance.

The Atlantic blue crab has moved from curiosity to constant presence along much of the Spanish Mediterranean. It is established in the Albufera of Valencia, the Mar Menor, the Balearic Islands, Santa Pola, El Hondo, and in the Ebro Delta, where it was first detected in 2012. Since then it has spread rapidly across the Ebro delta including the river mouth, two shallow bays (Fangar and Alfacs), lagoons, and the adjacent shelf—areas that also underpin Catalonia's artisanal fisheries and shellfish aquaculture. Among the blue crab's prey are razor clams, cockles, and clams. Faced with ecological pressure and mounting conflicts with traditional fisheries, Catalonia's government and other stakeholders including several research institutions invested in managing the invader. The aim was not eradication, but an attempt to convert a threat into a resource based on science and markets.

Choosing a management pathway

At the outset, the administration weighed two starkly different scenarios. If blue crab were listed as an invasive alien species, commercialisation, possession, transport, and traffic would be banned, forcing reliance on costly, long-running eradication campaigns of doubtful effectiveness. If it remained unlisted locally, a targeted commercial

Margarita Fernández Tejedor, IRTA, is among the researchers working with blue crabs.

fishery could be authorised, creating income for professionals, generating auction-based data on removals, and—critically—exerting sustained pressure on the population. Catalonia chose the latter path, authorising only professional, not recreational, fishing for blue crab. This decision gave fishers another source of income, while giving managers a picture of the state of the stock from catches passing through the fish auctions. According to Margarita Fernández Tejedor from IRTA and colleagues, captures in the Ebro delta peaked in 2020 at close to 500 tonnes falling to under 200 tonnes in 2023. The crabs feed on molluscs, crustaceans, fish, and algae and have a high fertilisation rate, bearing 700,000 to two million eggs. Moreover, egg-earing females appear through much of the year.

A dedicated co-management committee for the blue crab convened fishers and their federations, the Catalan public administration, NGOs (e.g., *Ecologistes en Acció*), the scientific community (ICATMAR and ICM), and aquaculture representatives. Decision-making is on an equal footing and allows rules to tighten or relax as conditions change. The committee's primary mandate was to create a legally robust management plan.

Monitoring programme in line with international recommendations

ICATMAR designed a three-pillar monitoring programme to (1) evaluate the status of the crab, (2) control its population, and (3) underpin a regional fishing programme aligned with General Fisheries Commission for the Mediterranean (GFCM) Recommendation 42/2018/7 on blue crab research. The Ebro delta accounts for almost all of Catalonia's blue crab landings, so studying daily first-sale records from fishers' associations to track volumes, value, and price trends would give a good picture of the state of the resource and the market. Before auctions, teams conducted monthly measurements of sex, carapace size, presence of epibionts, and ovigerous status, and recorded per-boat weights with locations provided by fishers. These data reveal habitat use across deep and shallow bay zones, channels, and adjacent open sea, enabling managers to spot demographic shifts and spawning periods. Complementary, standardised trap surveys run bimonthly at 13 fixed stations spanning river (four stations), bays (four), lagoons (two), open sea (two), and a protected zone (one). In the lab, individuals are sexed and measured; maturity stage and gonad weight are recorded to track changes. Findings include a pronounced autumn migration, with about 95% of females inseminated, and habitat-linked maturation patterns. Importantly, independent and dependent data converge on the same distribution picture, boosting confidence in management measures.

Managing the stock is also about managing prices

Turning a pest into a managed resource depends on viable prices. Since the first sale in La Ràpita in 2016, blue crab catches in Catalonia have exceeded 1,865 tonnes, with first-sale income above €4.54 million and an average auction price of €3.9/kg across the early years. By 2025, cumulative landings reported for the fishery had reached around 2,688 tonnes—roughly ten million crabs—with average first-sale prices approaching €4.8/kg. These figures reveal both the rapid expansion of the fishery and the success of efforts to develop demand. Price management can sustain the removal effort. When first-sale prices collapse, incentives to target crab vanish, undermining control. The committee therefore monitors catching effort to prevent market saturation. At the same time, promoting the crab in gastronomy and new value chains has been encouraged, with the explicit objective of maintaining prices so that fishers have an incentive to keep fishing.

The management plan approved in 2022 formalised the rules: only professional fishers may target blue crab; specific gears and fishing areas are authorised; authorisations are listed openly; and a monitoring programme is mandatory. This approach was designed to mitigate an invasive population. Other statutes specify the fine print (areas, gears, numbers of gears, and the list of authorised fishers) and can be updated quickly to respond to environmental or market changes. Internationally, GFCM Recommendation 42/2018/7 helped align Catalonia's monitoring with a Mediterranean-wide research framework, ensuring that methods and indicators in the Ebro delta contribute to, and benefit from, regional evidence.

Sustained pressure on the stock and an extra income for fishers

Six to seven years after the initial management choices, officials close to the process characterise the decision to authorise a professional fishery—embedded in co-management and backed by monitoring—as the right one. They point to interest and investments from the fishers as indicators that the system is working. However, the autumn migration of inseminated females, the role of the river's saline wedge in structuring abundance, and the crab's capacity to exploit multiple deltaic habitats mean that pressure must be continuous. The Ebro model's strength is precisely this continuity: traps in the river and lagoons, targeted fishing in the bays and adjacent sea, and auctions that convert removals into traceable data and income.

Socio-economically, the managed fishery has offered an alternative income stream that is particularly useful when traditional shellfisheries face pressure from predators and climate change. Yet the committee has had to balance catch effort with market absorption, so that at times when prices dip, communication and product development have been used to maintain catches., and. The committee has also worked to build trust. By publishing the list of authorised fishers, gears, and areas, and requiring monitoring as a condition of access, it has prevented opportunistic, poorly controlled removals. Justifying those controls with a scientific programme has helped their acceptance by fishers.

The Ebro delta's blue crab initiative is an experiment in adaptive co-management involving professional fishers, market signals, and continuous monitoring to convert an ecological threat into an income-generating fishery. As the Mediterranean continues to grapple with blue crab, the Ebro's lessons can surely be adapted to other countries in the region for the benefit of both fishers and the environment.

An association that made a resource of an invasive predator

***Cofradía de Sant Pere* is an association of fishermen with medieval roots based in La Rapita along the Mediterranean coast between Barcelona and Valencia. Today it is managed by José Luis Navarro, and its members target several species including seabass, seabream, eel, flatfish, mullet, and blue crab.**

The *Cofradía de Sant Pere*, a collective organisation of local fishermen, traces its origins to 1114, marking it as one of the oldest institutions of its kind. Throughout the years members of the *cofradía* worked together with the local administration to regulate fishing activities and manage resources. Today, it is still an essential part of local life, with around 280 active members, though the number has seen a decline in recent years due to an aging population and generational shifts in interests. The *cofradía*'s members primarily operate in coastal lagoons, where freshwater from the Ebro river mixes with seawater, creating a nutrient-rich environment for various marine species, including blue crabs.

Blue crabs are both a resource and a threat

One of the most significant changes in recent years has been the rapid spread in local waters of the blue crab (*Callinectes sapidus*), an invasive species feared for its disruption of native ecosystems as well as the impacts on fishing gears. First detected in the Ebro delta in 2012, the blue crab's explosive population growth was a cause for concern, as it outcompeted local species and also preyed on them. According to

From left, Raúl Paulino Pujol, José Luis Navarro, and Vicente Comes of the *Cofradía de Sant Pere*

Mr Navarro, local fishermen were alarmed as the crab aggressively spread, killing off other marine life, destroying their nets and consuming quantities of valuable shellfish. To combat this, the *cofradía*, in collaboration with local authorities, began regulating the crab's fishing, making it a targeted catch rather than a bycatch. This move was essential to reduce its population and ensure that the crab didn't continue to harm the biodiversity of the area. Managing the predator called for a series of steps that culminated in a management plan approved in 2018 that had the support of all the stakeholders. Among the initial steps was a monitoring programme which sought to evaluate the blue crab situation in the Ebro delta and control the population. Researchers from ICATMAR calculate that between 2016 and 2023 catches amounted to 1,865 tonnes which generated an income of EUR4.5m. The average first sale price was EUR3.9/kg. Most of the catches, close to 70%, were in the two bays Fangar and Alfacs with 20% caught in the river Ebro. Sampling stations were established in the bays, river, sea, and lagoons and crabs were caught in traps to capture biological (sex, size, weight, etc.) data. The researchers found that the blue crab was an important resource for the fishers and they emphasise the importance of promoting the blue crab market and maintaining the first sale price to minimise the blue crab population and to preserve the environment. Mr Navarro notes that fishing methods for blue crab have evolved significantly. At the beginning of the invasion, the approach was volume-driven to land as many crabs as possible to alleviate ecological pressure, while initial prices stood at around 1 EUR/kg, and occasionally lower. Today, the average fisherman can capture 50 to 60 kilos of blue crab per day, with a market price of around 4 euros per kilo.

Various fishing gears used to target blue crab

The methods used by the *Cofradía de Sant Pere* reflect a balance between tradition and modernity. The *cofradía* worked with the administration to enable the use of all kinds of gear to catch the crab. A second priority was to ensure that only professional fishers were permitted to catch and sell the crab, says Mr Navarro. If catching and selling the animal was open to all, it would have an impact on the price

Gears used to trap blue crabs dry in the sun before being placed in the lagoon again.

and fishers would lose the incentive to target it. The local police and the fishers themselves patrol the fishing areas to prevent unlicensed fishing. Catching the crab still employ techniques passed down through generations, such as the use of traps called *gangil*, which are designed to capture various species like eels, crabs, and fish. Other kinds of traps are used in the sea. Irrespective of the gear, the crabs are caught live and after being harvested have their claws tied together to prevent them from attacking the fishers or the other crabs, and maintain their good quality for a higher first sale price. A significant feature of the region's fishing practices is the rotation system for certain species, including eels, which are allocated to a few members of the *cofradía* each year via a lottery. This system ensures that fishing is sustainable and that the stocks are not overexploited, maintaining healthy populations for the future. The crabs like the fish and bivalves are sold through an auction if the *cofradía* also manages an auction. Fishers in *cofradías* which do not manage an auction sell their catch either to the closest auction or to a *cofradía* that is associated with an aution, which is the case of the *Cofradía de Sant Pere*.

Fishing does not attract the next generation

Despite its historical significance, the *Cofradía de Sant Pere* faces numerous challenges, particularly when it comes to attracting new generations to join the profession, as it is happening in other areas of the fishing sector. The younger generation, according to Mr Navarro, is less inclined to enter the fishing industry, preferring to pursue careers in other fields like administration. This shift is causing the number of active fishermen to decrease, with many aging members nearing retirement. Furthermore, the community faces environmental challenges, including climate change and pollution, which are increasingly impacting local fishing practices. Rising water temperatures, particularly in the summer months, make conditions less ideal for certain species, while changes in water salinity are also affecting the health of local marine life. The area's proximity to rice fields, which can increase water pollution, further complicates the situation, as it interferes with the delicate balance needed for healthy fish stocks.

The *Cofradía de Sant Pere* faces a balancing act. On one hand, it must preserve its historical practices, ensuring that traditional methods of fishing and resource management are maintained. On the other hand, it must adapt to new environmental challenges such as the rise of invasive species like the blue crab and the impacts of climate change, as well as a shifting labour force that no longer views fishing as a sustainable career. Successfully negotiating these dynamics will take skill, support, and some luck.

Blue crabs are sought after on the Spanish market


Petra Kutlesa

As prices for blue crab have increased, Alain Pinza, a shellfish gatherer, has started catching blue crab in addition to his main target species.

Alain Pinza is a member of the *Cofradía de Sant Pere* who gathers shellfish, cockles and other clams, from the Alfacs bay off La Ràpita. Some years ago, he extended his activity to the fast-spreading blue crab, catching them in traps. The work starts pre-dawn, typically between 04:00 and 05:00, tending lines of lightweight cylindrical traps known locally as *gandil*. Bait, which is typically chicken, is renewed daily, and the gear is chosen specifically because it is gentler on the clam grounds than heavier square cages used elsewhere. A typical haul on a good day reaches 50–60 kg, which he sells through the local auction. Prices are seasonal: quantities fall in winter but the unit price rises to about €12–14/kg, with peaks during the Chinese New Year, thanks to a big community present in the area. Temperatures in the lagoon can range from 4–7°C in winter to around 31°C in summer, when larger and more active crabs approach the shoreline. As temperatures fall in September, the stock tends to move seaward again. The traps feature two entrance funnels which improves the odds of success regardless of currents and flow direction. Mr Pinza reports that blue crab predation on farmed mussels and oysters necessitates protective netting around the structures on which they grow. While blue crab has become a side business and a stable source of income alongside his principle clam work, Pinza stresses that successful management depends on accepting the species' presence, adapting gear and routines, and collaborating with buyers to build demand—a process that, over roughly two years, has helped lift prices to a level that makes it worthwhile to catch the crabs.

Fepromodel, the centre of bivalve production on Spain's Mediterranean coast

Mussels, oysters, and clams are produced in the Ebro delta for distribution to Barcelona and the rest of Spain.

The river Ebro travels in a south easterly direction from its origin in the Cantabrian mountains in northern Spain to the Mediterranean coast between Barcelona and Valencia. The Ebro delta in the province of Tarragona in the autonomous community of Catalonia is an area of some 320 sq. km, a quarter of which comprises a nature reserve.

Gerardo Benet, the manager of Fepromodel

The reserve hosts a shellfish industry producing mussels, oysters, and clams in the bays, Fangar in the north and Alfacs in the south. Production is managed by the federation Fepromodel (*Federació de Productors de Mol·luscos del Delta de l'Ebre*), a body with 56 concessionaires, which also carries out research and testing of the shellfish to guarantee quality and food safety.

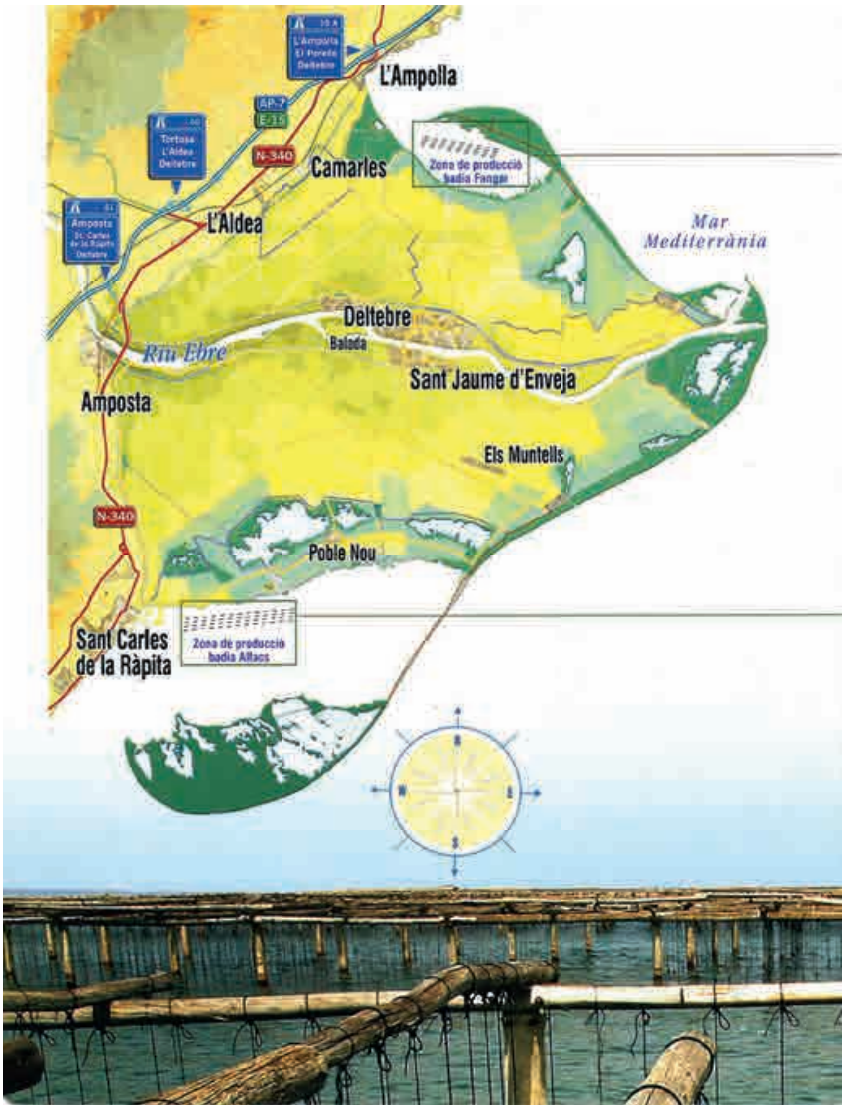
Four fifths of Mediterranean mussel production in the Ebro delta area

Gerardo Benet, the manager of Fepromodel, says the federation produces about 2,700 tonnes of Mediterranean mussels in the Alfacs bay and a further 800 tonnes in the Fangar bay, while Pacific oyster production is 500-600 tonnes in Fangar and around 100 tonnes in Alfacs. Mussel spat is collected on ropes in the two bays during the season from December to March or April but is also supplemented with imports from Italy or Greece, if spat collection is poor. Once the spat has settled on the ropes suspended in the Alfacs bay, they are moved to Fangar where the winds are stronger and water circulation in the bay is better. The ropes are suspended from wooden frames, and the mussels grow until they are harvested the following spring. Mussels thrive in water temperatures from 15-24 degrees C. At 26 degrees the mussels stop feeding and at 28 degrees, if there is prolonged exposure, the animals will perish. Oysters, however, are more resistant to high temperatures, and thus offer an insurance policy if mussel mortality is high.

One of the federation's main functions is to get rid of the waste, mainly discarded shells, byssus threads, and residual meat, which is produced by the producers. Dead bivalves, or those that are too small to be marketable, amount to 1,000 tonnes each year. The federation is also responsible for the sale of mussels. The best quality product has 40-60 mussels per kilo with a meat ratio of 100 to 250 g per kilo. The bays are classified as a B zone so the mussels must be depurated before they can be released on the market. There 12 depuration centres in the delta, Mr Benet states, so depuration is not an issue. On the Spanish Mediterranean coast 70-80% of the mussels are produced in the Ebro delta most of which is sold at the wholesale market in Barcelona while the rest goes to other parts of Spain. Apart from wholesalers, buyers are retail chains, fishmongers, and restaurants. The product is sold live in wooden boxes or nets of assorted sizes depending on the buyers' preferences.

Blue crab is less of a threat today

Mr Benet has considered adding value to the mussels either by canning or freezing but it calls for a significant investment which may not be justified by the



An illustrated map of the area

volume of production. Another activity the producers participate in is tourism. Boats with tourists sail to the installations where they can see how mussels and oysters are grown. The industry is of economic importance in La Rapita and the surrounding area. Apart from tourism, the number of jobs in management and maintenance of the installations, depuration centres, and in transport and logistics amount to more than 700 people, Mr Benet calculates. But many of these positions are not full-time and the workers must find other job opportunities as well. Some producers, for example, grow both mussels and oysters which corresponds to full-time work. The industry also faces threats, the biggest of which is probably the impact of climate change. The average depth of Fangar bay is about 2 m with a maximum depth of 4 m, while Alfacs bay is about 4 m on average and 6.5 m at its deepest. The shallow water results in high water temperatures that can affect production, as well as negatively influence spat production or nutrition for the bivalves. Another issue is predation from species such as salema (*Sarpa salpa*), and blue crab (*Callinectes sapidus*). To protect the stocks producers drape them with nets. This is not the ideal solution as it affects the water flow and the currents, but the alternative is worse. Blue crabs were first detected in 2012 and two years later the population exploded with major consequences for the shellfish producers. Since then, we have learnt to manage this predator, Mr Benet explains, and now there is a market for it so fishers catch and sell it at the auction where they can get a decent price. This has put pressure on the resource and reduced the impact on the shellfish. As shellfish farmers Fepromodel members are not allowed to fish for blue crab, as this is decreed to be the exclusive prerogative of commercial fishers.

Increasing production carries rewards but also risks

Production on the whole has been largely stable for the last 40 years though climate impacts in the last few years have caused a slight decline in output. Mr Benet says the federation could produce more—perhaps even up to three times the current volume, but the drawback would be apparent at harvest time. Producing such a large quantity elevates the risk of losses as there is only a narrow window, which has been getting narrower over the years, for harvesting before the water temperature increases to critical levels. Moreover, lower production volumes lead to higher quality as the available nutrition per line increases and handling and logistics is easier. The volume produced also influences the unit price which this year was about EUR2.7/kg. If a large volume were produced and unloaded onto the market it is likely to reduce the unit price. For Fepromodel the benefits and drawbacks of increasing production need to be carefully weighed.

Predation on blue crab by octopus and turtles in the Ebro delta

Experiments at the Catalonian Institute of Agrifood Research and Technology reveal that octopus and loggerhead turtles are efficient hunters of blue crab, an invasive and highly destructive species in the Mediterranean.

The introduction of the blue crab (*Callinectes sapidus*) into the Mediterranean, specifically into the Ebro Delta in 2012, has led to a marked shift in the local ecosystems. Originally native to the Gulf of Mexico, this invasive species has spread rapidly across the region, posing challenges to both marine biodiversity and the local fisheries. The management of the blue crab population in the Ebro Delta has therefore become a priority, as it threatens native species and the health of the delta's ecosystems.

One of the methods under investigation for controlling the blue crab population is through its natural predators, notably the common octopus (*Octopus vulgaris*) and the loggerhead sea turtle (*Caretta caretta*). These two species, both present in the Mediterranean, have shown potential for top-down regulation of blue crab numbers. Recent research conducted by Patricia Prado and colleagues from the Catalonian Institute of Agrifood Research and Technology (IRTA) in collaboration with researchers from the Polytechnic University of Valencia (UPV) and the Oceanographic Aquarium of Valencia has explored how these predators impact the blue crab population, examining their feeding behaviours and the effectiveness of predation on different sizes of crabs.

The blue crab's invasive impact

The blue crab, while not native to the Mediterranean, has adapted well to the region, spreading across various habitats such as lagoons, rivers, and even the open sea. Its ability to feed on a wide variety of organisms, including clams, algae, and organic matter, has made it a formidable competitor in these ecosystems. Its rapid proliferation has raised concerns about its impact on native species, particularly those that rely on the same resources. For instance, blue crabs have been found to negatively affect clam populations, particularly in the Fangar bay, where they feed heavily on clam nurseries.

This invasive species also competes with native predators for food, disrupting the balance of local marine food webs. As a result, managing the blue crab population is essential not only for maintaining biodiversity but also for sustaining the region's fisheries.

Octopus as a predator of blue crab

The common octopus, a highly intelligent and versatile predator, has long been known to feed on a wide range of

marine organisms. In the Ebro Delta, studies have shown that octopuses readily consume blue crabs, with subadult and adult octopuses both participating in this predation. The experiments designed by IRTA included various sizes of crabs to determine octopus preferences and their feeding efficiencies. Interestingly, while subadult octopuses showed a preferential trend towards smaller crabs, they were also capable of capturing and consuming larger crabs, demonstrating the octopus's adaptability in its prey selection.

The predation studies revealed that octopuses, even those as small as one kilogram (subadults), could consume crabs that were half their size, with larger individuals consuming up to 500 grams of blue crab biomass per day. The feeding efficiency of the octopus was particularly high because it consumed only the soft tissues of the crabs, leaving the exoskeleton behind. This means that the total biomass consumed by octopuses is higher than what is often reported, as the discarded exoskeleton is not considered in the calculations.

Moreover, the ability of octopuses to feed on crabs of various sizes, coupled with their relative abundance in the region, makes them an effective predator for controlling the blue crab population. The IRTA study concluded that octopuses are likely the most effective natural predator of blue crabs, particularly in the absence of other significant predators like larger fish or reptiles.

Turtles and their role in blue crab predation

Loggerhead sea turtles are another potential natural predator of blue crabs, though their impact on crab populations may not be as pronounced as that of octopuses. Loggerhead turtles, which are present in the Ebro Delta, have been observed to consume blue crabs, though they tend to be more cautious and less efficient predators compared to octopuses. Turtles were less likely to display a preference for specific sizes of crabs. Instead, they were willing to consume both small and medium-sized crabs, with larger crabs sometimes proving more difficult to handle. In fact, when results from all sizes of turtles were pooled, a trend towards enhanced consumption of smaller crab sizes was observed. The experiments were conducted at the Oceanographic Aquarium with turtles that had sustained injuries in the field and were recovering at the institute. No turtles were captured for the experiments.

The key difference between turtle and octopus predation is that turtles consume the entire crab, including its exoskeleton, which means their biomass consumption is higher than that of octopuses. However, while turtles were found to consume a significant amount of biomass—especially in larger individuals—octopuses were more efficient predators, consuming more blue crabs per day, and exhibited less handling difficulties (shorter predation time).

The challenges of using predators for blue crab control

Despite the promising results from studies on octopus and turtle predation, there are several challenges to using these predators for effective blue crab management. For one, the presence of these predators in the Ebro Delta is not guaranteed. While octopuses are relatively abundant, loggerhead turtles are less so, and their numbers have been declining in recent years. The ability of these predators to exert significant control over the blue crab population is further complicated by the size and availability of crabs. Larger blue crabs may be more resistant to predation, requiring even larger predators to handle them effectively. Additionally, factors like the salinity of the water, which can affect the health of octopuses, also pose barriers to successful predation.

Another consideration is the ecological impact of introducing or encouraging certain predators in an area. While octopuses and turtles are native to the Mediterranean, increasing their numbers for the purpose of controlling the blue crab population could have unintended consequences for other species in the ecosystem. For example, fish or birds that may also feed on blue crabs could be displaced or affected by the shift in predator-prey dynamics. Moreover, the researchers only explored predation on large blue crab sizes, while most of the predation occurs on smaller ones, a further subject for exploration in the Mediterranean.

Integrated management strategies

Given the complexities of managing the blue crab population, a more integrated approach is needed. The research conducted by IRTA, UPV and the Oceanographic Institute has shown that natural predators, particularly octopuses, play a role in controlling blue crab numbers, but they cannot be relied upon solely. Instead, a combination of strategies—including targeted fishing, habitat management, and monitoring of predator populations—will be essential for effective blue crab management.

The development of a co-management approach, as outlined in the blue crab management plan for the Ebro Delta, brings together stakeholders from the fishing sector, public administration, and scientific communities. By incorporating data from predator-prey studies, these stakeholders can work together to create a balanced and sustainable approach to managing both the blue crab population and the overall health of the ecosystem.

Citizen co-creation is a recipe for coastal resilience and blue protein innovation in Europe

Across Europe's coasts communities are adapting to climate change, shifting fish stocks, and the socio-economic challenges of traditional livelihoods. From Denmark to Greece a new generation of projects is showing how community-driven innovation can link gastronomy and environmental stewardship with useful skills.

Launched in 2024, Forgotten Fish unites partners from Denmark, Greece, and Italy to revive the use of neglected species and traditional fishing practices. Through hands-on workshops and transnational exchanges—ranging from events on the historic *Trabucco* fishing platforms in southern Italy to local food events in Denmark—the project aims to rebuild traditional culinary knowledge while promoting biodiversity. Moreover, its online courses on fish biology and sustainable cooking encourage participation from the uninitiated. Lars Münter, a project partner from the Nordic Wellbeing Academy, says, while we still need to fight to reduce or reverse climate change, people depending on the ocean also need to adapt. By combining local storytelling, gastronomy, and digital tools, Forgotten Fish aims to turn community building into a practical strategy for climate adaptation and blue food innovation.

GastroFish combines education with gastronomy

GastroFish, also an Erasmus+ funded project, mobilises young people in coastal regions to deepen their political and social participation through digital learning and co-creation. Led by Turkish and Mediterranean partners, the project builds a multilingual e-learning platform that blends education in fisheries with expertise in gastronomy. Participants co-develop recipes such as anchovy-seaweed pizza, tub gurnard soup, and spirulina-infused fish burgers. Three online modules on fisheries basics, seafood species, and cooking skills enable peer-to-peer learning across Greece, Italy, Turkey, and Spain. With contributions from InnoPolis, the platform promotes cross-sector cooperation between youth, chefs, and educators leading to new skills and intercultural dialogue.

Together, Forgotten Fish and GastroFish highlight how co-creation can transform climate adaptation into a broader social movement that rests on four pillars: The first pillar is Rooted Innovation, meaning the revival of artisanal fishing traditions and regional cuisines which embeds sustainability in local identity and tradition. The second pillar is Intergenerational Learning. Youth engagement ensures knowledge transfer, skill building, and continuity of coastal heritage. Cross-Sector Collaboration represents the third pillar. Partnerships among chefs, fishers, educators, and cultural actors to foster new networks and shared goals. The fourth pillar is Digital Innovation—using MOOCs (Massive Open Online Course), podcasts, and online recipes to democratise access to knowledge, particularly for women, youth, and marginalised groups. These pillars enable small, citizen-led partnerships to generate cooperation across borders and ecosystems. The projects offer practical lessons for implementing the EU Green Deal, the Farm to Fork Strategy, and the Restore our Ocean and Waters mission. By empowering citizens to co-create solutions, they help diversify diets with low-impact, nutritious species while strengthening artisanal fisheries. They also connect vocational education with climate-smart food systems.

The ISRICM-EU project (Innovative Solutions for Refugee Integration and Crisis Mitigation in EU Member States), coordinated by the Nordic Wellbeing Academy and InnoPolis, applies co-creative, community-based training to support refugees, particularly from Ukraine, through vocational training and local engagement. ISRICM-EU shows how approaches tested in coastal settings can foster intercultural understanding.

Lessons for Europe's fishing and coastal communities

When communities design projects—reviving recipes, developing training, or managing resources—they take ownership giving them a stake in the project's success. Another insight is that combining the use of digital tools with heritage skills can open new markets—apps and online platforms help fishers sell directly, with chefs sharing local stories. Generally, fishing can successfully be connected with tourism, education, and local gastronomy. Another key insight is that exchange across regions keeps innovation alive. What works in an Italian harbour might inspire a Finnish village to adapt ideas. With this, EU and national programmes for climate adaptation, innovation, or community development can take inspiration from local ideas. Together, these strategies illustrate the benefits of co-creation. Join us on Ærø, Denmark, 17-18 June 2026 to experience this coastal revitalisation firsthand.

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Connecting fish data for open and sustainable science

The world's most widely used database on fish species, FishBase, is set to become even more useful thanks to the SemantyFish project that will integrate it with other databases to allow complex queries on different fish-related topics.

FishBase, the world's largest and most widely used database on fish species, is a cornerstone resource. Despite its importance, it cannot fully support the demands of modern, data-driven science and policy in its current form. The SemantyFish project seeks to transform FishBase from a static collection of database tables, into a dynamic, machine-readable and interoperable knowledge graph. This approach enables data to be linked, queried, and integrated with global research infrastructures, opening new possibilities for understanding fish biodiversity, fisheries sustainability, and aquaculture development. The transformation aligns with global moves and practices towards open science and FAIR (Findable, Accessible, Interoperable, Reusable) data principles.

What is a knowledge graph and why it matters?

Think of a knowledge graph as a well-organised fishing net. Each knot in the net represents a piece of information, such as fish species, its habitat, its biology, etc. The hundreds of connected threads show how these pieces of information are related. Instead of having isolated bits of data scattered in separate databases, a knowledge graph weaves everything together, making it easier to identify relations, patterns and trends, across the entire interconnected network. In fisheries science, this approach opens new possibilities. Traditional databases can store huge amounts of information, but they often struggle to answer complex questions that span species, ecosystems, biological characteristics and human activities. With a knowledge graph, data from FishBase can be linked to other global sources, such as biodiversity records, environmental monitoring data, stocks and fisheries assessments. This allows researchers to ask questions like "which fish species in the North Atlantic are both commercially important and most sensitive to temperature changes?".

To support turning FishBase into a knowledge graph requires much more than simply reorganizing and changing the structure of the data. It requires transforming the way information is structured, connected and shared. At the heart of SemantyFish lies a top-level ontology used as the conceptual model, able to model the semantics of FishBase resources in a non-ambiguous manner. Through the ontology, it is possible to capture relationships between species, habitats, ecological interactions, bibliography, etc. Practically, it ensures that fish species information is no longer isolated, anybody can trace its connections to other species, ecosystems, and habitats.

The main outcomes of SemantyFish

The first and most visible outcome of the project is the knowledge graph itself. The knowledge graph organizes species data, biological characteristics, ecological traits, distribution information, and related references in a way that is both human- and machine-readable. This interconnected structure allows researchers to explore complex relationships, uncover patterns across species and ecosystems, perform queries that were previously cumbersome or impossible, and come up with new facts and knowledge about them. Moreover, through an evolution workflow, the knowledge

graph remains continuously aligned with updates from FishBase, ensuring that it reflects the most current biodiversity information. In essence, the static database tables of information become a dynamic fisheries knowledge base.

The second outcome is a programmatic API (Application Programming Interface), that allows developers to discover and access the contents of the knowledge graph. Through the API, users can retrieve information on various types of entities, integrating it into their own research workflows, applications, or decision support tools. By providing standardised, automated access, the API ensures that SemantyFish is not a static resource, but a living infrastructure that can be widely used, shared, and connected with other services, platforms and infrastructure.

New possibilities for research, management, and innovation

Smarter fisheries management: With SemantyFish, managers can run queries that combine biological, ecological, and distribution data, helping them identify vulnerable species, track shifting populations, or assess the sustainability of particular fisheries. For example, it becomes possible to quickly identify which commercially important species are more at risk from climate-driven habitat changes.

Advancing aquaculture research: Developers and researchers benefit from reliable access to species traits, growth conditions, habitat details, and ecological requirements. By linking this information with environmental data, SemantyFish can support the design of more sustainable farming practices. For example, users could get answers about freshwater species that have traits suitable for low-input farming systems in tropical regions.

Enabling interdisciplinary research: Since the knowledge graph is designed for integration, it can connect FishBase data with broader or related scientific resources, from global biodiversity platforms to climate databases, and food-related data sources. This allows new kinds of interdisciplinary studies, linking fisheries biology with oceanography, climatology, or nutrition research.

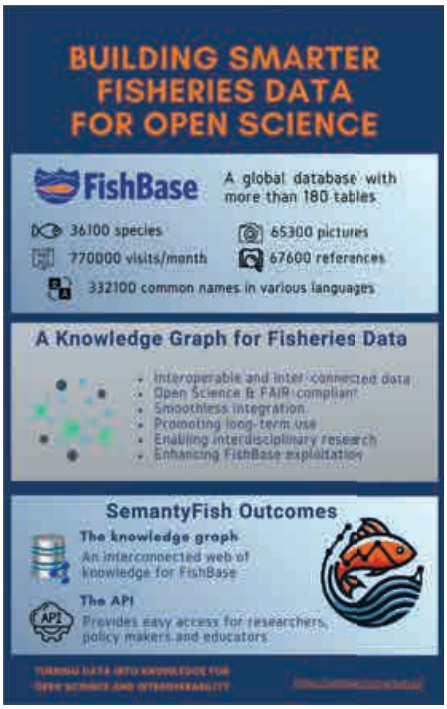
Education and capacity building: SemantyFish offers students, educators, and early-career scientists access to a flexible tool that makes complex data easier to explore and understand.

Fostering open-science and FAIR data principles: The SemantyFish knowledge graph can integrate with biodiversity portals like GBIF, taxonomic registries such as WoRMS, marine observation platforms like OBIS, or stocks and fisheries assessments like the Global Record of Stocks and Fisheries (GRSF). This enables holistic analyses of fisheries data that were previously difficult to achieve.

Promoting long-term use: The availability of an API ensures that SemantyFish can be plugged into a wide range of research tools, policy platforms, and decision-support systems. Whether used by scientists modelling the impact of warming seas, policymakers drafting regional fisheries plans, or educators developing training materials, the API is designed for broad, long-term use and collaboration.

Towards smarter fisheries knowledge

As challenges such as climate change, biodiversity loss, and food security grow more pressing, the need for reliable and interoperable fisheries data has never been greater. SemantyFish provides a foundation for meeting this need, offering a resource that will continue to evolve alongside global research infrastructures and community priorities. In doing so, the project affirms a simple but powerful idea: when data becomes knowledge, and knowledge is shared openly, we all gain the tools to build a more sustainable future for fisheries and aquaculture.



FishBase, the popular database of fish species, is set to become a powerful and freely available tool for understanding all things fish.

SemantyFish, is an open science project funded under the OSCARS 1st Call for Open Science Projects and Services. Start date: October 2024, End date: September 2026. https://semantyfish.github.io/

Seafood sustainability is not a joke

While seafood represents one of the most widely traded food commodities globally, it remains among the most misunderstood by consumers. The VeriFish project is introducing card games, infographics, posters and calendars to highlight key sustainability indicators, helping players—ahem—consumers understand what makes a fishery more (or less) sustainable.

When we began the VeriFish project in May 2024, together with colleagues from eight institutes across eight different countries, we didn't know each other yet—but we knew we were facing a very challenging task: to make the complexity behind fish sustainability understandable to stakeholders in the seafood value chain by introducing an approach that was as transparent, verifiable, and widely accepted as possible among all involved actors.

The VeriFish Indicator Framework was therefore conceived as an "impartial" tool, based on data collected by scientists, researchers, and industry experts in Europe and around the world, organized into databases (FAO Global Record of Stocks and Fisheries (GRSF), EuroFIR's FoodExplorer database, Fishsource, SeafoodWatch, to cite a few), and analysed according to FAIR scientific practices. The VeriFish indicator framework has become our reference matrix bringing together all the variables that should be taken into consideration when discussing a sustainable seafood supply chain.

Within the VeriFish indicator framework (released in April 2025), information about sustainability, provenance, and nutrition is available in one place. We needed to demonstrate that this wealth of data, made available for the first time in its entirety, could be used to explain the complexity of sustainable fishing.

Media products targeting European families, citizens and younger generations

Among the VeriFish project's targets are families, young people, and, more generally, all of us as consumers. This includes environmental and ethical consumers who are motivated by environmental sustainability and ethical consideration. There are familiarity-driven consumers who stick to familiar fish types due to a lack of knowledge about selecting and preparing different species. There are also health-conscious consumers who look for nutritional benefits of food, and seafood.

To help disseminate this information to all these types of consumers—both adults and children—VeriFish is releasing card games, infographics, posters and calendars and a recipe book that translate complex sustainability, nutrition, and provenance data into accessible and engaging formats. These products aim to promote informed seafood choices, increase visibility of under-communicated fisheries and aquaculture products and foster awareness about the environmental and socio-economic dimensions of seafood.

Scientific based, focusing on specific species

VeriFish media products address sustainability challenges by relying on verifiable information and scientifically accurate data sources, as presented in the VeriFish indicator framework. To make the materials appealing, the media products focus on some specific species, offering real life examples that consumers and consumer associations, parents and educators recognise in their everyday lives.

For this purpose, the most consumed species in the EU-27 countries according to the EU FISH MARKET 2024 report have been analysed. As VeriFish needs to address several objectives, further considerations were made in order to come up with species variety to reflect these different objectives. Namely:

- Sustainability aspects can be clearly explained with the species (invasive species, cephalopods)

- The species group has a very high nutritional value in relation to the environmental footprint (small pelagics, bivalves)
- The species is consumed in high volumes in the EU and has both sustainable and less sustainable choices (salmon and tunas)
- The species are important in EU aquaculture (trout, seabass, and seabream)
- The species are caught in the EU and can be promoted as alternative for imported products (saithe, hake, whiting, northern prawn)
- The species is less known but is very responsibly farmed (carp, Arctic char).
- The species group is relevant for European fisheries, but some species are less well known (flatfishes)

Considering all the above, in the VeriFish media products consumers will learn about 25 species from 10 categories: bivalves, crustaceans, flatfish, whitefish, small pelagics, freshwater fish, salmon, tunas, cephalopods, and species popular in Mediterranean aquaculture.

Overfished! Explore nutrient values, origin of species, and fishing gear types while having fun

The first media product released by the VeriFish project is "Overfished!". Hidden behind a funny card game, it is a first step toward understanding the complexity behind sustainable fishing by learning more about environmental and nutritional aspects of species with a "Least Concern" conservation status.

VeriFish species cards provide scientific information about five different species, along with tips and interesting facts. While challenging family and friends, players will play with small pelagics or bivalves, which have very high nutritional value. They'll encounter some of the species consumed in high volumes in the EU, such as tuna. But they'll also learn more about other species that are less well known such as flatfishes. Users will learn about five different types of gears and their impact on marine habitats, such as bottom trawling, that significantly disrupt marine habitats, whilst others have smaller ecological footprints. Nutritional tips about mussels, skipjacks, sardines, plaices and northern prawns are also included.

Posters about ecological impact of different gear types

Different fishing gears interact with the environment in different ways—some are selective and cause little disturbance, while others may damage habitats like seafloors, catch non-target species (bycatch), or threaten endangered marine life.

The next media product to come is a poster to improve understanding of the potential environmental impacts associated with capture fisheries, with a focus on gear-specific ecological considerations such as biology, habitat interactions, gear-related effects, and gear loss. The poster illustrates seven common types of fishing gears, along with their potential environmental impacts and targeted fish species: 1) Trawls and dredgers; 2) Hooks and lines; 3) Gillnets and entangling nets; 4) Traps and pots; 5) Lift nets; 6) Seine nets; 7) Surrounding nets. Conceived for schools and associations, the poster combines textual and quantitative information with visuals and catchy sentences focusing on data from the capture fishery of the VeriFish indicator framework, namely, impact of that gear type on marine ecosystems, concept of "bycatch" and examples of amount of discard typical for gear type and landed catch, gear used to fish, considered per seabed type proxy, and the impact of gear loss. The poster will be available from December 2025.

VeriFish children's recipe book

In 2026 VeriFish will also publish a children's recipe book to promote healthy, sustainable seafood consumption among children and families. Developed in collaboration with EUROFIR nutritionists and culinary educators, the eBook will feature seafood species chosen for their sustainability and health benefits (e.g., shrimp, sardine, trout). It will combine simple, family-friendly recipes with educational content including sustainability tips, nutritional facts, and cultural food stories, via storytelling elements to engage young readers. Are you ready to order yours?

Sara Pittonet Gaiarin
Trust-IT Services, VeriFish Coordinator

Get your pack of Overfished!

To enable healthy and sustainable choices, we need trustable information. Overfished! is the best way to start testing your knowledge about sustainable seafood. The information included in this game is sourced from FAO Global Record of Stocks and Fisheries (GRSF) and EuroFIR's FoodExplorer database. Overfished! is available in English upon request from the VeriFish website (https://verifish.info/verifish-media-product/#Overfished_Card_Game). Translations are ongoing in Italian, Spanish, Norwegian, Dutch, Polish, Swiss and Greek.

Fisheries must become more selective and sustainable

Although there has been considerable success in efforts to make fishing more sustainable, it has not yet been possible to significantly reduce the proportion of overfished stocks worldwide. Design changes to fishing gear can help achieve this urgent objective. Sometimes even small changes to the nets are enough to make them more selective. What ideas are currently emerging?

Double the work: although set nets are deployed in the sea and hauled in, the main work takes place on land, when the fish are removed from the mesh.

Fisheries make an important contribution to the humanity's protein supply, but they should be operated more sustainably. This means organising fishing pressure and catch volumes in such a way that the reproductive capacity of fish stocks is ensured, the environment is not irreparably damaged, and fishing methods are improved to reduce unwanted bycatch. Around the world, the fishing industry and the scientific community are collaborating to develop solutions that make fisheries more sustainable, as well as socially and economically equitable. A key focus of these efforts is the reduction of bycatch, pursued through two main approaches:

- Reorienting fisheries management to better preserve the reproductive potential of fish stocks, for example, by imposing restrictions on fishing effort or implementing spatial and temporal closures of certain marine areas and habitats, such as seagrass beds.
- Introducing technical improvements to fishing gear and methods to enhance their selectivity.

In some sectors of the fishing industry, such as shrimp trawling – where unwanted bycatch is often high – bycatch reduction devices (BRDs) are already widely used in fishing gear. These devices typically consist of diagonally arranged, fine-meshed barrier grids or nets positioned within the tunnel just before the codend. While allowing slender shrimp to pass through, they prevent larger bycatch species from entering and guide them out through escape hatches. BRDs come in various sizes and designs, tailored to the specific fishery and the potential bycatch species found in a given fishing area. However, such modifications are not always practical or feasible. For instance, no effective BRD has been developed for driftnets, which were commonly used in

tuna fishing in the past. These nets – often stretching several dozen kilometres and drifting like impenetrable walls in the ocean – frequently became lethal traps for countless fish, seabirds, and marine mammals. Sharks, albatrosses, sea turtles, dolphins, and other species have become entangled in the nets, often dying in agony. As no solution to this problem was found, driftnets were banned for deep-sea fishing in 1992 by a United Nations (UN) resolution, which has also been enforced in European Union (EU) waters since 2002. Although violations of the ban are still occasionally reported (e.g. in the Indian Ocean), the driftnet issue has largely been resolved, contributing to a slight improvement in the sustainability of fishing.

Regional gillnets, often considered a smaller version of driftnets, are now facing similar criticisms. Unlike driftnets, which typically drift freely in the sea, gillnets are anchored in a specific location. In fact, gillnets have several positive characteristics that are quite desirable. They fall into the category of "passive" fishing gear, meaning they do not require energy to be dragged through the water, making them more climate-friendly. They are also relatively selective, as the size range of the target species can be predetermined by the choice of the mesh size (although it remains possible to catch fish of similar size and shape). Criticism of gillnets in the Baltic Sea is primarily driven by the occasional bycatch of diving seabirds (such as auks, common scoters, long-tailed ducks, and common eiders), which forage for mussels and other organisms near the seabed or hunt for fish, as well as seals and porpoises. Their feeding grounds are also key areas for gillnet fisheries. Even dolphins and porpoises, which use acoustic signals to navigate underwater in a manner similar to bats, do not perceive the nets as an impenetrable barrier, as their thin nylon threads produce only a very weak echo. This increases the likelihood of them becoming entangled and drowning.

Solutions should be as simple as possible

One approach to better protecting the porpoise, also known as the harbour porpoise, is to improve the reflective properties of the nets so that they can be recognised as barriers. In the practical implementation of the project, researchers came up with the idea of gluing small transparent acrylic beads, about the size of a chickpea, at regular intervals onto the nets. This significantly enhances the echo of such 'pearl nets', allowing marine mammals to avoid these dangerous obstacles.

Another way to make bycatch-intensive fishing gear more visible in the water is through the use of light. A comparative study of unlit and lit gillnets over several months demonstrated that green LED lighting significantly reduces nocturnal bycatch. Lighting the nets led to a 95% reduction in shark bycatch biomass, an 81% reduction in Humboldt squid, and a 48% reduction in unwanted species. Nearly twice as many loggerhead sea turtles were caught in conventional nets compared to those with lighting. Additionally, there was another benefit: lighted nets could be collected much more quickly in the dark of night. Operational efficiency is crucial, as it may encourage fishers to switch to lighted nets. Although these nets are easy to handle, the situation is not so straightforward, as they are relatively expensive and require constant recharging during operation. Nevertheless, the study has compellingly demonstrated that green LED lighting could be a viable technology for reducing bycatch in gillnets.

Regional solutions to a global problem

Bycatch is indeed a global problem. Regardless of the fishing method, nearly every fishery has to contend with it. The Food and Agriculture Organisation (FAO) of the United Nations estimates that almost 7 million tonnes of fish bycatch are caught unintentionally and discarded every year worldwide. As previously mentioned, the bycatch rate in industrial shrimp fishing in tropical waters is particularly high, accounting for more than a quarter of all discards globally. It is therefore unsurprising that research and development efforts are focused on this sector of the fishing industry, although many ideas and solutions can, of course, be applied to other fisheries. Some ideas are relatively simple and easy to implement, while others are more demanding and technically complex. For example, almost all larger Australian shrimp trawlers have water tanks on the back deck to keep the fish alive during sorting. This way, the unwanted bycatch has a better chance of surviving after being discarded into the sea.

In trawling, bycatch rates vary depending on the area of operation and the target species. They are generally higher near the seabed than in pelagic fishing.

Shrimp fishing in tropical waters is typically characterised by particularly high bycatch rates. In extreme cases, 1 kg of shrimp may be accompanied by up to 15 kg of bycatch.

Of course, it is even better if bycatch is already sorted in the fishing gear and does not come on board in the first place. Fishing experts have developed various devices to allow so-called 'non-target species' to escape from trawl nets. These range from larger mesh sizes, through which small fish can escape, to grid frames made of vertical bars that prevent larger fish and other protected species from entering the net, instead guiding them out through escape hatches. In this way, for example, the capture of sea turtles in trawl fisheries has been significantly reduced. All sea turtle species are considered highly threatened or endangered, with six of the seven species worldwide having been on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species since 2003. The mandatory use of Turtle Excluder Devices (TEDs) in shrimp fisheries in the Gulf of Mexico and the south-west Atlantic has ensured that at least 97% of turtles are safely released from trawl nets. Similar efforts are being made in other regions of the world. For example, the Southeast Asian Fisheries Development Centre (SEAFDEC) has developed the Thai Turtle Free Device (TTFD), a specially designed escape hatch better suited to local shrimp fishing conditions. It is already in use in several Southeast Asian countries, including Thailand, Indonesia, Malaysia, and the Philippines.

Greater focus on species-specific behaviour

Optimising the selectivity of fishing gear is a key aspect of sustainable fisheries management. The main challenge is to minimise bycatch as much as possible without reducing the catch potential of the gear, i.e. without significant losses of target species. Moreover, the practical adoption of new gear depends on its ease of use, efficiency, durability, and affordability for fishers. From a fishing technology perspective, major breakthroughs are rare; often, small adjustments produce the desired effect. Therefore, technical improvements primarily focus on refining mesh sizes and shapes to better match the size and body contours of target species. Juveniles with round-oval body cross-sections can only pass through the mesh if it remains fully open and does not become compressed into narrow slits under pressure when the net is pulled. The placement of escape hatches in the trawl is also crucial. For some species, larger meshes and escape grids positioned towards the front of the net are most effective, while for others, they work better when placed closer to the codend. There is rarely a single solution that meets all requirements; instead, a series of small modifications can collectively achieve the desired outcome.

Some fishing gear innovations are based on the different behaviour of fish species. For example, cod tend to swim upwards in a trawl, whereas flatfish swim downwards. This insight has led to developments such as CODEX (COD EXcluder), where a guide net within the trawl tunnel directs cod upwards towards an escape opening in the upper section of the tunnel. Another example is the ROOFLESS net, in which the net in the upper part of the tunnel has been completely removed, creating an escape opening several metres wide. Tests have shown that nearly three-quarters of the cod escaped through the open roof of this

When collecting oysters, scallops and mussels, dredges are commonly used, which are towed close to the seabed.

The use of purse seines requires the precise location of rewarding schools of fish, which are then encircled with the surrounding net.

Basket traps work according to the trap principle. The catch is taken out of the water alive so that unwanted bycatch can be released back into the sea unharmed.

convertible net, while flatfish, the actual target species, remained largely unaffected, with minimal loss of catch.

Innovative smart trawls that integrate artificial intelligence, stereo camera technology, and selective fishing mechanisms represent the state of the art of bottom trawl fisheries. Together, these components have the potential to drastically reduce bycatch while significantly enhancing both the profitability and sustainability of fishing operations. The smart technology is positioned just before the codend of the bottom trawl, where every fish approaching is captured by the camera. Using image recognition, the AI identifies the species and determines its size. Based on this analysis, the system then decides whether to open the rotating gate of the codend or to divert unwanted species away from the net. Currently, this system can process up to 100 fish per minute. While smart trawls are not yet fully ready for large-scale practical application, the technology has the potential to revolutionise the industry. Whether it will be suitable for mass production in the future will, of course, depend on its purchase price and operating costs.

Advantages and disadvantages combined in one fishing method

Depending on the technique used, angling can be both a sustainable fishing method and a high-risk source of bycatch. For instance, trolling and pole-and-line fishing, both of which are individually and manually controlled, are considered stock-friendly and environmentally responsible. Each fish is brought on board individually, removed from the hook immediately, and any unwanted bycatch can be quickly returned to the water. Seabirds often mistake the baited hooks for prey as the gear is deployed or hauled in, becoming entangled in the lines and drowning. Albatrosses, petrels, and several other bird species are particularly at risk. A relatively simple, effective, and inexpensive method of protecting these birds is the use of bird-scaring lines, which act as flapping deterrents. Brightly coloured streamers are deployed from the stern of the ship, creating a curtain over the area where the longline with hooks and bait is set and retrieved. The several-metres-long, wind-driven streamers deter birds and prevent them from accessing the baited line beneath. In Namibia's hake fishery, where demersal longlines are used, the introduction of these streamers – a relatively straightforward measure – has reduced seabird mortality by 73–95%.

Purse seines often exceed their reputation

Less successful, but still quite effective in protecting birds, is the Scarybird – a simple device that has been tested in the Portuguese artisanal purse seine fisheries. The Scarybird is a bird of prey-shaped flying object, akin to a kite that children and surfers enjoy flying in the wind. The device can be attached either to the fishing vessel itself or to a buoy, which is then placed within the purse seine. As soon as the silhouette of the supposed predator starts to hover over the fishing gear, many birds are deterred from the "dangerous" area. In practice, it has been shown that the number of gulls can be reduced by more than half, and the number of gannets

approaching the vessel and equipment can be reduced by almost three-quarters. This deterrent is effective and can significantly reduce bird bycatch.

Purse seines are often criticised by environmental activists, particularly in connection with fish aggregating devices (FADs), which attract many marine species. However, they are more selective than is often assumed. On the one hand, purse seines are only deployed when a sufficiently large and rewarding aggregation of animals from the target species has been located. On the other hand, there are now methods that allow accidental bycatch, such as dolphins, small cetaceans, and sea turtles, to escape from the encircling net. The backdown method, for example, is quite effective in providing these animals with a safe escape route, especially when combined with a small-meshed net liner (medina panel). In this method, the net is stopped, and the motor is switched into reverse, creating a current that reshapes the net into a long channel in the water, through which unwanted species can escape. The backdown method has contributed significantly to the reduction of bycatch mortality of small cetaceans in purse seine fisheries in the eastern tropical Pacific. For smaller target species in purse seine fisheries, such as herring, mackerel, or anchovy, larger meshes in the upper part of the net wall allow undersized juveniles to escape as the net bag becomes more constricted when the fishing gear is hauled in.

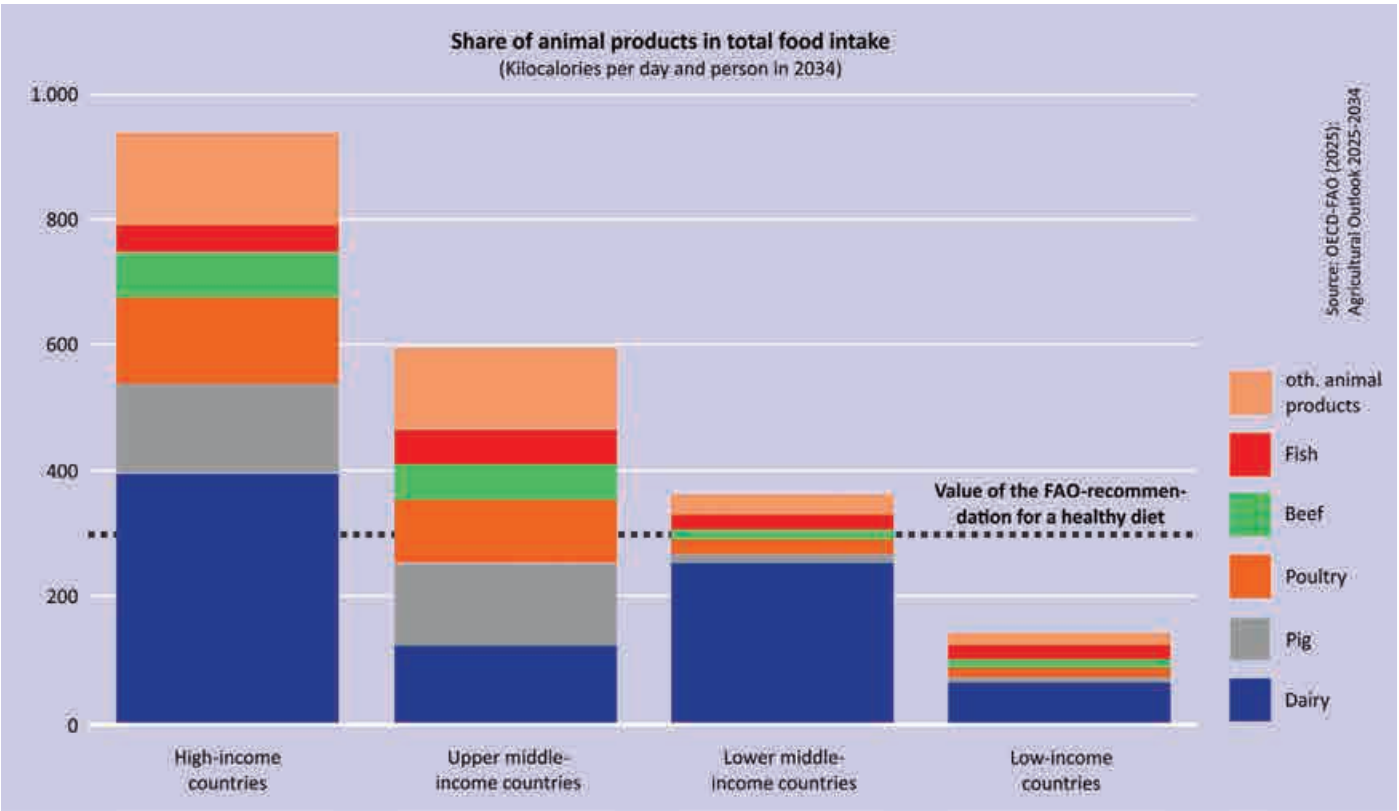
There is, therefore, not just one solution for all problems in fisheries, but rather numerous possibilities for making fishing gear more selective and sustainable. However sensible such developments may be in theory, they can only be effective in practice if they are applied as widely as possible. This is usually best achieved through participatory approaches, where fishers are involved in the projects from the development phase. After all, the success of many good ideas ultimately depends on their willingness to abandon their usual and familiar methods in favour of new fishing gear. A great idea is only great if it is accepted and actually adopted in practice. *Manfred Klinkhardt*

Global fish consumption set to rise to 21.8 kg per capita

The picture painted by print, television, and other mass media of the future of our oceans and fisheries is bleak: destroyed ecosystems, depleted stocks, and empty seas. Anyone seeking reliable information should instead read the report *Agricultural Outlook 2025–2034*, in which the OECD and FAO look ahead to the coming decade—and despite some problems, their assessment is more optimistic.

On a regular basis, the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization (FAO) assess markets for agricultural commodities and fish, and forecast likely developments to provide policymakers with a sound basis for decisions. On 15 July 2025, the OECD and FAO published the 21st edition of this analysis, Agricultural Outlook 2025–2034, according to which consumption of animal-based foods is likely to rise particularly in middle-income countries. There, analysts expect growth of a hefty 24 percent—four times the global average. Despite this increase, the share of animal-based foods in daily caloric intake remains low in middle-income countries, averaging 364 kcal per person, only just above the FAO's recommended 300 kcal per day. In low-income countries, 143 kcal does not even reach half the benchmark for a healthy diet.

Taken together, global agricultural and fisheries production is expected to grow by 14 percent by 2034. The contribution made by fisheries and aquaculture is greater than many media forecasts suggest. In 2024, they produced a combined 193 million tonnes of fish, crustaceans, and other aquatic animals, and this volume is expected to



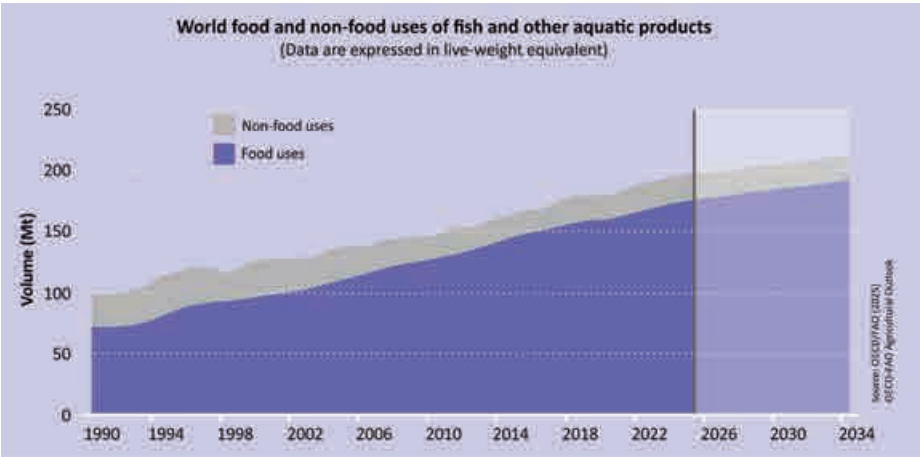
Fish and seafood have the highest proportional share of calorie supply from animal-based foods in upper-middle-income countries.

rise to 212 million tonnes by 2034. Despite this increase, production growth is likely to slow. By 2034, analysts expect growth of 12 percent. The increase in fish supply is mainly due to aquaculture. Although its growth rate is also expected to slow by 2034, aquaculture is projected to account for 56 percent of total output over the outlook period, delivering more aquatic animals than capture fisheries.

Total production of aquatic animals set to keep rising

Landings from capture fisheries are also likely to increase, but only modestly. After the El Niño-related low anchovy catches in Peru in 2023, they have recovered and are expected to stabilise at 94 million tonnes by 2034. Nonetheless, volatility in fisheries remains high because they can be affected by hard-to-predict events. Production declines of roughly 2 million tonnes are expected, for example, in 2027 and 2031 if the forecast El Niño events do in fact occur. This leads to lower anchovy catches and thus reduced supplies of fishmeal and fish oil, which also affects feed availability for aquaculture.

Even so, the OECD-FAO Outlook assumes that global aquaculture production will reach an expected 118 million tonnes (aquatic animals only) by 2034. That would be a 20 percent increase over the average for 2022 to 2024, well below the 51 percent of the previous decade. According to the study, the reasons for the weaker growth are stricter environmental regulations and the shortage of suitable production sites globally. Although the growth rate of Asian aquaculture is expected to slow sharply in the next decade, the continent is estimated to account for 88 percent of total production in 2034. China maintains its position as the world's largest producer. Emerging aquaculture nations, especially India and Vietnam, are expected to significantly expand their contribution to global output. Production increases are likely to be particularly strong for shrimp (+38 percent), freshwater and diadromous fish (excluding carp and tilapia) (+29 percent), and salmonids (+26 percent).



The share of non-food uses in total fish supply is declining slowly but steadily. By 2034, they are expected to account for only about 10 percent.

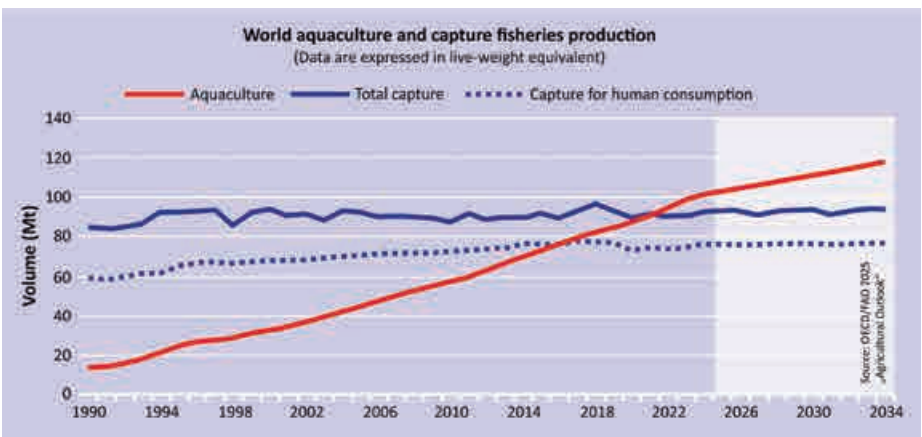
More fish for human consumption

The OECD-FAO Outlook forecasts a rise in global per-capita consumption of fish and seafood from 21.1 kg in 2022–2024 to 21.8 kg by 2034. There will be regional differences. Per-capita consumption in Africa is expected to decline, especially in sub-Saharan countries. A slight decrease is also expected in Europe. Growth in demand in Asia slows to only 11 percent compared with 32 percent in the last decade. This is also likely to affect non-food uses of aquatic products, especially the production of fishmeal and fish oil. As a result, the shares of food and non-food applications are expected to shift slightly. The food share will rise to 90 percent by 2034. Although per-capita consumption of aquatic foods is likely to grow less strongly in the next decade, it will still increase.

In nominal terms, prices for aquaculture and fishery products are expected to rise by 8.7 percent and 12 percent respectively. In real terms, prices are likely to fall by 13 percent in aquaculture and 10 percent in capture fisheries. The price declines are due to increases in production, as well as competition from other protein sources. Poultry prices are expected to fall over the outlook period. In addition, inflationary pressure could ease by 2034. Changing environmental conditions, mainly because of climate change, geopolitical upheavals in world trade, and a shift towards sustainable production practices in fisheries and aquaculture all influence developments in global trade. This is why compliance with binding rules in the global seafood trade is becoming more important for global food security. No one can yet foresee how China's policy realignment, with a stronger focus on sustainable practices, will affect future production and what consequences this will have for global market supply. China's aquaculture is already growing more slowly than in previous years.

Non-food uses continue to decline

Anyone looking for links between fisheries and aquaculture will inevitably come across fishmeal and fish oil, which closely link the two sectors. Catches from fisheries form the basis for the production of fishmeal and fish oil, which in turn are indispensable components in feed for aquaculture—despite the growing share of alternative agricultural raw materials. According to the OECD study, by 2034 an expected 10 percent of total fish and animal-origin seafood will be used to produce fishmeal and fish oil and for other non-food purposes, such as ornamental fish, bait, or pharmaceutical products. Aquaculture remains the largest consumer of fishmeal and is expected to increase its market share to 84 percent by 2034. The forecast assumes



While landings from capture fisheries are expected to remain at roughly the same level by 2034, aquaculture production will continue to rise according to the OECD forecast.

that China will account for around 42 percent of global fishmeal use by 2034. Fishmeal output is expected to rise slightly over the next decade to around 5.9 million tonnes worldwide by 2034. However, this is not due to fisheries catches but to the increasing utilisation of processing leftovers, trimmings, and by-products from fish processing. By 2034, an expected 31 percent of fishmeal will come from such "waste". This trend is driven by rising demand for fish fillets in wealthy countries, which leads to more processing residues. In addition, the feed industry is turning to other components, especially oilseed meals.

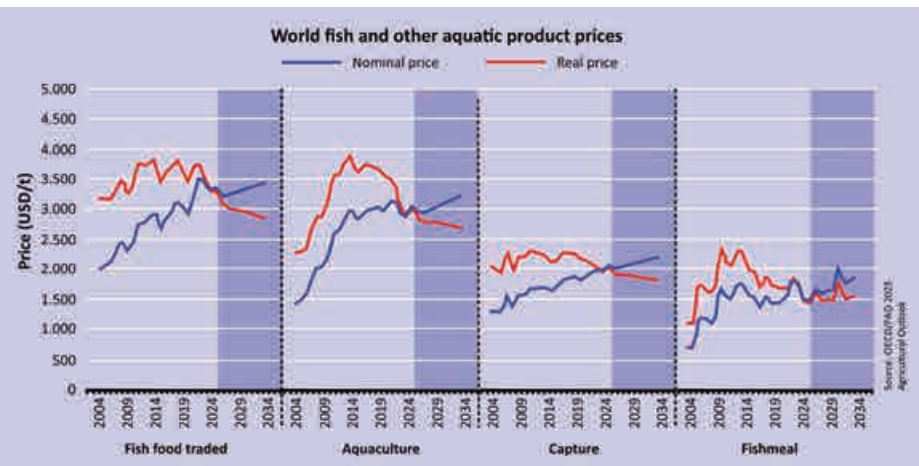
Fish oil production is also expected to recover significantly after the slump in 2023 when Peru's anchovy catches faltered. The study forecasts an increase to 1.5 million tonnes by 2032. Nevertheless, the supply situation for aquaculture is likely to ease only slightly (by 2034, an expected 59 percent of fish oil will be used by aquaculture), because competition is intensifying with the pharmaceutical industry, which is claiming more and more high-quality fish oil as a dietary supplement for human consumption. Compared with historical values, real prices for fish oil and fishmeal will remain high, but probably below their peaks (2012–14 for fishmeal, 2023 for fish oil).

Climate change threatens the reliability of the forecasts

The OECD and FAO analysts' forecasts are, however, subject to uncertainties. Environmental changes, amendments to existing regulations, and trade tensions influence production over the outlook period. Fisheries are particularly affected and are already suffering from climate change. Experts fear that usable fish biomass could decline by more than 10 percent in some marine regions by the middle of the century. That would be a serious setback. Short-term changes and extreme weather events—for example, marine heatwaves—affect fisheries production more than longer-term warming trends caused by climate change. This is especially evident in El Niño events in the Pacific, whose frequency, intensity, and duration affect anchovy abundance and thus the production and prices of fish oil and fishmeal, and subsequently aquaculture. Climate change also favours non-native and invasive species. They are spreading into regions where they could not previously survive or reproduce. Such changes are hard to predict and are a source of uncertainty in the Outlook projections.

Climate effects can probably no longer be averted, but at best mitigated and limited. This would require vigorous climate-protection measures from policymakers, but many governments lack the courage. Regulatory interventions in fisheries and aquaculture are therefore more likely, in order to prepare both sectors for the changes ahead. In fisheries, more flexible management would be helpful to allow certain areas or fisheries to be closed more quickly. In aquaculture, it would probably help to move production sites further from the coasts into open marine areas, where temperature conditions are more stable.

One important measure that is likely to help improve the situation is already on the horizon. After years of negotiations, the World Trade Organization's (WTO) first agreement to combat overfishing entered into force in mid-September 2025. The agreement prohibits the 166 WTO member states from continuing to subsidise illegal fishing. Governments spend an estimated 22 billion dollars every year on harmful subsidies that contribute to overfishing. There will also be no state aid for the harvesting of already overfished stocks. The subsidy ban applies to all vessels and companies engaged in illegal, unreported, or unregulated fishing (IUU fishing). This includes, for example, prohibited fishing methods that lead to by-catch of other fish. For developing countries and their fishing areas, the rules will not take effect until two years later. However, the fisheries agreement could fail again after a short time. The WTO has announced the goal of reaching a broader agreement against overfishing within the next four years. If these negotiations fail, the new agreement will automatically expire. *Manfred Klinkhardt*



The nominal price is the going price of a good at the current time. The real price, by contrast, also takes inflation and other price changes into account, and thus reflects the actual value of the good.

Whelk catches have more than quintupled since 1990

Among the underestimated resources on the European seafood market are whelks, which are highly valued in other parts of the world, What kind of animals are these, how do they live, and what do they have to offer us?

Hildegunn Sørstrand, 2018 (Wikimedia Commons)

On the white body of the European whelk (*Buccinum undatum*) there is a striking black spot pattern. Particularly noticeable is the siphon stretched upward.

The term "whelk" is used for numerous snail species, but strictly speaking it only applies to the roughly 50 species of the family Buccinidae, which differ slightly in size, shape, and colour, but all have a conical, spirally coiled shell. The majority of the "true" whelks live in temperate waters. Another common feature is the culinary value of the body of these molluscs, which are considered not only edible and nutritious, but in many regions of the world an outright delicacy. Whelks are unusually rich in protein (almost half of their dry matter consists of crude protein) and an excellent source of iron, zinc, copper, and potassium as well as vitamins B12 and E. They are typical marine inhabitants, preferring sandy or muddy habitats in coastal areas below the low-water line at ebb tide. Occasionally they have been found at depths of 1,400 m, but mainly the animals concentrate in the zone down to about 180 m.

Whelks are carnivores

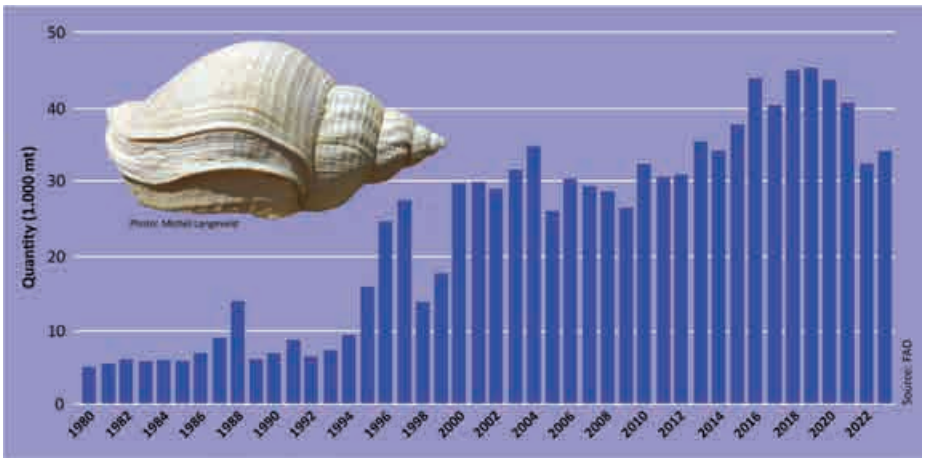
A typical feature of whelks is their spiral conical shell of calcium carbonate, which depending on the species can be completely smooth or equipped with ribs or knobs in striking arrangements. It provides solid protection from surf in upper subtidal habitats and from predators. The soft body consists of the strong, very muscular foot and a relatively small head with a tubular "snout" containing a rasping tongue (radula) as its central feeding tool. Unlike land snails, the simple eyes (ocelli) are not at the tips of the sensory tentacles ("feelers") but at their base. These sense organs react sensitively to light and tactile stimuli. When the snail retreats into its shell, it closes the oval opening with a perfectly fitting plate (operculum) made of robust material located on the foot. Oxygen is absorbed via a gill and transported to the tissues and organs by means of haemolymph, a blood-like fluid that circulates freely in the body (open circulatory system), driven by the two-chambered heart.

Unlike many other sea snails, whelks do not eat algae or other aquatic plants, but feed mainly as predators on various prey animals, though they occasionally rely on

freshly dead carrion. Their prey spectrum includes polychaetes and other worms, small mussels, echinoderms, crustaceans, and fish eggs. They track down their prey by traces of its scent in the water. In the search they extend their tubular siphon and pump water into the gill, which is connected to highly sensitive chemoreceptors that perceive scent trails. As soon as the whelk has picked up a trace, it approaches the potential prey at "top speed" of up to 15 cm/min (this pace can be maintained over distances of several metres!). To get to the nutritious flesh hidden under the protective shell of mussels or crabs, the snail can use several techniques. For example, it can bore a hole in the armour of its prey with its rasping tongue, or it can press the sharp edge of its hard shell against a mussel shell so firmly and for so long that pieces eventually break off. Here the muscle strength of its foot pays off, as it can exert enormous pressure. Once an opening has been created, the meal can begin. With its rasping tongue, the whelk scrapes the victim's flesh thoroughly from the shell in small pieces.

No pelagic larval stage

Incidentally, the living colouration of the snail shells can differ depending on species and location. Shells of dead snails, which one occasionally finds on beaches, usually appear white or cream-coloured. In living whelks, however, they are covered with a thin brownish layer, the so-called periostracum, whose exact shade is also influenced by the preferred diet. Yet, since healthy marine ecosystems usually maintain "balance and fairness," whelks themselves are targeted by numerous predators. Young life stages in particular often appear on the menu of cod, spiny dogfish, rays, flatfish, large crabs, and sea turtles, as well as starfish and sea urchins. Presumably only a few whelks reach their maximum age, which is reported to be a remarkable 40 years.



Globally, officially recorded landing volume of whelks rose temporarily to over 40,000 t at the beginning of the 2020s.

The onset of sexual maturity varies in whelks depending on species, age, and size. Usually the female is fertilised by several males. It then develops thousands of eggs, which—enclosed in lens-shaped capsules that can contain several hundred eggs—are typically attached from October to May in long sticky strings to hard structures such as rocks, mussels, or stones. The capsule chains with the whitish eggs, from which after four to five months tiny and fully developed whelks hatch (there is no planktonic larval stage!), are often called "fishermen's soap" because when rubbed with water they produce a foamy secretion. Because there is no swarming larval stage in whelk reproduction, their dispersal potential is low. In addition come the low mobility and limited activity radius of adult snails. Even directly neighbouring populations scarcely mix. Therefore, particular caution is required in whelk fisheries, as replenishment of overfished stocks and recolonisation of affected areas would be difficult and take a very long time.

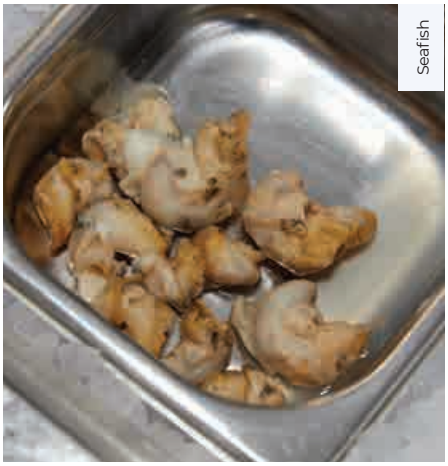
Commercial interest in whelks is growing

The best protection for "population-dynamic low performers" such as whelks would naturally be a complete ban on their capture. However, this seems difficult, as interest in their commercial use is growing. Specimens are repeatedly found as bycatch in lobster pots, bottom trawls, and mussel dredges, which are now no longer discarded but landed. In some regions of the world they are considered annoying pests because they supposedly destroy local shellfish and crustacean stocks, among the reasons for which they were fished in the past.

The most economically important whelk species in European waters is *Buccinum undatum*, usually called northern, edible, or simply European whelk. It is widespread in the North Atlantic and occurs along the coasts of North America from western Greenland to New Jersey and in Europe from Iceland and Norway to the Bay of Biscay. The shell of this snail species has 7 to 8 whorls with spiral ribs, whose wavy folding pattern is yellowish-brown with irregularly distributed light and dark spiral areas. At 10 cm high


Seafish

When the snail retreats into its shell, it closes the oval opening with a perfectly fitting plate (operculum) made of robust material located on the foot.


Seafish

Whelks should be cooked in salted water for not longer than 10-15 minutes depending on the size otherwise they can get tough and rubbery.

and 6 cm wide, it is the largest sea snail on Europe's coasts.

Strong demand drives fishing

Driven by growing demand from domestic and foreign markets in the globalised seafood trade, targeted fishing of whelks experienced a visible upswing towards the end of the 20th century. According to FAO statistics, worldwide landings quintupled in just three decades from around 7,000 t in 1990 to nearly 41,000 t in 2021 (subsequently falling to 34,000 tonnes in 2023). Actual volumes are likely to be even higher, since data collection shows gaps especially with these "minor species." This rapid increase in catch and landing volumes is not only the result of increased fishing effort, but also due to improved fishing technologies. Within a very short time, fishing methods for whelks were made more professional and perfected. The devices are baited traps that work on the principle of lobster pots. They are usually simple plastic tubes, weighted at one end with a concrete block for fixed positioning on the seabed, and fitted at the other end with a net that allows snails to enter, but keeps out fish, crabs, and other unwanted species attracted by the bait. To make retrieval of the traps more efficient, several are usually connected in a chain by ropes. Every two to three days they are hauled up from the seabed to remove the catch and, if necessary, renew the bait.

Stock control is relatively difficult

Although undersized snails identified during inspections were immediately thrown back, these devices fished so effectively that in many areas, with intensive fishing, clear signs of stock declines and overfishing soon appeared. This pointed emphatically to the necessity of effective fisheries management to protect whelks. Implementation of these demands was, however, more complicated than originally thought. Even the control of the prescribed minimum sizes was very difficult, because it was initially unclear how and at which points the asymmetrically built shells should be measured. Several methods proved impractical, as they were too cumbersome and inaccurate. In North America, therefore, a special procedure was developed that combines two measurement methods. The first—chute gauge—is a rigid three-sided measuring device whose internal wall distance corresponds to the minimum shell width. Subsequently, however, the snail is measured again with a second method. The animal must be pulled through the device lying flat with the shell opening facing downward, so that the axis between siphonal canal and shell top runs parallel to the walls of the device. Snails that pass through the device without difficulty are considered undersized and must be released. This procedure provides fairly reliable results, but is cumbersome and time-consuming and has therefore not yet been adopted everywhere.

To effectively protect whelk stocks, fisheries management therefore uses a whole bundle of measures. These range from licences for commercial fishers and precise specifications for the number and size of fishing gear used, as well as their individual marking to enable personal assignment to fishers, through the establishment of closed seasons, to catch limits, so-called bag limits. In addition, CPUE (catch per unit of effort), an important figure measuring the amount of snails caught in relation to the fishing effort applied, serves as a useful proxy for the biomass of stocks. A higher CPUE generally indicates a healthier or more numerous stock. However, only a small part of whelk fisheries is actually managed, since most animals are still collected or fished unregulated and uncontrolled. Nevertheless, there has been an MSC-certified whelk fishery in Normandy since 2021. The 72 boats of this fishery in Granville Bay between Granville and Cap de la Hague land about 6,000 to 9,000 t of whelks annually, mostly exported to the Far East. Attempts to produce these animals in aquaculture are also known, especially from China, South Korea, and Vietnam.

THE CATCH WELFARE PLATFORM SUPPORTS WELLBEING OF WILD-CAUGHT FISH

Wild-capture fisheries feed hundreds of millions of people and sustain coastal economies across Europe. Yet the welfare of the fish we catch has only recently begun to receive the attention it deserves.

Improving welfare during capture, handling, and slaughter is not merely an ethical obligation, argues Michelle Boonstra, the manager of the Catch Welfare Platform, in this interview. It can also strengthen stock sustainability (through higher survival of released fish), enhance product quality and shelf-life, and support the sector's long-term economic resilience. In short, she says, catch welfare is part of future-proofing European fisheries.

The Catch Welfare Platform (CWP) is an industry–science initiative dedicated to welfare-conscious fishing. The platform convenes fishers, processors, retailers, technologists, and researchers to develop realistic best practices and to accelerate adoption at sea. Its goals are to give industry a voice, share knowledge, and create profitable solutions.

From niche topic to standard practice

Welfare needs to become as routine a part of fisheries conversations as sustainability is today, emphasises Ms Boonstra. The platform is a hub where people meet and collaborate to create solutions, starting with risk assessments to identify the main welfare hazards in each fishery, then translating those findings into best practice and, where needed, technical innovation. CWP frames its work in the One Welfare concept—recognising the interdependence of animal welfare, human wellbeing (including crew safety), and environmental stewardship. At the same time, Ms Boonstra acknowledges the constraints that exist when crews juggle time pressure, safety, weather, and profitability. Any welfare improvement must "fit daily practice," she notes, acknowledging trade-offs, and avoiding measures that create new risks for people while solving problems for fish.

The scientific case for catch welfare has accelerated. Catch Welfare Platform highlights that minimising injury and stress during capture and handling can reduce bycatch mortality, increase survival of released animals, and improve meat quality—tangible benefits that link ethics to economics. Moreover, CWP observes that more supermarkets are now setting requirements touching on seafood welfare, while public interest continues to rise—a sign that better welfare can become a route to product differentiation, not just a cost.

Low-cost improvements that can be made today

Catch welfare is not only about complex machinery. Many meaningful gains are within easier reach on working decks. For example,

- Reduce unwanted catch by using selective fishing gears. This limits the stress and injury to unwanted and undersized fish/animals by allowing them to escape before they are brought to the surface to be discarded.
- Reduce air and light exposure. Handling more fish in water, rather than in air, cuts stress and physical damage and can lift quality.

Michelle Boonstra, Manager, Catch Welfare Platform

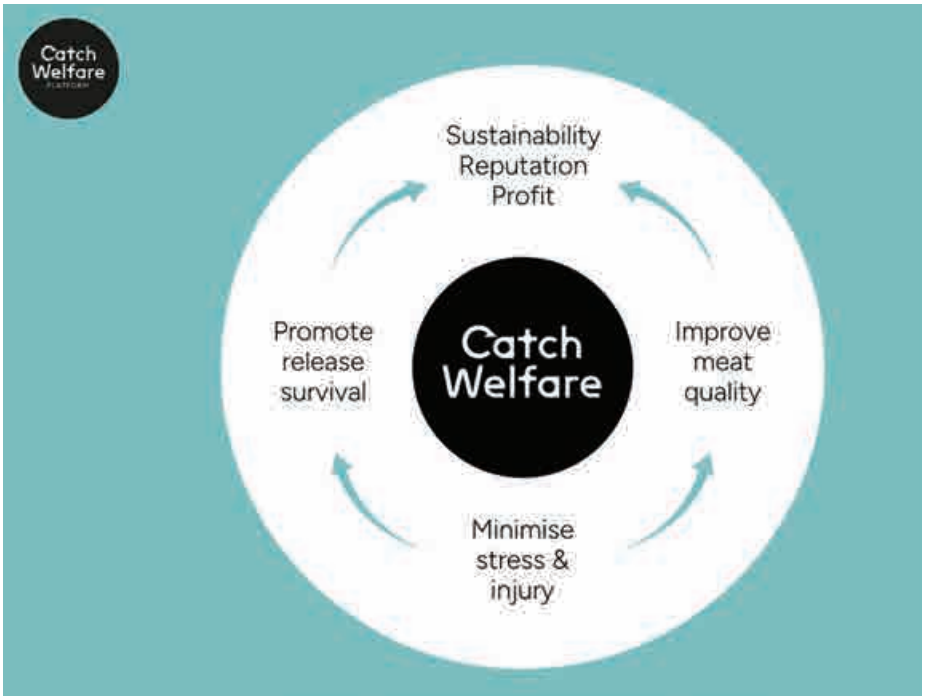
– Fix the "hard edges." Removing sharp bends and high drops in pump systems and chutes reduces physical trauma and injury, can lower discard mortality, and improve catch quality.

Ms Boonstra characterises these as the "low-hanging fruit" in some fisheries: practical changes that are relatively cheap, quick to implement compared to for example advanced stunners, and that make immediate sense to crews and skippers because they reduce damage and raise product value.

Vitality assessment could be a useful indicator

Objective, animal-based indicators are essential for monitoring progress. One of the most practical tools is vitality assessment —a rapid evaluation of fish condition during fishing operations. Recent Norwegian research links larger catches and longer crowding to poorer vitality in Atlantic mackerel during purse seining and pumping operations. CWP stresses that vitality methods are still being developed and will need to be species- and context-specific in the near term. Over time, some metrics may prove general enough for broader standardisation While science will necessarily lead this innovation, it will be heavily dependent on collaboration with fishers to develop of the protocols.

Among the technical solutions in development of interest are codends with reduced water flow (FloMo/Tiaki). Inspired by New Zealand's Precision Seafood Harvesting programme, membrane-lined codends reduce water flow around the catch, reducing crowding and physical contact with the net and so improving conditions during towing and hauling. Within a Dutch project the FloMo was tested on different demersal fisheries, aiming to improve selectivity, welfare and thus discard survival.



The win-win argument for catch welfare

Another technology is integrated electrical stun-and-kill systems that stun fish and swiftly kill before recovery. These can not only reduce stress in the catch but can remove heavy manual tasks for the fishers. However, success depends on both the hardware and the human element—crews not only need to know how to operate equipment, but also why it matters, so procedures are done correctly even under heavy workloads.

European law recognises animals as sentient beings and requires that fisheries policy pay full regard to animal welfare (Article 13 TFEU). Yet there are no explicit EU-level provisions dedicated to the welfare of wild-caught fish during capture and on-board handling, and the principal slaughter regulation (1099/2009) does not set detailed operational standards for wild fish at sea. This creates a policy gap that the sector and regulators are now beginning to address. Ms Boonstra cautions against rushing regulation without a solid evidence base, because poorly designed rules risk being counter-productive at sea and unfair in practice. Better, she argues, is to proceed step by step, building consensus around validated methods and creating a level playing field—especially when costly equipment such as stunners is involved. There are encouraging signs of institutional movement. In January 2024, the European Commission designated the fourth EU Reference Centre for Animal Welfare, this one focused on aquatic animals, that is developing animal-based indicators and supporting enforcement. While its initial focus is aquaculture, its work on indicators, training, and knowledge transfer is also of relevance to capture fisheries. In addition, the International Council for the Exploration of the Seas (ICES) is planning to establish a working group in 2026 to coordinate science and advice on aquatic animal welfare

in commercial and recreational fisheries, as well as aquaculture.

Retailers not yet ready to offer premiums for greater welfare

Retailers are increasingly active on seafood welfare policies including as part of CWP, but Ms Boonstra's experience reflects that buyers will offer market access but that consistent price premiums are harder to secure. That makes external funding and risk-sharing important during the transition—and it underscores the value of certification add-ons or indicator frameworks that help the market recognise better practice. Here, CWP's approach is two-pronged. First, it demonstrates that better welfare and product quality often go hand-in-hand (for example, fewer damaged fish, higher auction grades, and less waste). Second, it helps buyers understand what "good" looks like in different fisheries, so procurement standards are both auditable, fair and science based.

Towards practical, auditable criteria

Because capture fisheries are diverse, CWP starts with risk assessment at the level of species and gear. For a pelagic purse seine, hazards may cluster around the crowding and pumping phases, including the use of RSW tanks; for crustaceans sold live, entirely different points in the chain could matter more. From this analysis, best practices can be codified, and—where feasible—translated into criteria that buyers can recognise and auditors can verify. Stunning and killing methods will be central where applicable, but other criteria (e.g., maximum crowding duration, limits on drop heights, or in-water handling standards) will vary by fishery.

When pumping fish on board, reducing sharp bends and high drops in the system decreases the risk of physical trauma and injury and leads thus to better quality.

Adoption at scale hinges on different factors. Crews are more likely to adapt when they see that welfare-driven adjustments improve product quality and maybe even their own working conditions. Ms Boonstra cites trials where better capture systems sharply reduced the share of fish falling into low-quality categories. Another factor refers to the realities of life on board. Solutions must respect deck space, crew safety, and working load. Finally, acknowledgement that early adopters face real costs is needed. Grants and innovation funding help, but level playing fields—through validated standards, procurement requirements, or regulation once the science is settled—will ultimately be needed to encourage investment. These and related issues were discussed at the third Catch Welfare Platform Conference where awards and an idea challenge highlighted good practice, recognised innovation, and matched ideas with partners. The event took place on 19–20 November 2025 in IJmuiden, with a dedicated crustacean welfare workshop the following day.

If welfare can become as unremarkable—and as fundamental—as sustainability in fisheries, countries within Europe and without will have taken a decisive step toward a seafood system that is ethically sound, science-based, and commercially feasible. That is precisely the future the Catch Welfare Platform is organising to deliver.

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