



# EUROFISH MAGAZINE

## Türkiye

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PROMISE OF MUSSELS**

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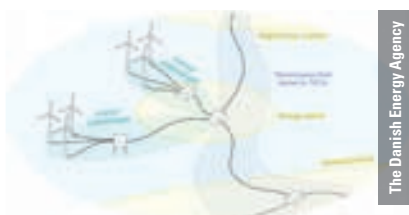
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# Türkiye seeks to expand mussel production



The Turkish aquaculture sector has done the country proud in several ways. Not only is production the biggest by far in the Mediterranean, but the industry is completely self-sufficient, capable of meeting all its needs from domestic suppliers. Indeed, many producers are vertically integrated producing everything from eggs to feed to market sized fish which is then processed into value added products. Over the years the industry has pioneered solutions to challenges such as the requirement to move offshore that resulted in the development of more robust production technology. This expertise and knowhow is now being exported to other countries in the region and beyond. Having mastered the science of producing finfish Türkiye turns now to the cultivation of Mediterranean mussels. Both the administration and investors reckon there is potential to expand the farming of mussels which are currently produced in small amounts both from aquaculture and capture. In Balıkesir province, for example, several mussel farming project proposals have been approved, while others are being processed, so the province may well become the highlight of a new chapter in Türkiye's ongoing aquaculture story. Read more [from page 36](#)



Denmark is on its way to achieve a 70% reduction in the country's CO<sub>2</sub> emissions by 2030. Emissions in the fisheries industry have already fallen by 62%. However, it is not planning to stop at that. Many of Denmark's policies and grant programmes are oriented towards this environmental-friendly objective. They assist the sector with "going green" by aiding the research and development of renewable energy sources: how to make biofuels less expensive or how to implement electric systems to operate on all sizes of fishing vessels. Other projects seek to popularise eco-friendly catch certifications or to develop "Energy Islands" meant to further the country's production of renewable energy. All these changes greatly impact Denmark's small-scale fisheries—sometimes beneficially, but also detrimentally. The Danish Small-Scale Low-Impact Fishers' Association and Producer Organisation is there to help the fisheries adjust to the changes but also advocate for them during discussions of new ideas. To learn more about how small-scale fisheries in Denmark help to combat global warming and what challenges they face from new environmental policies, read [from page 50](#)



There is increased competition for space at sea, where the main battle is between offshore wind farm investors and fisheries. Offshore wind energy is a prerequisite for achieving some of the European Green Deal's desired outcomes. However, the construction of new farms is difficult due to regulatory frameworks which compel investors to take various environmental considerations into account when planning their investments. Fishermen (and conservationists) voice their concerns as installation, operation and maintenance of offshore wind farms can have a negative effect on their operations. Scientists are also divided on the impact of offshore farms. Some say it is positive as it creates a new undersea environment, while others highlight that construction of turbines can result in the loss of important nursery and feeding areas. Many countries are trying to come up with and implement co-use policies that would satisfy all sides to the conflict. New technologies, like turbines anchored in the deep-sea are also emerging providing solutions to some of the issues this sector faces. Read Dr Manfred Klinkhardt's article [on page 56](#)



Did you know that approximately 50% of the squid consumed in Europe originates from Falkland Islands waters? This is an area in the Southwest Atlantic that is a formidable participant in the global fisheries and aquaculture market. In the islands' exclusive economic zone, three fishing methods stand out: jigging for Argentine shortfin squid, demersal longlining for Patagonian toothfish, as well as bottom-trawling for Patagonian squid and other fish species. The fishing in the Falklands is carefully managed by the government using Individual Transferable Quotas and by other regulations prescribed by the Regional Fisheries Management Organisation. Careful management and close monitoring are particularly important due to the squids' slow reproduction rates. The Patagonian toothfish is another example of a vulnerable species the stock of which requires prudent management. Falkland Islands fishers take special care to reduce the collateral damage caused by fishing. They do this by observing and documenting seabird and marine mammal interactions with fishing gear and then implementing appropriate measures. Read more [on page 59](#)

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## Belgium: EU and UK agree on measures to improve sustainable fishing on shared stocks

International fishing of shared or cross-boundary stocks has been one of the areas of unfinished business in Brexit, even though such fishing was, along with illegal immigration, the driving impetus behind the UK decision to leave the EU in the first place. Most of the species in EU waters in or directly connected to the Northeast Atlantic are shared with other countries, especially the UK. From the beginning of Brexit, disputes over such access have been bitter.

Recently, however, the two parties—negotiating in the EU-UK Specialized Committee on Fisheries (SCF)—took some major steps forward, reaching agreement in three important areas for improved bilateral fishery management. These areas are:

1. A mechanism for voluntary transfer of fishing opportunities between the EU and the UK,

2. Common guidelines for notifying management measures to the other party, and
3. Improvements in the management of four shared stocks, namely lemon sole, witch flounder, turbot, and brill.

The agreement on a mechanism for transfers of fishing opportunities means greater efficiency in reallocating fish quotas between the parties, even with a single fishing season, much like the system existing between EU member states. The guidelines for notification of management measures help each party to adjust to changes made by the other in a timely way. The agreement on four important shared fish stocks sets out clearer means for setting Total Allowable Catches, based on ICES advice, to reduce the risks to stock sustainability from the English Channel to the Skagerrak that have been observed in recent years.



The mechanism will help fleets on both sides to tailor the distribution of fishing opportunities to specific operational needs.

According to Virginijus Sinkevičius, EU Commissioner for Environment, Oceans and Fisheries, these agreements demonstrate that the EU and UK can work effectively together under

the framework of the underlying EU-UK Trade and Cooperation Agreement. These agreements will improve the sustainable management of shared fishing stocks and support both parties' fleets.

## Estonia: Funds available to encourage cooperation among stakeholder groups

Madis Kallas, Estonia's Minister of Regional Affairs, has announced a package worth EUR8.6 million for development of the country's fisheries, aquaculture, and exploitation of other living aquatic resources. The ministry hopes the financial boost will encourage cooperation between businesses, non-profit organisations, and research and development institutions active in the aquatic resource sector. We hope that the collaboration will generate innovative ideas that will lead to positive economic outcomes, a smaller environmental imprint, and a better image for our fisheries, Mr Kallas said.



Estonian fishing boats in Läänemaa.

Fund recipients will gather and evaluate data, as well as coordinate information campaigns. Support is also contingent on close cooperation with economic

operators and local fisheries action groups. The fund's budget of €8,657,000 includes €3,121,000 allocated for the transfer of knowledge in fisheries, €1,415,000

for the transfer of knowledge in aquaculture, and €4,121,000 for the transfer of knowledge in the exploitation of living aquatic resources.





## Estonia: New Deputy Secretary General for Fisheries Policy and Foreign Affairs

Tõnis Tänav has been appointed the new Deputy Secretary General for Fisheries Policy and Foreign Affairs in the Estonian Ministry of Regional Affairs and Agriculture as of 1 July 2023. Mr Tänav has a PhD in economics from the University of Tartu and has worked with risk analysis at the Agricultural Registers and Information Board. He was also a junior researcher at his *alma mater* and lead analyst at Enterprise Estonia, an Estonian national foundation promoting economic development in the country. Before his promotion he was head of research and development in the Ministry of Rural Affairs.

According to Marko Gorban, Secretary General in the Ministry of Regional Affairs and Agriculture, Tõnis Tänav's experience and

competence in innovations were the main reasons for his selection from the four applicants for the position. "In the coming years, many sectors, including fisheries policy, will face significant challenges that will require strong input and effort from the ministry to ensure that people, businesses, and communities in all regions of Estonia prosper" said Madis Kallas, the Estonian Minister of Regional Affairs and Agriculture. With his background Tõnis Tänav will fit very well into the new structure of the ministry where he will seek to turn the challenges facing the fisheries sector into opportunities for development.

Some of Tõnis Tänav's priorities will concern discussions on various green transition initiatives



**Tõnis Tänav, Deputy Secretary General for Fisheries Policy and Foreign Affairs, Ministry of Regional Affairs and Agriculture, Estonia**

at EU and national levels, as well as the launch of a new cycle of the European Maritime, Fisheries and Aquaculture Fund, which provides support for innovative projects that ensure aquatic and maritime resources

are used sustainably. The new Deputy Secretary General is certain that with knowledge-based policymaking and innovation systems, Estonia will greatly benefit from the talks and funding opportunities.

## Denmark: Tuna monitoring program includes an app for anyone who "sees a tuna"

There's a tuna! I need to record my sighting. Now you can, with an app created by researchers with the National Institute of Aquatic Resources at the Technical University of Denmark (DTU Aqua) for its annual tuna tagging project.

Like similar monitoring programs, DTU Aqua's project included tagging and releasing tuna, but that requires actually getting one's hands on a fish. With the app, anyone who so much as sees a tuna -- whether from a fishing boat, a cruise ship, a ferry, even from a dock or beach -- can record their sighting with valuable information. The kind of

information requested by the app includes:

- place/position (where you have observed tuna),
- what you have seen (e.g. individual tuna, approximate number of tuna),
- the sizes of the tuna (e.g. approx. 0.5-1 m, 1-2 m, 2-3 m),
- time of day you saw the tuna, and
- any observed possible prey, such as herring, mackerel, or garfish, jumping out of the water to escape.

In addition, one can send a photo and/or video if/when possible. More information including the app is found at <https://www.aqua.dtu.dk/nyheder/nyhed?id=52aaefec1bc4-4b3c-9c2b-80740893c2e0>



**Bluefin tuna returned to Danish waters a few years ago after being a very rare guest for more than half a century. DTU Aqua invites beachgoers, yachtsmen, fishermen, crew and guests on ferries, tour boats, etc. to submit information through the app if they observe one or more tuna.**



## USA: Commerce Department imposes preliminary tariffs on tin plate used in canned seafood

A U.S. investigation has begun into unfairly priced imports of tin plate from China, Canada, Germany, and five other countries. The product is the sort used to make canned foods, including seafood. The investigation follows a petition from a mining company and a trade union. The tariffs preliminarily imposed range up to 123% depending on the country but may change after the final investigation.

In the United States, by WTO rules, such investigations are jointly carried out by the Commerce Department, which measures the extent of dumping (selling below cost) and subsidy (aid from government in the foreign country), and the International Trade Commission, which examines the extent of injury to a domestic industry producing a similar product.

Both agencies must find in the affirmative (finding the unfair act and finding injury from the act) before import tariffs are set. Each investigation has two stages, preliminary and final. The preliminary stage ends with a preliminary finding of an appropriate import tariff, before a longer and more involved final stage.

In this case into alleged dumping of tin plate a preliminary tariff has been imposed on tin plate imports from China, Canada, and Germany only; imports from the five other countries (South Korea, Netherlands, Taiwan, Türkiye, and UK) were found in the first stage to be not unfairly traded. The preliminary tariff levels imposed are 123 percent for Chinese tin imports, 5 percent for Canadian imports, and 7 percent for German imports, to offset the calculated



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**Canned seafood products account for about one-fourth of the seafood consumed in the U.S.**

margins of dumping below cost by exporters in each country. The case now moves into its final stage.

Industry reactions to the latest announcement were predictably mixed. The two petitioners Cleveland-Cliffs company and the United Steel Workers (USW), which in their petition had asked

for tariffs ranging from 47 to 300 percent, on tin imports from eight countries. The U.S. Can Manufacturers Institute, opposing the petition because they are tin plate importers, praised the exclusion of five countries and hoped the included three countries will be dropped too, after the final stage of the investigation ends later this year.

## Japan: Government starts controversial release of Fukushima water into the sea

After an earthquake and tsunami in March 2011, a triple meltdown of the Tokyo Electric Power Company's nuclear power plant in Fukushima Prefecture raised serious concerns about massive amounts of contaminated cooling water inside the plant as well as possible contamination of the water near the plant and any resulting effects on (among other things) fishery resources in the area. Fishery activity in the region was immediately curtailed but eventually resumed when officials were assured the seawater was not dangerous and harvested resources were safe to eat.

Now, the government has taken the additional action of allowing treated water stored in the disabled plant to reenter the ocean, a slow process that will take 30-40 years to complete. This has raised an outcry from citizens, including the members of Zengyoren (the National Federation of Fisheries Cooperative Associations), and even from the Government of China which is protesting the risk of contamination of its adjacent waters with actions that include a ban on all aquatic products originating from Japan. In late August Japanese prime minister Fumio

Kishida announced the planned water release, stating his government is assured that the plan is safe and will monitor the local seawater after the release to test for any negative results.

Before it imposed its import ban, the Chinese government called Japan "extremely selfish and irresponsible" by dumping the water into the ocean, spreading the risks to the rest of the world, and passing an open wound onto the future generations of humanity. It further stated that the ocean is the common property of all humanity, and forcibly

starting the discharge of Fukushima's nuclear wastewater into the ocean ignores international public interests. Japan's Foreign Ministry disputed China's claims, saying the release of treated water has been approved by the International Atomic Energy Agency.

Prime Minister Kishida also announced an JPY80 billion (EUR500 million) fund to support fisheries workers in the area, who have long suffered both production and market consequences of the plant meltdown.



## Iceland: Survey looks at public views on corruption in the fishing industry



**Icelanders consume more fish and seafood than any other country on the globe. According to FAO data for 2018, per capita consumption in the country reached 92 kilos.**

Most Icelanders think the fishing industry is corrupt but not so corrupt that the authorities should do much about it, according to a recent survey by the Social Science Research Institute of the University of Iceland for the

Ministry of Food, examining the country's fishery management system. The survey of 1,133 citizens determined that most Icelanders think the fishing industry created value for too few. More than half (56%) of the survey's respondents

"strongly" or "rather strongly" disapprove of the current state of affairs in Iceland's second most important export industry (after raw aluminum), while around a quarter (22.5%) reported "strong" or "rather strong" satisfaction.

Nevertheless, the majority also feels that fixing the problem should be near the bottom of the list of current government priorities.

Those with "little knowledge" of the industry and those with "much knowledge" had about the same shares of negative or positive views, according to the results. The survey was stratified by age, gender, and residence, in addition to knowledge of the industry. The majority (58%) of the population of all regions and age groups agree on the importance of fishing, but in Reykjavík, one-third said they disagreed. As for what government should do about it, respondents were asked to rank six systems – health, fisheries, transportation, welfare, education, and agriculture – according to where the most needed reforms are considered. The decisive majority (67%) answered: healthcare. Only 10% put the fishing industry first.

## Denmark: New guide to regenerative aquaculture aims to encourage sustainable farming

The recently published *Handbook for Sea Harvesters* seeks to change how aquaculturists view their operations, whether they are an established a commercial business, an emerging small farm, a fisher who also farms as a sideline, or a household growing its own food supply. The handbook, prepared by the independent institution Havhøst, shows how sustainable income streams can be created by farming sustainable aquatic resources, such as the many species of algae and shellfish that already are a growing sector all across Europe and beyond. Regenerative aquaculture supports a holistic approach to the symbiosis that is possible between ecosystems, human lifestyles, and business models.

The founder of Havhøst, Joachim Hjerl, explains that with the *Handbook for Sea Harvesters*, they try to pass on their positive experiences with regenerative sea farming to coastal fishermen and other local, commercial players. A huge untapped potential in terms of climate and commercial gains existed because for many years people did not have an eye on the necessary interaction between healthy ecosystems and healthy business models. Together with the Danish Small-Scale Low-Impact Fishers' Association and Producer Organisation, Havhøst has combined the experience of maritime farms with that from coastal fishing to create a series

of concrete recommendations on how you, as a commercial actor, can get started with regenerative aquaculture.

Hurdles to small-scale farming exist, such as getting legal permits, but many localities are easing the way when they see how farms can have positive rather than negative environmental impacts. Also, financial assistance is increasingly available from the EU as well as local or national sources. These and other practical issues (for example, what species can I grow and how?) are all addressed in the handbook, which is available at [www.havhost.dk](http://www.havhost.dk) (in Danish only).



**The book is relevant not only for Denmark as the commercial approach to regenerative aquaculture is highly important for other EU countries, where regenerative sea farming is spreading.**



## Albania: Italian aid to Albania's artisanal fishing seeks to modernise infrastructure

Albania is borrowing EUR25 million from the Italian government to improve infrastructure for artisanal fishermen and to build a fish market, the Albanian Deputy Minister of Agriculture for Fisheries said recently. The investment is undertaken mainly in the ancient city of Durrës, on Albania's central Adriatic coast. The project includes an increase in mooring capacity and landing sites, as well as a fish market in Durrës. The market is to be operated, with fishermen responsible as a group for employment, costs and receipts, and sales tax collection and payments.

The fisheries sector of Albania has not escaped the trends seen throughout the Mediterranean area of overfishing and aging equipment, vessels, and people. The average age of the fleet is 43 years, compared to the EU average of 30 years, and young people (as everywhere) do not find the industry's jobs attractive. External forces, including the high price of fuel, are hurting artisanal fishermen too. By better organisation of the industry, including improved infrastructure, the Albanian government hopes to improve its efficiency and economic viability.



Eurofish

**After Russia's invasion of Ukraine in 2022, fuel prices rocketed causing a drastic decrease in fishing activity and production in Albania. In February-April last year the number of fishing days fell by 1,300 compared to the same period in 2021, and the same situation was observed in May-June 2022, bringing sea fishing almost to a halt.**

## Spain: Breakthrough in bluefin tuna aquaculture

Bluefin tuna aquaculture is difficult. For one thing, bluefin have a hard time producing eggs in captivity due to stress. Therefore, until recently, this species has more successfully been ranched rather than farmed, by holding wild-caught fish in cages to fatten them up before harvest. Moreover, the idea of farming them in land-based facilities seemed far-fetched at best. But things have suddenly changed. In the first-time-ever category of achievements, researchers from the Spanish Institute of Oceanography in the Region of Murcia have managed to reproduce the bluefin tuna (*Thunnus thynnus*) in an onshore facility.

The institute has a facility, based in Cartagena, which the Ministry of Science and Innovation has declared a Singular Scientific and Technical Infrastructure for Bluefin Tuna Farming, that is used for controlled bluefin reproduction. It contains two big tanks (20 and 22 meters in diameter and 10 meters



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**Although in the past bluefin tuna was considered a low-class fish, as it spoils easily and smells, nowadays it is the most sought fish species in the world. Overfishing and illegal fishing caused a severe decline in the bluefin population, however, in the past few years a slight increase of the stocks has been observed. Will aquaculture be a solution?**

deep), and two smaller ones (14 and 8 meters diameter) with combined seawater capacity of 7 million liters. Two groups of bluefin tuna populate the tanks, one containing 25 fish born in 2017 and the other eight fish born in 2018.

In July of this year scientists injected hormones into the second group of tuna to induce final maturation and egg laying, thereby overcoming the stress-caused difficulty noted earlier. Three days later the tuna produced 3 million

eggs. While the Institute had done this with tuna in sea-based floating cages, this had never been done in a land-based facility. The next step is to see how the newborns survive and, in the future, perhaps reproduce themselves.





# 51st WEFTA CONFERENCE

## Conference of the Western European Fish Technologists' Association – WEFTA

The 51st Western European Fish Technologists Association (WEFTA) Conference will take place in **Copenhagen, Denmark from 16th-20th October 2023.**

WEFTA is the central platform in Europe for institutions engaged in fish processing, applied food science, aquaculture, seafood technology, health effects of seafood consumption and consumer studies. WEFTA aims at improving safety and quality of seafood on and from the European and other markets through research within this area. Research activities of the WEFTA institutes are coordinated to the benefit of research institutes, the fishery industry, consumers, stakeholders and governments. The annual WEFTA conference is a valuable occasion for scientists, students and the seafood industry to meet and present recent research achievements and to share experience. Besides, the conference constitutes an outstanding forum for discussions and networking.

WEFTA consists of 17 European universities and organisations within fisheries and aquaculture research

in Europe (Belgium, Poland, Finland, Croatia, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and Türkiye).

The theme for this year's conference is:  
**Sustainable utilization of aquatic resources – changing the way we Seafood.**

Through the following topics, we intend to broaden our knowledge and thus the way we Seafood. All aspects of fish technology, which lead to sustainable utilization of aquatic resources, can affect the way we Seafood.

The topics will be:

- Sustainable aquaculture and its link to seafood quality
- Micro-/macroalgae and its applications in food
- Side streams for food and non-food products to reach zero waste production
- Processing and quality of seafood
- Safety and authenticity
- Consumer attitudes, societal challenges and seafood products



## Italy: Invasion of blue crab poses risks to Mediterranean fisheries

Continued invasions in Mediterranean waters of blue crab, a native of the Atlantic coast of North America, are creating trouble for fishermen and shellfish stocks in Italy, Albania, and other countries, industry and government officials report. The crusty invaders are assumed to arrive in the ballast water of shipping vessels, which is collected along western North Atlantic coasts and discharged often untreated into the Mediterranean. The crabs have no natural predators here and adapt quickly, voraciously consuming local crabs and other shellfish to the point of endangering the ecosystem and the local economies that depend on Mediterranean natural resources. In the western Atlantic, blue crabs are a favorite food of sharks, rays, and other predators, but thrive unchallenged in parts of the Mediterranean.

One solution that has been proposed – eat as many as you can



Mark Steinicki

**Blue crab – so beautiful, so delicious, so dangerous.**

catch – has resulted in about 326 tonnes of harvested crabs in Veneto so far this year but with little observable dent in their population growth. One industry official complained that fighting with a cookbook such a widespread emergency that was

causing thousands of fishermen to struggle was wrong. We need a serious programme to control the blue crab in our waters, he said, adding that it was a mere illusion to hope to eradicate this species in the short to medium term. According to the fishers'

association Fedagripesca-Confcooperative, the crabs had already caused economic damage of about EUR100m in Italy as a whole and have devoured up to 90% of young clams in the Po delta, severely threatening future production.

## Spain: Selling commercial fishing to tourists helps fishermen bring in extra income

Want to be a commercial fisherman for a day? A digital reservation platform in Spain that works with the fishing industry, offers trips onboard fishing vessels and other educational but fun activities such as workshops for landlubbers who fancy a taste of what a real job is like. This company, and others, have developed a business that is growing every year, catering mostly to foreign visitors except in Galicia where the market is mostly local. *Pescaturism*, or fishing tourism, is more than a dockside tourism attraction, it educates and informs the public about an artisanal industry that battles decline as young people increasingly leave for the big

city. Furthermore, the fishers and their artisanal vessels and methods that bring the catch from the sea face threats from industrial fishing that may be more efficient but may be less sustainable.

This subsector of Spain's fishing industry has attracted the attention of the Secretary of State for Tourism, to create a national fishing tourism network that has launched this activity. Nearly a dozen entities from all over the Spanish coast have joined this initiative, to combine the proposals for visits on board, gastronomic fairs and hospitality businesses involved in the dissemination of marine heritage.



**Tourists interested in angling can book a tour with a professional fisher in many ports in Spain. Visit <https://www.pescaturismospain.com/> for details.**

As it evolves, there will be vocational training, where participants become certified fishing tourism workers, with all the various skills in fishing including

knot tying, first aid and emergency response, dockside maintenance and management, and more. The certification course will begin in 2023-2024.



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## Italy: A new producer organisation for red shrimp will help protect a valuable Sicilian resource

The Gambero Rosso PO Blue Sea of Mazara del Vallo has been formed at the mouth of the Maraza River in southwestern Sicily, with the task of protecting the sustainability of the red shrimp resource and the economic life of the people who depend on it. The PO's main focus, it says, is consumer involvement and education, teaching people about the entire production process from capture to display in the marketplace. The goal lies in teaching not just how to cook red shrimp, but also where it comes from—its natural environment and its fragile ecosystem, the importance of sustainable fishing, and conservation of the red shrimp stocks. The PO's focus broadens

to people, too: to ethics and social responsibility with regard to fishing.

We will transmit the history and development of this activity, says Maurizio Giacalone, president of the PO, the treatment reserved for our valuable personnel, the cutting-edge technologies always used with an eye on the blue economy, and the process of integration between the peoples of the Mediterranean that is recorded along the supply chain. All of this encourages the local community's involvement in protecting their region's valuable marine resources. This ensures the sustainability of red shrimp populations but also of the people's traditional ways of life.



**Gambero Rosso (*Aristaeomorpha foliacea*), the giant red shrimp lives in the muddy seabed of the Mediterranean Sea, feeds on plant organisms, and is fished at a depth ranging from 200 to 1,000 meters, using trawls.**

## Hungary: HAKI Days discusses the future of Hungarian aquaculture

The 47<sup>th</sup> HAKI Days, a Scientific Consultation on Fish Production was organized on 7-8 June 2023 in Szarvas, in the Research Institute for Fisheries and Aquaculture of the Hungarian University of Agriculture and Life Sciences. The conference focused on defining strategic directions for the development of Hungarian aquaculture and generated a high degree of interest as shown by the 154 participants from higher education, research, industry, nature protection and from government ministries who participated in the event.



**Participants at HAKI Days, a conference on freshwater fish production, contributed with comments and suggestions regarding the direction of Hungarian aquaculture.**

The conference was opened by Bela Halasi-Kovacs, the director of HAKI, and participants were welcomed by Istvan Nemeth, the president of MA-HAL and Mihaly Babak, the mayor of Szarvas. Based on the main topic, plenary sessions targeted subjects like freshwater aquaculture in Europe, directions for innovation in

Hungarian fish production, main challenges and possible solutions in pond fish production from the perspective of fish producers, and the complexities of aquaculture and fish production in natural waters. During the panel discussions following the plenary sessions the audience contributed to finding solutions to different

challenges of aquaculture development. Conclusions from the discussion shaped the Hungarian position at the International Carp Conference also held in Szarvas a couple of months later.

In the final stage of the event scientific results were presented in person and as posters by national

and international researchers from a variety of fields including aquaculture technology and fish management in natural waters. The width and depth of discussions at HAKI Days showed once again that it is a useful and informative event for freshwater aquaculture stakeholders in Hungary and beyond.



**DanFish**, 10-12 October 2023, **Aalborg**

# A must-attend event for the global fishing sector



DanFish International takes place on 10-12 October in Aalborg Congress & Culture Center (AKKC). It is the 28<sup>th</sup> time this key fishing industry event is being held. The last time the show was held, in 2021, corona restrictions were still in force. The organisers therefore look forward to welcoming the industry to an event not overshadowed by the pandemic.

There is an almost fifty-year tradition behind this event, which has grown over the years to establish itself firmly as the most international fishing industry exhibition in Europe, consistently attracting visitors and exhibitors from all around the world. It has not always been this way. Since the 1990s, what had been a modest local event successfully partnered with the Danish Ministry of Foreign Affairs to attract overseas visitors. The rest is history.

## Exhibitors and visitors from around the world

DanFish is a genuinely global exhibition, attracting partners, clients, and colleagues from across the world, says Francis Parrott of Notus, a Canadian electronics company and long-standing exhibitor at DanFish. Despite recently emerging from the pandemic, the previous DanFish event was a remarkable success, he continues, and we look forward to our return to Aalborg this year and beyond, continuing the momentum of this thriving exhibition. The 2021 event was limited in size as it took place under difficult circumstances because of restrictions on travel introduced in response to covid. However, now that the world has come back to normal, DanFish International



**Visitors to DanFish can expect to meet companies representing the entire range of products and services for the fishing sector.**

looks forward to welcoming participants to a restriction-free exhibition.

It is a relief to many that visitors can again visit Aalborg again without having to be concerned about restrictions. We are aware that both exhibitors and visitors look forward to participating in the DanFish exhibition in October without being hampered by corona restrictions, says Else Herfort, Head of Sales and Expos, AKKC. Everyone is looking forward to coming to the event, feeling the atmosphere and seeing the many products.

## New midweek format gives attendees a full weekend at home

In response to comments from exhibitors and visitors DanFish International has chosen an innovative approach for this year's event. For the first time, the exhibition will take the form of a midweek event. It has been many years since the extension of the exhibition into Saturday was abandoned in response to those who were tired of business events regularly taking place on the weekends. Now, DanFish's organisers have gone a step further: this

year's event opens on Tuesday and ends on Thursday evening, giving participants the opportunity to travel home for the weekend.

## Showcasing the world's fishing industry

This year DanFish is back in full swing with 7,000 square metres of exhibition space at Aalborg's AKKC venue, and an additional 4,000 square metres of space set up specifically for the busiest fishing industry event in the northern hemisphere. While the exhibition centre itself buzzes with activity for



three days, the city's hotels, restaurants and other venues will benefit from the event as thousands of visitors come from around the world to exhibit, look for new business, inspect the latest developments, and catch up with innovations in the fishing industry. For Thyborøn Trawldoor, a Danish trawl door manufacturer, DanFish is a big deal. It is the biggest international exhibition, well visited by decision

makers from all over the world, and even better, it is right here in Denmark, says Henrik Andreasen, the company's sales manager. Its international credentials notwithstanding, DanFish offers an unparalleled opportunity to show the world what Danish craftsmanship, quality, and development are all about.

Zusanna Slowik, [info@eurofish.dk](mailto:info@eurofish.dk)

#### Organiser:

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#### Admission:

Early bird prices (before Monday, 9 October, 18.00)  
Day ticket: DKK150  
3-day ticket: DKK250

Prices at the entrance  
Day ticket: DKK200  
3-day ticket: DKK300

**EU consumers** reduce seafood consumption and find substitutes in response to higher prices

## EUMOFA talk on consumer behaviour

The European Market Observatory for Fisheries and Aquaculture products (EUMOFA), an initiative of the European Commission Directorate-General for Maritime Affairs and Fisheries (DG Mare), hosted an insightful talk titled "Seafood on a budget: How EU consumers are adjusting to reduced purchasing power" on 5 July.

During the two-hour event moderated by Francesca Barazzetta from EUMOFA, three experts from the sector discussed the profound impact of external shocks, including Brexit, the COVID-19 crisis, and the Russian invasion of Ukraine, on the fishery and aquaculture markets. They explored how consumers are adapting to these challenges while striving to maintain their seafood consumption in an increasingly cost-sensitive environment.

### Understanding factors affecting demand

The event was opened by Christophe Vande Weyer, Policy officer in DG Mare, who highlighted the significance of the topic. Showing the perspective of the commission, he emphasised how the fishery and aquaculture sector has experienced considerable disruptions in the last years, such as social distancing measures and increased fuel costs, which have mainly affected the supply side. However, the European

Commission supported this talk as it would shed light on the demand side as general inflation affected consumer purchasing power.

Dimitar Taskov from the Food and Agriculture Organization of the United Nations (FAO) discussed trends in demand for eco-labelled fisheries and aquaculture products in the European Union (EU) amidst the challenging economic situation. Rising global food prices and their implications for food security were highlighted. Consumers react to increasing prices by adopting strategies like reduced consumption or substitution. The market responses varied across EU countries, showing heterogeneity in consumer behaviour. Eco-certification, a market-based approach to sustainability, was discussed as it relies on consumer choices to drive sustainable production. While price premiums associated with eco-labels may decrease over time, the overall quantities of certified seafood are expected to increase, driven by retail and production commitments.

### Healthful and sustainable products increase in popularity

The second speaker, Els Bedert from Eurocommerce, provided valuable insights into the evolving consumer demands in the retail and wholesale sector. Today's consumers are not only concerned about the taste and quality of their seafood but are increasingly conscious of their health and environmental impact. As a result, there is a growing preference for healthier and more sustainable food options. Bedert also emphasized the need for greater transparency in the supply chain, as consumers demand more information about the products they purchase.

She explained how digital transformation has revolutionized the way consumers interact with the retail sector. The convenience of online shopping and the integration of digital technologies into everyday shopping experiences have become pivotal factors in shaping consumer behaviour. However,

between the economic challenges, affordability remains a significant concern. As seafood prices rise, consumers are becoming increasingly price-sensitive, leading to a shift towards cheaper alternatives. The COVID-19 pandemic further exacerbated these challenges, causing uncertainties that affected consumer confidence.

### Italian consumers adjust consumption in response to rising prices

Finally, Patrizio Piozzi from the Italian Institute for Services for the agricultural ministry (ISMEA) shed light on the specific situation of the fish and aquaculture sector in Italy. The country has seen a decline in domestic production leading to a heavy reliance on seafood imports to meet the demand of its population. Despite this dependence, fish consumption in Italy has remained relatively stable. However, the economic crisis and rising inflation have impacted domestic consumption. Piozzi noted that seafood prices have increased



**Consumers are changing their consumption patterns in response to rising prices of seafood.**

in recent years, influencing purchase volumes and consumption dynamics. To address these challenges, the seafood industry in Italy, as in other EU countries, needs to consider diverse consumer profiles, considering factors such as family composition, age, and income levels. Supermarkets and superstores have emerged as dominant distribution channels for seafood in Italy, whereas traditional fish shops have experienced a decline in market share over time.

In conclusion, the EUMOFA talk provided useful information on how EU consumers are navigating the seafood market in the

face of economic challenges. As the fishery and aquaculture sector confront external shocks and changing market dynamics, the event emphasized the significance of sustainability and eco-certification as important drivers for the industry's future. While affordability remains a pressing concern, efforts from policymakers, retailers, and producers to meet consumer demands for healthier, more transparent, and sustainable options are crucial to shaping the future of seafood consumption in the EU.

*Francesca Barazzetta, Eurofish,  
francesca@eurofish.dk*

**Seagriculture EU 2023** highlights the potential of seaweed to address climate challenges

# Interest in seaweed is global

Seagriculture EU 2023, the leading conference for the seaweed industry, took place 21 – 22 June 2023 with resounding success, bringing together an impressive gathering of industry professionals, researchers, policymakers, and entrepreneurs from around the world.

The conference, hosted in Trondheim, Norway, showcased the immense potential of seaweed as a sustainable resource and explored innovative solutions to address climate challenges. With a record attendance of 221 delegates from 26 countries, Seagriculture EU 2023 witnessed an unprecedented level of participation. More than 130 companies and institutions from various sectors actively engaged in discussions, networking, and knowledge sharing, highlighting the global interest in seaweed farming and its wide-ranging applications.

## Field trips combine information with recreation

The conference featured an impressive lineup of keynote

presentations, with five renowned experts offering valuable insights into the latest developments and emerging trends in the industry. Additionally, a diverse panel of 30 speakers delivered seven informative sessions on topics ranging from cultivation techniques and product innovation to market trends and investments in the sector. In addition to the presentations, Seagriculture EU 2023 organized two field trips for attendees to explore the world of seaweed. The visits included an immersive experience at Korsvika beach, studying and tasting local seaweed species, and a tour of the SINTEF and NTNU laboratories showcasing cutting-edge research at the NTNU campus at Gløshaugen.

One of the highlights of Seagriculture EU 2023 was the trade

show which saw the participation of 14 exhibitors representing leading companies and organisations in the field of seaweed farming. The trade show provided a platform for the newest technologies, sustainable practices, and products that contribute to the growth and advancement of the industry. The event also featured an area with poster presentations, where 27 researchers presented their findings and engaged in discussions with fellow participants. This platform offered a unique opportunity to explore novel research and foster collaborations within the seaweed research community. We are thrilled with the success of Seagriculture EU 2023, says Kuno Jacobs, Managing Director of DLG Benelux, the organiser of the event. The enthusiastic

participation of industry professionals, researchers, and policy-makers underscores the growing recognition of seaweed as a vital component of a sustainable future, he stated, adding that the conference had played a pivotal role in advancing knowledge, fostering partnerships, and propelling the seaweed industry towards a regenerative economy.

## Spreading the message of sustainability

Seagriculture EU 2023 served as a catalyst for innovation, collaboration, and knowledge exchange, paving the way for transformative advancements in the seaweed industry. By bringing together a diverse range of stakeholders, the conference has accelerated the adoption of sustainable practices,



Some of the 220 participants at Seagriculture EU 2023 in Trondheim. The event illustrated the keen global interest in the production and applications of seaweed.

facilitated market growth, and positioned seaweed as a key solution to global climate challenges. Following Seagriculture USA 2023 which took place from 6 -7 September 2023 in Portland, Maine in the US, the next event will be Seagriculture EU 2024 on 18 - 20 June 2024 in Tórshavn, Faroe Islands. Next year's conference promises to be a unique experience including an exclusive site visit to Ocean Rainforest on 18 June 2024. It is the first time the organisers offer such an extraordinary site visit within the Seagriculture conference.

For more information on the conference, the organizers, pictures, contact details of speakers, applications for press passes, and barter deals, visit [www.seagriculture.eu](http://www.seagriculture.eu) or write [info@dlg-benelux.com](mailto:info@dlg-benelux.com).

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## Seafood Expo Global, Seafood Processing Global

# Companies look forward to 2024

Many of the Eurofish member countries were represented at Seafood Expo Global and Seafood Processing Global. Some of the companies are presented in the following pages. They illustrate the diversity and dynamism of the seafood sector with products and services to meet a variety of needs. The company representatives were very happy with the shows thanks to the contracts they had signed, and the contacts they had made. And they were unanimous in wanting to return to Barcelona next year.

Orahovica, Croatia

## Carp products available 365 days a year

Orahovica, a carp producer based in the Slavonia region in Croatia, had a stand at the Croatian pavilion at the Seafood Expo Global in Barcelona this year. The company produces three types of carp: grass, silver, and bighead. These species only feed on grass and plankton. Mr Gadzo reported that due to inflation in recent years, carp prices increased, preventing many consumers from buying it. He said it was a pity people could not eat carp at Christmas as they had historically done for generations. This year, however, with lower inflation and stable prices, Orahovica hopes that

consumers will return to their traditions and eat carp for Christmas.

To make fish accessible throughout the year, even when production is low, the company has introduced a line of value-added products. These are typically breaded fish items which are packaged and frozen after they have been processed. They include breaded fish chips, fish burgers, fish nuggets, and breaded carp steaks. The breaded fish chips could be sampled at the Orahovica stand and proved to be very popular. Mr Gadzo reported that their value-added products have saved their business, because whenever their



Katica Pekov, Marketing Manager, and Jakov Beslic Gadzo, Sales Manager, Orahovica



farms or the markets face any sort of trouble, they are able to produce to adjust to changes. Processing our fish and storing it for later has been the key to consistent distribution of our

products even through recent difficult times, said Mr Gadzo. These products are distributed in Croatia but are also exported to EU countries where carp is popular: Bulgaria, Czechia,

and Lithuania. In the coming year, Orahovica intends to produce 3,000 tonnes of fish. Most of this will be processed into value-added fish products, but some will be supplied as whole,

fresh fish. Part of the production will be exported live, for example, to Serbia and Bosnia where there is often a desire to see the fish swimming before it is purchased as proof of its freshness.

## Eurofish Napoli, Italy

### An association with a range of fish and seafood

In 1986, Eurofish Napoli was founded at the historic fish market in Piazza Duca deli Abruzzi in Naples as an organisation that promoted the development of the market, provide support to fishermen, and assistance to clients of the market. Ever since, the organisation has served as an important reference point and resource for those connected to the fish industry in Naples. More recently, the company has formed an association of fish producers from in and around Naples. The association currently comprises five members. Among them is an aquaculture producer, shellfish producers, a sardine producer, a brand offering other seafood, and a local fish

shop. Their aquaculture producer, Aqualife, grows and fattens bluefin tuna. While the market for bluefin tuna is dominated by Spanish companies, Aqualife has managed to hold its own successfully supplying bluefin tuna to wholesale and retail. Another association member, Oro di Nisida, has a mussel farm on the Italian west coast rather than Italy's Adriatic coast where mussels are typically produced. Oro di Nisida has been producing mussels on lines for ten years in the sea in the Gulf of Naples and also produces mussels in inland lagoons. The mussels are depurated and comply with all regulations needed to produce mussels for retail. According

to Biagio Cacciapuoto, the president of the association, one of Eurofish Napoli's primary goals is to encourage a connection between their current fishing practices and the Naples region's rich history. He says that their mussel farming practice mirrors the methods the ancient Greeks used in the region. Mr Cacciapuoto also explained that the consortium is looking to expand beyond the companies it already works with. In its mission to support biodiversity, local businesses related to the industry, and diversification within the fishing industry, Eurofish Napoli hopes to continue to work with a wide range of companies and organisations.



**Biagio Cacciapuoto, Eurofish Napoli, Italy**

## Carloforte Tonnare, Italy

### Value-added tuna products from a traditional trapping system in the Mediterranean

Carloforte Tonnare utilizes one of the oldest methods for trapping tuna, and their traps are some of the only remaining original tuna trapping systems to still exist in the Mediterranean. The trap has a series of chambers through which the bluefin tuna must swim through until they are finally captured. This sequencing makes the traps more selective, ensuring that the smaller and younger bluefin tuna are not captured. The fishermen are able to see the fish they have caught as they are dragged from the trapping system through the water, and often the fishermen can see when they have captured a fish that is too young for harvest, so they can release the premature fish

before they are brought on land. And, when tuna under 30 kg are captured, they are released. Through this process, the company works to ensure that their practice is eco-friendly and sustainable. Moreover, the path from the traps to the processing plant is shorter than any other tuna producer in the Mediterranean, so the carbon footprint of the process is limited. The company representative explained that the meat is more tender when the fish is captured in a trapping system compared to fish caught with hooks or nets because it limits the stress that the fish experience. The harvest season takes place only in May and June. After harvesting, half of their fish is processed and canned and the other



**Carloforte's canned tuna products are based on fish caught with an ancient system of traps.**

half is sold live to farmers. The tuna is canned depending on the part of the fish, and all of their tuna is preserved in an oil which is made from a combination of boiled fish and olive oil. This unique oil allows for efficient penetration of oil into the fish, so the

fish is cured quickly. The company always processes their fish fresh (it is never frozen), and the pieces of fish are hand selected before they are canned. All the Carloforte tuna is sold within Italy, much of which is sold in Sardinia specifically.

Mercamadrid, Madrid, Spain

## The world's second largest fish market celebrates its 40<sup>th</sup> anniversary

This year, 2023, marks Mercamadrid's 40<sup>th</sup> anniversary and the second year that Mercamadrid has a stand at the Seafood Expo Global. Mercamadrid is the wholesale market in Madrid which hosts 800 vendors of fish, fruits and vegetables, meats, and other food products. Last year, 417,000 tonnes of both imported and local fish were sold at the market with about 77% being Spanish fish. Mercamadrid is the second largest fish market in the world, with the Tsukiji Market in Tokyo, Japan being the first. The market is about the same size as Monaco, covering 220 hectares, or the equivalent of six football fields. More than 400 species of fish are sold at the market, of which the most popular are

hake, salmon, cod, and tuna. Hake was once the most popular fish at Mercamadrid, but in recent years, salmon sales have begun to compete with hake sales. Melanie Gonzalez, the market's customer service officer, said the majority of Spain's fish is sold in Madrid, where demand is the highest in Spain, even though Madrid is landlocked. Mercamadrid has 140 employees, but in total, 9,000 people work at the market, with 165 different fish vendors. Every day 14,000 buyers come to the market. Ms Gonzalez reported that since Covid, the fish sales volumes have not changed, but on a day-to-day basis fish sells more quickly. The market now sells out earlier in the day. Tuna sells out within the first hour of the market opening. The



**Melanie Gonzalez Vivero, Responsible for Customer Service; Ainhoa Garcia Lopez, Director of External Relations, Mercamadrid, Spain**

fish is transported from the coasts by truck and plane. The best buyers are in Madrid, so even when a fish is caught in the North, in Galicia for example, it is brought to the Madrid market first, and if it is not sold, it is transported back to Galicia for sale

there. Mercamadrid is for buyers only; non-buyers can only attend twice per month, and they must sign up in advance. There are also school visits and organized visits of the market for companies that are organized by Mercamadrid.

Kontali, Norway

## A database provides market predictions for fisheries

Kontali, a Norwegian database, is the world's most extensive database pertaining to aquaculture and fisheries. Subscribers have access to all sorts of information like production and market models, distribution volumes, and prices all for different fish species and countries. The predictions are quite detailed, outlining every generation of fish with long forecasts. Kontali's information can only be accessed through a subscription which can be done on their website ([www.kontali.com](http://www.kontali.com)). Subscribers can choose a species of fish and filter by country or region to learn more about its production. Their models predict production,

harvest, and market trends, and they are quite accurate; according to Ragnar Rønning, the company's commercial and sales director, last year's production model for Norway was off by just 1%. While data is limited for some of the countries that Kontali produces models for, through conversations with producers, fishermen, and representatives from markets all over the world, Kontali is able to produce models that prove quite accurate for fisheries and aquaculture. Fifteen analysts compare the markets in Europe, the United States, and Asia to solidify these models. Norway's new salmon tax is particularly interesting to Kontali, explained

Mr Rønning. It is not entirely clear how it will be implemented and it is difficult to predict its impacts because the tax is unprecedented. Kontali predicts that salmon volumes for the next year will likely remain the same because the fish eggs have already been laid, but in the years that follow it is likely that production will increase by 3-5% to compensate for the tax. Mr Rønning predicts that some salmon producers will have to drop out of the industry, but others will pick up the lost production. He even suggested that the market could support another 100,000 tonnes of salmon annually. Large volumes of salmon are not yet being produced on land in Norway—only a few thousand tonnes per month compared to 4 million tonnes that are produced annually in Norway (when considering all salmonids). Even with such high volumes, salmon remains a nice, high-paying, luxury product.



**Ragnar Rønning, Kontali's Commercial and Sales Director**



**Copego (Consorzio Pescatori Goro), Italy**

## Growing clams in tanks to evade the blue crab

Copego is one of the largest shellfish producers in the Goro area. Copego's representative Milena Montovani explained that the company originally focused only on year-round clam production in the Po Delta. It eventually introduced seasonal mussel production, which spans from March to August, with a small variety harvested in September and October. The variety with a longer season are particular to the Saca di Goro region. Copego began oyster production three years ago, offering two varieties: golden and black. The golden oyster is sweeter and more delicate than the black. While Copego is proud of their oyster and mussel production, Ms Montovani explained that clams remain their primary product; they produce 10,000 tonnes of clams

annually, making them the biggest clam producer at the national level. Since their mussels are seasonal, they only produce 3,000 tonnes annually. In addition, they produce one tonne of oysters per year since they too are seasonal, and production started only 2-3 years ago. However, Copego is investing heavily in oyster production. They utilize a unique system: when the oysters are very small they rest in containers which hang in a shallow part of the sea, and when the oysters grow, they are moved to a larger container. Copego monitors the tide, making sure it strengthens the muscle of the oyster. To do this, they remove the oysters from the water for eight hours each day while the tide adjusts to the ideal position for the oysters' development. Copego is building a new facility in response



**Copego's packaged clams are a popular product**

to significant increase in the blue crab population in the area which have been feeding on the young clams. The facility replicates the habitat of the delta and grows the clams in

containers until they are large enough to be reintroduced to the delta. The vast majority of Copego's sales are in Italy through Italy's biggest supermarkets, but they also export to Spain.

**Smart Packaging Solutions, The Netherlands**

## Solid board packaging for fish products

Smart Packaging Solutions, a part of the VPK Group, produces solid board packaging. According to André Giët, Account Manager of the company, solid board is preferable to corrugated board (standard cardboard) for packaging and shipping fish for many reasons. Solid board does not absorb humidity or lose its strength in humid conditions. Smart Packaging Solutions' product is extremely dense and compact because there is no air in it, making it heavy and strong. Solid board is not an insulator, so fish can be frozen inside the box, whereas with corrugated board, which is an insulator, this is not possible. The capacity to freeze fish within the box is crucial for

shipping. Solid board is also used to export meat, poultry, and flowers. Their solid board is sustainable as it is made of 97% recycled materials, and the product itself can be recycled, Mr Giët explains. In some instances, he adds, it is also being used instead of plastic. Additionally, transporting the boxes themselves is sustainable because they can be compacted for transport, fitting 25,000 boxes in a shipping container. The company has three production plants, two in Belgium and one in the Netherlands, but they work with clients all over the world. Mr Giët explained that with recent rises in energy prices, Smart Packaging Solutions' labor and energy costs increased, and they struggled



**Solid board fish packaging from Smart Packaging Solutions**

because of the extensive amount of energy and gas required for paper mills. As a result, the company had to raise the price of their solid board. Now, however, as the energy situation has improved production and product costs are returning to normal. Smart Packaging Solutions

can now concentrate on expanding its operations and developing new products for the benefit of its customers—and to remain competitive. Although we have only a few competitors in Europe, competition is intense and we cannot afford to be complacent, says Mr Giët.

Cromaris, Croatia

## Betting on organic fish

Cromaris is a leading producer and processor of fish in the Mediterranean Sea, focusing mainly on the production of seabass, sea bream, meagre, greater amberjack, and dentex. The company is based in Croatia, but also has a presence in Italy with Cromaris Italia Srl which opened in 2013. Italy's market for seabass and sea bream is the largest in the world, and Cromaris produces 8% of all seabass and sea bream sold in the Italian market. The fish is ISO certified, and in terms of sustainability, meets ASC, Global G.A.P. standards. In addition to their main fish production, Cromaris also offers a line of organic fish known as Bio fish. According to Mr Furlan, Cromaris's Bio fish are 20-30% more expensive

than traditional fish and make up 10% of their production. The most important markets for Bio fresh fish are Germany, France, Switzerland, followed by Italy and Baltic countries, where the demand for organic fish is larger than in other countries, according to Mr Furlan. Also, extra EU countries like USA and Canada are importing Bio seabream (mainly) and seabass. Mr Furlan reported that their stock of sea bream is still recovering from changes during Covid times, but that seabass production is normal. The company saw a rise in Bio fish sales during Covid, which Mr. Furlan attributes to the common desire to be healthier, but now that consumers are less concerned by Covid coupled with the current economic problems many consumers



**Davide Furlan, Administrative Director, Cromaris Italia Srl.**

are facing, their less expensive, non-Bio fish products are once again more popular. Bio consumption is still growing and showing a positive trend compared to pre-Covid period. Cromaris is hoping to

expand its Bio fish production in the coming years but must first understand the market and develop a communication plan to explain the benefits of Bio fish for the environment and sustainability.

Mariscadoras, Rimini, Italy

## Women combat the invasive blue crab in the Mediterranean

Mariscadoras was founded in December 2021 by Carlotta Santolini. The threat of the invasive blue crab to the Mediterranean's ecosystem drove the creation of Mariscadoras. The company's goal is to popularize blue crab with consumers, because humans are the blue crab's only predator, says Ms Santolini. Popularizing blue crab products will help the local ecosystem and fishermen alike. The Mariscadoras team is made up of five women, all from different academic backgrounds. Ms Santolini, a marine biologist, is supported by an anthropologist, an engineer, an economist, and a chef. Their range of backgrounds has made them a strong team and has contributed to the company's rapid progress, says Santolini. She also adds that they have had to work quickly because the

situation with the blue crabs is an emergency. Mariscadoras was named in honor of the Galician women who are fighting for gender equality in the maritime sector in Spain. The company is working with fishermen in the Northern Adriatic Sea where blue crabs are ubiquitous. Ms Santolini explained that originally, when fishermen caught blue crabs in their nets, they would simply throw them back into the sea. Explaining the importance of the blue crabs' removal to fishermen has been one of the most difficult tasks for the team. They have now negotiated contracts with the fishermen who now sell the blue crabs they catch to Mariscadoras. The crabs are processed into a variety of products like frozen whole crabs, crab sauces, as well as crab meat from different parts of the crab. Mariscadoras



**Ilaria Cappuccini, Giulia Ricci, and Carlotta Santolini of Mariscadoras**

collaborates with Tagliapietra, a larger fish producer that has helped distribute Mariscadoras' products, labeled as BlueEat, to some Italian supermarkets. There is demand for blue crab in Greece, Tunisia, Albania, Croatia, and Montenegro, and the company is working to grow demand, especially in Italy. At the start, it was difficult

to teach consumers about the importance of eating blue crab, but now there is more interest in Italy, and it is even more popular among consumers in Spain and the United States. Santolini and her team are optimistic that Mariscadoras can make a difference for the Mediterranean ecosystem and women in the fishing sector.



## Kraken Sea's ready-to-eat products

### Kraken Sea, Valencia, Spain

**K**raken Sea is a company based in Valencia, Spain that imports seafood products, processes them in-house, and then distributes them. Esteban Andrés Gómez, the company's commercial director, explained that the company imports giant squid, cuttlefish, and octopus and process it in Galicia. This can entail a variety of different preparation methods for their different seafood products. Some of what they distribute is just frozen squid, cuttlefish, and octopus, but what makes Kraken Sea stand out, is that much of the production is refrigerated, ready-to-eat products, says Mr Gómez. The company has a variety of recipes, some of which are traditional Galician recipes, that they use to make different sorts of salads. Some of them mix multiple

types of fish, and others combine a fish product with vegetables. Mr Gómez mentioned, for example, that some of their recipes use paprika or whole peppers to provide lots of flavor. Many of these salads are prepared in oil, so they cannot be frozen. These products are meant to be enjoyed fresh, and Mr Gómez explained that most of the company's ready-to-eat products are sold to bars and restaurants in Spain, where tapas is extremely popular. Our products are meant to be shared and enjoyed amongst a group of two or three friends, says Mr Gómez. The company's products that are not distributed to bars and restaurants in Spain are primarily sold in supermarkets in Spain, France, and Italy. Mr Gómez explained that they import their cephalopod raw material year-round most of which,



**Esteban Andrés Gómez (left), Commercial Director, and a colleague, Kraken Sea**

specifically their giant squid, come from Peru. The company's cephalopods are block frozen in containers for shipment, and when they arrive at the facilities in Valencia, they are either boiled and then frozen, cut and frozen, or cut, seasoned, and

refrigerated. The company is currently producing between 2,000-3,000 kilos per month. Mr Gómez said that this was the company's first year at the seafood show, and he was excited about the positive impacts their attendance at the show might have on the company.

## A Pulpeira, Galicia, Spain

### Galician octopus distributor honours female industry pioneers

**A** Pulpeira is a Galician octopus processor named in honour of the women who pioneered the octopus industry in Spain for generations, explained Carlos Quintela from the company. Historically, women oversaw the production and cooking of Galician octopus, and only in the last twenty years did men become "pulpeiros." The name of the company is feminine to honour the women's work. Most of the octopus the company imports come from Morocco and Mauritania. A very low quantity of their octopus comes from Galicia because the region cannot produce enough to meet the demand. The company processed between 500 and 600 tonnes of octopus just last year. We must

import octopus to sustain the industrial level at which we produce, says Mr Quintela. He explained that the octopus is frozen when it arrives at their facilities. Any residual sand is washed off, and then the octopus is cut. The company mainly supplies restaurants, hotels, and catering companies all over Spain, but Mr Quintela also discussed their partnership with Pescanova, who uses A Pulpeira's octopus and makes dishes with their own recipes which are then sold to supermarkets. A Pulpeira sells octopus which has been cooked in vacuum packaging without seasoning. The octopus is simply cooked and then refrigerated. This way, the octopus can be put in the microwave for a minute or so, and then it is

ready to be seasoned. This technology is commonly used for meat, but it is rarer with seafood products, so they are particularly excited to have recently implemented this modern cooking technology. In the interests of sustainability A Pulpeira has restricted their harvesting dates. They used to harvest octopus year-round, but now they only harvest between December and March, and again between July and September when it is safe to do so, and in line with sustainable fishing practices. Mr Quintela reported that consumption of octopus had stabilized in recent years, though he sees consumption spiking in the summer months when many tourists visit Spain.



**Carlos Freijedo Quintela, A Pulpeira**

Accompany and open up paths **into the future**

# Tapping into the performance potential of aquaculture more effectively

According to the EAT-Lancet Commission, where leading scientists define global goals for healthy and sustainable food production, aquaculture has been identified as one of the most efficient ways of providing the planet's population with protein. To better meet the demands, innovations are needed to drive the development of aquaculture. Where are we now and what can we expect in the future?

Aquaculture is already making an important contribution to feeding the population of the planet. However, in order to further increase production quantities in line with demand, a large amount of effort and a number of innovations, alongside considerable investments are required in all areas. Classic production systems such as ponds, raceways or floating net enclosures are intended to be more environmentally and animal friendly for the climate, especially with regard to the welfare of animals. It is anticipated that a greater share of the total output will be produced from recirculating aquaculture systems (RAS) and other land-based facilities, where water is circulated, treated, and reused many times. The operational costs must be greatly decreased in order to boost their economic efficiency, and additional energy-saving technologies and procedures must be developed. Global aquaculture is being increasingly hampered by the lack of fish meal and fish oil. The feed industry is searching for alternate, accessible, and reasonably priced raw material sources that can meet the nutrient needs of the fish species that are farmed. Most



**One of the most important innovations in aquaculture is the recirculating aquaculture system (RAS) which reuses the water after carefully filtering it for impurities.**

importantly, there is ongoing pressure to improve sustainability. The CO<sub>2</sub> and ecological footprint have to be reduced, water management must be optimized, animal welfare in aquaculture facilities must be better monitored and production processes need to be traceable and transparent.

Just these few examples already show us the multitude and scope of the challenges facing the

aquaculture industry worldwide. This is unlikely to be possible without targeted innovations. Especially since these goals are not only that of more efficiency, higher production and greater profitability, but at the same time promote sustainable and environmentally-friendly behavior. All of this is necessary if aquaculture is to continue to contribute to the future food security of mankind. Of course, aquaculture has already made

much truly spectacular progress. Some things happen so quickly that the changes and successes are only partially recognized by the public or even not at all. Some aspects are deliberately ignored by aquaculture critics. Just consider widespread but long-since debunked falsehoods like the ratio of 5 kg of wild fish to 1 kg of farmed salmon, the idea that salmon are pumped full of antibiotics, or the idea that prawn farms are mostly





**Recirculation aquaculture systems are complex and require trained personnel to manage them, but they allow adjustments to be made to all the parameters within the system.**

to blame for the destruction of mangrove forests. Even though manufacturers of fish feed use only 6 percent of the global soybean crop, which is substantially less than poultry producers (37 percent) and cattle breeders (20 percent), aquaculture is blamed for deforestation of the rainforest to cultivate soybeans.

### **Sustainability becomes the guiding operational principle**

Although aquaculture producers try to keep the extent of the environmental damage they cause as low as possible, certain environmental impacts cannot always be completely avoided everywhere – as is the case with any type of food production. In this context, however, it is often overlooked that, thanks to

innovative ideas, aquaculture occasionally also contributes to the restoration of damaged ecosystems and the preservation of the environment. An example of such restorative aquaculture is the company Urchinomics, which is helping to reforest kelp forests off the California coast that have been overgrazed by sea urchins. Divers collect the sea urchins so that they can be nursed in aquaculture facilities on soy and corn-free feed. Thanks to this high-energy diet, the echinoderms develop their plump, ripe roe within 6 to 10 weeks. A product of exceptional quality that is highly prized by discerning high-end diners. The kelp forests stand a much better chance of rebounding and becoming a habitat once more for a variety of marine creatures if the sea urchins are removed. Open Blue and Forever

Oceans, which have relocated their net enclosures 10 to 15 km offshore to farm cobia (*Rachycentrum canadum*) and the greater amberjack (*Seriola dumerili*) with minimal impact on sea floor ecosystems, are among the growing companies doing innovative work to protect the sensitive coastal ecosystems. Sometimes entirely new technologies are needed for this resettlement in open, usually unprotected sea areas, and these technologies come with significant advancements. However, there is also a chance of restoring the mangrove forests and sea grass meadows that were destroyed along the coastal strip. They fight against ocean acidification, absorb significant amounts of CO<sub>2</sub> from the atmosphere, and enable the slowing down of climate change as “blue-carbon ecosystems”. One must be aware

that approximately 33 percent of all anthropogenic CO<sub>2</sub> emissions are absorbed by the oceans.

Combating acidification, i.e., the worldwide trend towards falling pH values, also indirectly benefits aquaculture itself, because the carbonic acid in the water makes it increasingly difficult for mussels, crustaceans and other shell-bearing organisms to form protective, strong shells. There is a critical demand for innovation in the fields of animal welfare and the control and prevention of disease. One of the largest marketing obstacles for aquaculture products is the concerns that many consumers have about the use of pesticides, medications, and antibiotics. Some problems, such as the use of antibiotics in Norwegian salmon farming have been overcome for

a long time now, but they are still stubbornly held as important in public opinion. Perhaps there is a lack of clarity in how advances in this field are conveyed to and perceived by the public. Modern diagnosis and therapy methods are complex, and understanding them requires some basic scientific knowledge. Who knows how the DNA tests, hormone tests, or blood biomarkers that are frequently used to track cattle stress levels and detect illnesses actually work? Especially when they are increasingly being coupled with artificial intelligence evaluation methods. The potential for innovation in this area is enormous. Vaccination can prevent the outbreak of dangerous diseases. Mechanical, thermal, and other technical means are now being utilized instead of chemicals to eliminate sea lice in salmon aquaculture.

### New solutions for the environment and animal welfare

Innovative solutions are emerging, even in complex fields such as the animal welfare-friendly stunning of prawns and other crustaceans, which up till now was thought to be extremely difficult and unlikely. Ace Aquatec's shrimp stunner is designed to gently stun the shrimp in less than a second, without any stress to the animal, which is in itself a huge leap in animal welfare. Animal welfare has recently emerged as a critical driver of aquaculture innovation, affecting nearly every aspect of the industry. For instance, efforts are being undertaken to integrate various rearing technologies with the aim of minimizing emissions and waste while closing material and energy cycles. In studies, Biofloc cultures of whiteleg shrimp (*Litopenaeus vannamei*)



Keiran Magee, Aquanzo

**The company Aquanzo produces a marine ingredient on land from *Artemia* fed on ricebran and other agricultural byproducts. It is a more sustainable alternative to fishmeal.**

were combined with production of Nile tilapia (*Oreochromis niloticus*) in an integrated multitrophic aquaculture system, effectively utilizing suspended solids such as unconsumed feed and metabolic waste from both species. This allowed suspended solids such as uneaten feed and metabolic waste from both animal species to be put to good use. Similar advantageous combinations could also be explored for other species.

The potential for innovation in enhancing fish breeding toward "domestication" is far from exhausted. Out of approximately 450 fish species regularly cultivated in aquaculture worldwide, only around 100 have been influenced by breeding in such a way that one could speak of domestication, albeit in a broad sense. Apart from species like carp, rainbow trout, tilapia, salmon, sea bass, and sea bream, most aquaculture species still closely resemble their wild counterparts. Estimates say that just 10 percent of the global aquaculture production comes from genetically improved stocks. Selective breeding offers a highly effective means of boosting yields.

Breeding programs focusing on growth enhancement achieve an average of 10 to 20 percent higher growth rates per generation! Other breeding objectives, such as improved feed conversion, delayed sexual maturity, enhanced resistance to bacterial and viral diseases, and traits related to product quality (meat color, muscle lipid content, tenderness, taste), hold significant promise. Advancements in genomic selection have expedited and refined breeding processes. New tools such as SNP (Single Nucleotide Polymorphism) panels, advances in DNA sequencing and bioinformatics make it possible to move from family breeding to solitary breeding. This allows targeted modification of economically valuable traits, resulting in more robust and efficient individuals in a relatively short timeframe.

### Feed supply must not become a limiting factor

Ensuring an adequate feed supply is crucial. Innovations in feed are imperative due to the scarcity and costliness of marine resources like fishmeal and fish oil, necessitating alternative

sources that are as similar as possible. To achieve projected aquaculture growth, nearly 40 million tonnes more feed will be required by 2040, driving the search for suitable resources. Promising alternatives include various agricultural products, insect meal, microalgae extracts, and isolates such as single-cell proteins. Aquanzo, a company dedicated to the sustainable production of marine protein, uses ricebran and other agricultural byproducts to feed *Artemia* that is then processed to produce a farmed marine ingredient, similar to fishmeal or krillmeal but without threatening the ocean as it is produced on land. One of the main advantages is that it is scalable globally offering a sustainable alternative to fishmeal, says Remi Gratacap, Aquanzo's CEO. However, many of these surrogates can only be used for aquaculture purposes after undergoing extensive pre-treatment. As a result, prices are often too high or the quantities available are not sufficient to cover demand. For this reason, soybeans and soy concentrates continue to be favored by the feed industry, and although they are available in large quantities, they are highly



controversial from an environmental point of view. Thus, the search for alternative raw materials continues. Feed is an increasingly important issue for the growth and commercial success of aquaculture.

However, aquafeed innovation is not only about the selection and processing of alternative raw materials, but also about the formulas, i.e., the optimal composition of feed and nutrition. The industry is increasingly adapting products to the changing needs of individual animal species and different stages of life. There are already healthy foods to help fish get through the stressful times of their production cycle, as well as specialized diets that meet their changing seasonal

nutritional needs. Just as important as food is the feeding regimen. When, how often and how much to feed. Attempts are made to more closely match the dosage of each feed to the fish's appetite and feeding behavior, to avoid waste, maintain water quality, and save costs. For example, CageEye's technology uses state-of-the-art hydroacoustics to monitor changing fish densities and activity, and analyses the acquired data with machine learning algorithms. With the help of artificial intelligence, the system learns to more accurately assess fish behavior and decide for itself when and how much to feed, depending on the fish's appetite. This improves feed conversion and ensures optimal growth.

## Artificial intelligence optimizes management systems

Among them, the importance of virtual reality is on the increase. For example, aquaculture simulators are innovative, allowing farmers to "go under water" with the fish and gain a three-dimensional picture for specific situations on site, such as during feeding. One of the most important innovations in aquaculture is the land-based recirculating aquaculture system (RAS), whose production is currently very low compared to traditional methods around the world, but its importance in the future is expected to rise. They are intended to make some of the problems of traditional pond and net enclosure

cultures, such as water pollution, disease outbreaks, escapes and environmental risks to local ecosystems, more manageable. However, these benefits come at a price with prohibitively high investment and operating costs. A complex RAS requires a lot of know-how and a great deal of technical effort, and places very high demands on personnel training, making its use rather difficult in some parts of the world for the time being. However, that could soon change as innovative AI and software solutions take over the optimization and automation of RAS management here as well. The initial technical shortcomings of some turnkey plant concepts now seem to have been largely eliminated so that after any

# THE WORLD OF AQUACULTURE



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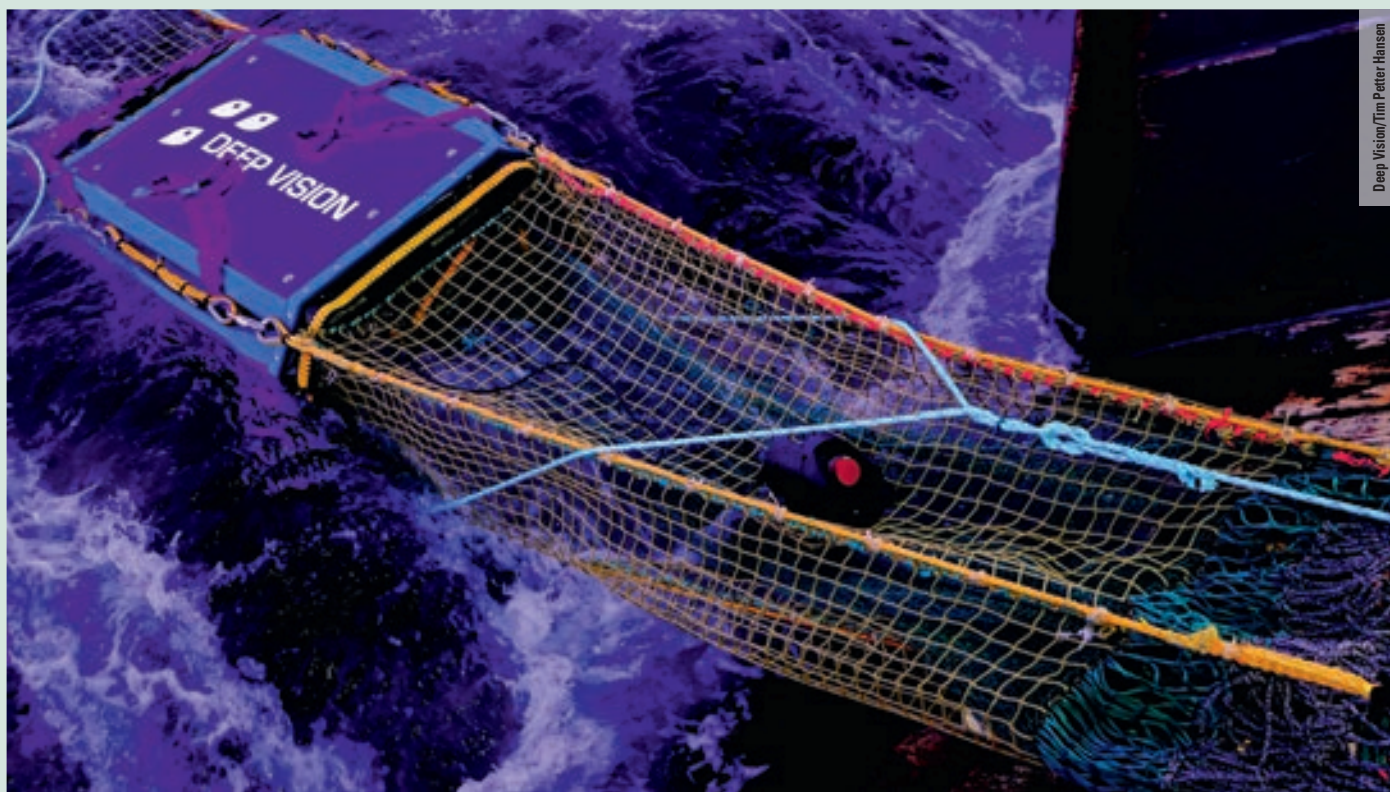
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**Underwater cameras, image recognition systems, and highly sensitive sensor technologies allow fish to be monitored individually ensuring better welfare of the stock.**

necessary innovations in the field of energy supply, nothing could stand in the way for its broader application, apart from perhaps the potential for further cost increases. Now that the proof-of-concept phase of this challenging technology seems to have been reached, the field now needs to mature and prove not only to be productive but profitable. Red numbers should turn black. Expectations are high for this innovative technology, as can be seen from the example of Canada, which is currently working to shift production from its offshore salmon farming industry to land.

However, the most important driver of innovation for the further development of global aquaculture is believed to be artificial intelligence and machine learning technologies, which are now permeating

almost all areas of life around the world. For example, AI opens up fascinating possibilities for operators to monitor and remotely control state-of-the-art cloud-based aquaculture platforms in real time, around the clock and based on certain environmental conditions. The same is true for farms in remote areas. This will open up entirely new possibilities and represent a major step towards increasing yields and profitability in aquaculture. Such a vision is based on innovative technologies such as surface and underwater drones, satellite imagery and sensor monitoring, where data can be meaningfully networked with each other, resulting in highly sophisticated control technologies and lower financial efforts. It's no longer pure science fiction. Reliable management systems already exist that constantly monitor key water quality parameters and

contribute significantly to protecting fish stocks from hazards such as extreme temperature fluctuations, lack of oxygen, and harmful algal blooms. But this is only the first step towards the goal of reducing the human factor in monitoring aquaculture production, making fish growth more efficient, yields more stable and even better.

Intelligent, technologically enabled management increasingly depends on cutting-edge ideas like precision farming, smart farming, and digital farming, which are frequently used interchangeably but mean different things. The transition from mass control to individualized monitoring of the fish and the advancement of fish welfare to a new level are made possible by underwater cameras, image recognition systems, and highly sensitive sensor technologies. This enables the fish

farmer to take preemptive measures in cases where a situation within the business spirals out of control and maybe becomes critical. Aquaculture innovation is constantly evolving. The Internet of Things (IoT), in which a lot of data and information is networked and allows a better overview of the entire system, ranges from better recycling of outdated equipment and devices to more energy-efficient pumps and environmentally friendly mooring systems (Marine Flex, for example, uses elastic bungee cords instead of heavy metal chains that sweep across the seabed and harm the local habitats). The general push towards digitization, improved 5G network coverage, and numerous new data collecting and analysis technologies mean that we are only at the beginning of a process that presents enormous prospects for the future. *Dr Manfred Klinkhardt*



Utilising copepods as live feeds to prevent *Vibrio* spp. infections in marine fish larvae

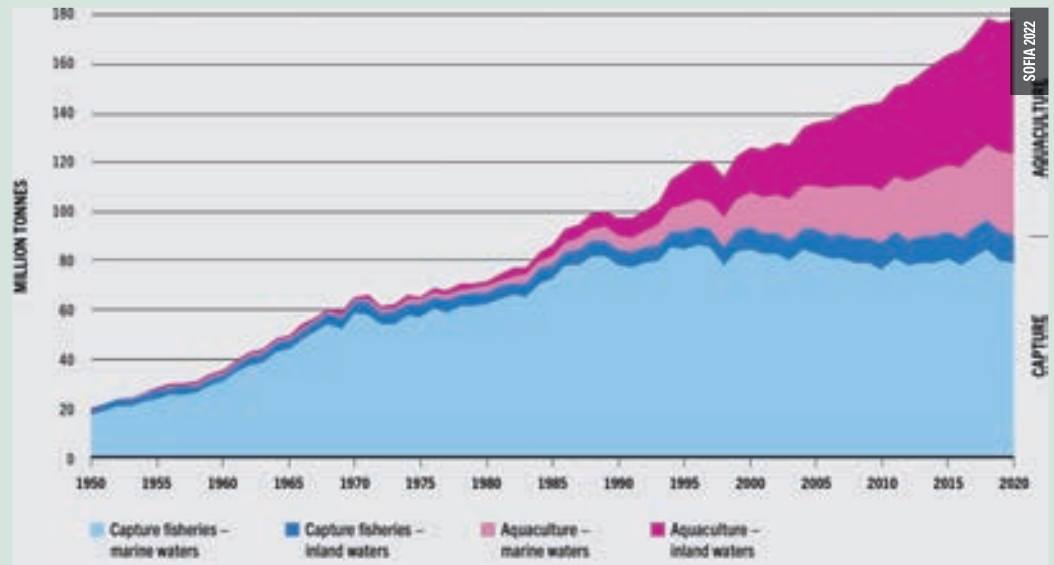
# Improved fish hatcheries could boost marine aquaculture

According to FAO's latest (2022) edition of *The State of World Fisheries and Aquaculture* marine aquaculture is growing but still produces only half the tonnage of freshwater aquaculture. When looking at fish from capture fisheries, marine species contribute by far with the largest tonnage, and there is robust demand for high value marine fishes.

One of the major bottlenecks within marine aquaculture is the supply of managed hatchery-bred fish larvae. Within freshwater aquaculture, most freshwater fish larvae are large when they emerge from the egg and can easily be fed with formulated feed pellets. For marine fish larvae, most larvae must be fed with live feeds from day one, and for some species, for up to a month after birth. Hence, in marine aquaculture hatchery production, live feeds like rotifers, *Artemia* and copepods are often the only options to produce marine fish larvae of high value species. Copepods, in particular, are important, as they are a natural live feed for fish larvae. In contrast to rotifers and *Artemia*, copepods are biochemically superior and do not need enrichment before being fed to the fish larvae. Further, copepods exhibit behaviour that triggers an attack response from many marine fish larvae.

## Preventing microbial contamination of fish larvae is critical

One of the obstacles to produce and use live feeds is microbial control, preventing pathogenic bacteria from being introduced to the fish larvae through the live feeds. The management of bacterial communities in live feeds has been widely studied in rotifers



Global capture fisheries and aquaculture production

and *Artemia*. For example, with regard to *Artemia* research a model system has been developed to understand, control, and protect against pathogenic bacteria in *Artemia* cultures. Whereas with copepod cultivation, and its use in marine aquaculture, very few researchers are working with pathogenic bacteria control. It is an understudied but very promising area of research in marine aquaculture.

*Vibrio* spp. are known fish pathogenic bacteria found in both fresh- and marine aquaculture and leading to severe production and economic losses for the aquaculture sector. The *Vibrio* genera are among the most common and widespread disease-causing

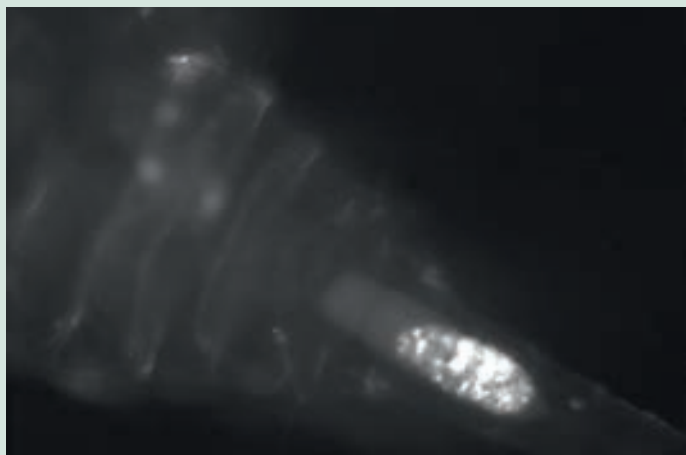
agents, and *Vibrio* infections play a leading role in constraining the growth of the aquaculture sector worldwide. Especially during the early larval stages of development, *Vibrio* species are a common cause of high mortality rates in reared fish. For juveniles and adult fish, vaccines are used to prevent *Vibrio*, but this is not an option in the larval stages since fish larvae are too fragile to vaccinate. Moreover, these early life stages are also where the fish larvae are highly susceptible to diseases such as *Vibrio*.

## A copepod variety that produces omega-3s

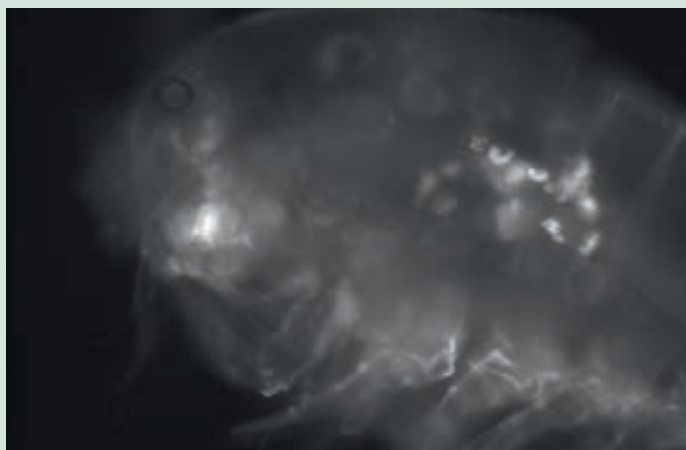
At Roskilde University (Denmark) researchers have been

cultivating a new promising tropical copepod species for use as live feed in marine aquaculture. The cyclopoid copepod (*Apocyclops royi*) is one of a few known copepod species that can biosynthesise fatty acids. They can be fed with, for example, yeast that only contains short-chained non-essential fatty acids and will then biosynthesise and prolong the fatty acids into long chained essential omega 3 and 6 fatty acids. Omega 3 and 6 fatty acids are just as essential in the diet for fish larvae as well as they are in the diets for humans.

Almost all other copepods need to obtain the essential fatty acids in their diets, hence the only



A faecal pellet is filled with *V. anguillarum* suggesting that the copepods ingest *V. anguillarum* together with the food into the gut system and then some is concentrated and expelled again through faeces.



A few illuminated colonies of GFP tagged *V. anguillarum* can be seen closer to the copepod's head as blurry white spots.

option is to feed them with the correct microalgae strains. This complicates copepod production and around 70% of copepod cultivation costs are solely related to the production of microalgae. So, removing this link in the production chain makes copepod cultivation easier and cheaper. Another huge advantage is that, when they are not restricted to microalgae, it is possible to experiment with other feed types that have pro- or prebiotic properties as well. Feed companies producing pelleted feeds or

derivates have developed different feed products with pre- and probiotic properties, that both target potentials within the gut of the fed species, and also the surrounding aquatic cultivation medium, as a bioremediation effect.

### Generating a carry over protection from copepod to larva is the goal

Now the job is “just” to find the correct feed, or the combination of feeds, and/or derivatives

to try to prevent *Vibrio* infections in live feeds and secure a potential carry over effect to the marine fish larvae in hand. This “treatment” with different feed types, preventing *Vibrio* in live feed, could reveal a preventive treatment, and thus save marine aquaculture hatcheries from many losses.

A recent master's thesis from Roskilde University investigated how different feed types affected *A. royi* when infected with *Vibrio anguillarum*, a so-called challenge experiment. To ensure that *A. royi* could be cultivated on the different feed types, multiple cultures were established and fed to *A. royi* for a minimum of a month before conducting the challenge experiment. This revealed that *A. royi* could be fed on microalgae, inert feed pellets and different derivatives, such as yeast. This outcome was not a surprise, since another recent study from this research group showed that *A. royi* is an ambush feeder. If it senses a prey or particle, it attacks and attempts to eat it<sup>1</sup>. So, a prerequisite for a feed for *A. royi* is that it needs to have the correct size and be able to stay in suspension in the culture water. After finding appropriate feed items the researchers challenged *A. royi* with different concentrations of *V. anguillarum* for three days. During this period *V. anguillarum* was tagged with a luminescent which was revealed when exposed to the correct wavelength of light (see black and white images).

Some of the other foods used in the study have, according to the producer, strong pathogen binding properties and will activate

several immune receptors. Yeast derivatives are examples of foods that in some cases show strong pathogen bindings or simply physically occupy the sites inside the gut of a species where a pathogenic bacteria would normally bind.

### Microalgae the most effective at preventing infection

A reduced effect of *V. anguillarum* colonies over time was observed on *A. royi* when fed some of these products. Surprisingly it was discovered that some microalgae diets were effective in preventing *V. anguillarum* infections. So, aquafeeds known to prevent *Vibrio* in shrimps did not have the same significant preventive effect in copepods, even though they are both crustaceans. On the other hand, microalgae worked very well in prevention of *Vibrio* for the three days of the experiment. This could either be due to the presence of another *Vibrio* strain or that the shrimps are a more advanced crustaceans than copepods. A possible explanation for less *V. anguillarum* infection in *A. royi* fed on microalgae could be because a diet of microalgae contains all fatty acids, and *A. royi* do not need to utilize energy to biosynthesis fatty acids, which is the case when *A. royi* are fed, for example, on yeast derivatives.

Nevertheless, interesting food candidates were found, and the next step is to carry out experiments over a longer time span. Another important step is to investigate possible carry-over effects to marine fish larvae. In other words, if a “*Vibrio* free”

<sup>1</sup> Zempléni, A., Hansen, B. W., Kiørboe, T., & Ryderheim, F. (2022). Resolving the paradox of the ambush feeding cyclopoid copepod *Apocyclops royi* being microphagous. *Journal of Plankton Research*, 44(6), 936-941



copepod is fed to marine fish larvae, does one weaken or boost the fish larvae so they will have less mortality even when challenged with *Vibrio*? The team claims to have good reasons to believe that they will see enhanced effects when they feed *A. royi* with

pro- or prebiotic properties to marine fish larvae.

*Associate Professor Per M. Jepsen; Naja Bech, MSc; Rasmus B. Sandvig, MSc  
Roskilde University  
Denmark*

The project ORACLE-FISH (J. no. 34009-22-2029) is part of the Organic RDD 8 programme, which is coordinated by the International Centre for Research in Organic Food Systems (ICROFS). It has received grants from the Green Growth and Development programme (GUDP) under the Danish Ministry of Food, Agriculture and Fisheries.

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# Fishing nets for commercial or recreational use

FIAP GmbH, a company in Bavaria, Germany, specialises in a wide variety of products used in the aquaculture industry. They range from devices used for water analysis, water purification, and aeration, through products related to fish processing and marketing.

One of FIAP's iconic products is the profinet Aluminum fishing net series. The company has developed fishing nets for a variety of purposes over several years. Over time, there have been many attempts to steal the designs and technologies used by FIAP, resulting in cheap products of inferior quality. However, FIAP has remained a leading producer of fishing nets on the international market due to its high quality standards and the constant improvements to its products.

## **FIAP profinet Aluminum—always reliable quality**

The main advantage of the profinet Aluminum is that the devices are light yet sturdy due to the material they are made from. Among the features contributing to its durability and to user-friendliness is the aluminium bracket system, which is reinforced for strength and

resilience. The net is pulled onto the rail in the bracket and flexibly secured with plastic beads allowing for easy removal and replacement when necessary. Moreover, the latest version features a new and improved handle clamp.

The nets themselves come in different sizes to meet every need. Options are available in terms of frame width and mesh size and spare parts such as extra nets, beads, clamps, or handles can all be ordered from the company's website. The handles can in length from 1.10 to 1.80 meters and can be chosen to fit the user's preference. Other important variables relate to the depth of the net and the width of the aluminium frame, which can range from 30 to 60 centimetres. An interesting feature of FIAP profinet Aluminum is that the depth of the net mirrors the width of the frame in each of the models. Lastly, with each size of



**The profinet Aluminum is a series of fishing nets designed for the commercial as well as the recreational user.**

the product, nets with different mesh sizes are available—from 5 to 20 millimetres. The nets are suited for use by commercial fish farmers, production companies, and even recreational fishermen.

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Active sludge and intelligent disease control in **recirculated aquaculture systems** (RAS)

# Improving aquaculture's sustainability credentials

To reduce nitrogenous and phosphorous waste in recirculated aquaculture systems (RAS) new technologies are warranted. The development of novel methods to control disease will further reduce the environmental impact as well as improve the economics of fish farming. The aim of this project is to reduce the amount of nitrogenous and phosphorous waste using active sludge technology and to further reduce the occurrence of disease by developing a surveillance system using only water samples from RAS.

Farmed production of fish for consumption is on the increase worldwide and to control and reduce the environmental impact, RAS systems are becoming more popular. In these systems, a large proportion of the water is recirculated, and larger particles, proteins and nitrogenous waste must be handled. The production of fish in Denmark is regulated based on the environmental imprint of the farm and therefore there is an environmental and economic interest in reducing the emission of nutrients. In RAS, like in any other farming system for animals, there are risks

of outbreaks of disease and because most of the water is recirculated in RAS, outbreaks can be severe and can affect the entire production at the time. This creates economic losses, increased nutrient waste (e.g. feed that has been wasted on fish that die) and welfare issues (fish suffer when they die from diseases). The latter are becoming more and more important for consumers.

To accommodate these problems, the project *Active sludge and intelligent disease control in Model 3 and FREA/RAS farms* funded by the Fisheries Agency

under the Danish Ministry of Food, Agriculture and Fisheries focuses on the use of active sludge technologies to reduce the release of nutrients from both fresh- and saltwater fish production. Furthermore, the project seeks to develop a tool for surveillance of disease using only water samples.

## Active sludge technology reduces nutrients in waste water

Active sludge technology is not new, it has just not been implemented in full scale recirculated systems yet and that is what the partners in this project wish to do. The partners have constructed a small-scale active sludge facility and are testing this on salt- and freshwater.

Using this technology, the wastewater/discharge outlet from a drum filter within the internal water treatment system of the fish farm, is led into the active sludge treatment system, where the nitrogen and phosphorous content is reduced. Without an active sludge system, ammonia will be transformed into nitrate by nitrification in the aerobic biofilter systems, which are installed in the RAS fish farms. Within the active sludge

treatment system an anaerobic environment will be maintained, which is required for the development of denitrifying bacteria. Subsequently, nitrate is transformed into free nitrogen. The denitrification process requires an organic carbon source, which ideally is provided using the sludge from the fish farm. The sludge which develops within the system, is to a large degree composed of denitrifying bacteria.

The active sludge system consists of 4 different compartments (Figure 1). The outlet from the fish farm is led to the first compartment, and then the water is led into tank 2 where an additional carbon source needs to be added to intensify the denitrification process. Then the water and sludge are led into tank 3 where phosphorous is precipitated with iron chloride and the matter is aerated to release  $N_2$  to the air. Finally, the matter is led into tank 4 where the water is separated from the sludge (Figure 2). A proportion of the sludge is then harvested while another proportion is led back to tank 1 where the process starts all over again. The water is then discarded with much lower content of nitrogenous and phosphorous waste.



**Figure 1.** A small-scale active sludge system. In tank 1 wastewater from RAS is added and denitrification begins. In tank 2 a carbon source such as sludge or methanol is added to increase the efficiency of denitrification. The water and sludge are then let to tank 3 where phosphorous is precipitated and aeration is added to release  $N_2$  to the air. Finally, in tank 4, water and sludge are separated, and the sludge is harvested or returned to tank 1. The water is then discarded with much lower content of nitrogenous and phosphorous waste.



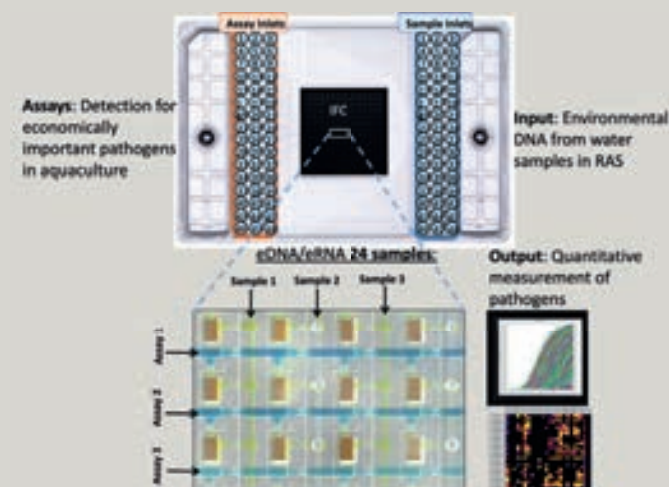


**Figure 2.** In this image the sludge in tank 4 can be seen. Because the active sludge was used with salt water from the RAS, the sludge is floating. Other methods to take out the sludge are needed compared to treatments for fresh water where the sludge settles at the bottom.

### Intelligent disease control gives advance warning of a possible outbreak

To develop a method to detect diseases before they become a severe problem or to just establish which pathogen is causing problems at a given time, the project will develop an intelligent disease control. With the use of a relatively

new technology, the partners aim to detect pathogens using environmental DNA (eDNA) that is directly extracted from the water. eDNA is a term for the DNA traces, that every organism leaves in its surrounding environment. It is relatively stable and can be detected even after the organism has died. Therefore, the aim with the intelligent disease control is that, instead of sampling fish and examining for



**Figure 3.** The Fluidigm chip (top) shown has 48x48 slots but the chip for this project will only have 24x24 slots. Input material for the chip is purified eDNA from water samples from RAS systems. Assays on the chip will be detections systems for up to 24 different pathogens. On the chip, classical real-time qPCR will be run giving quantitative data on the presence of the different pathogens.

diseases, the farmer can just sample water and get that analysed. From the water the purified eDNA is applied on a Fluidigm chip. The chip can take up to 24 samples and analyse up to 24 different pathogens in one go (Figure 3). Since making such a chip is a huge task, this project will focus on 10 pathogens, all central to rainbow trout aquaculture production.

The pathogens that the project is focusing on are: **Parasites (3):** *Ichthyophthirius multifiliis*, *Tetracapsuloides bryosalmonae* (proliferative kidney disease), *Myxobolus cerebralis* (whirling disease); **Bacteria (7):** *Aeromonas hydrophila*, *Renibacterium salmoninarum* (bacterial kidney disease), *Aeromonas salmonicida* subsp. *Salmonicida* (furunculosis), *Photobacterium damsela* subsp. *damsela*, *Yersinia ruckeri* (red mouth disease), *Flavobacterium columnare* (columnaris disease), *Flavobacterium branchiophilum* (bacterial gill disease).

### Combining hardware and software for better prediction

Such a chip brings the vision of better disease control and less morbidity and mortality on a farm. Regular use of the chip would work as a surveillance

system where the farmer has a chance to do something – like increase oxygen, add salt, stop feeding – before a disease outbreak occurs. Processing of the water sample should be rapid, and the farmer should get the data within 1-2 days ideally. When the chip has been fully developed the next step would be to write software or programmes to interpret the data and transform it into something that is easy to understand. Looking into the future, and assuming that all farmers use the chip on a regular basis, a database could be created where data would show the complex composition of organisms on the farms. These data could be used to interpret synergistic relationships and other co-occurrences that signal problems are on the way.

Aquaculture production should always aim to become more sustainable, reducing its impact on the environment and affording better welfare for the fish. With this project the consortium intends to achieve this goal with solid advances in water treatment and a front-line technological tool to detect and prevent diseases.

*Louise von Gersdorff Jørgensen, Faculty of Health and Medical Sciences, University of Copenhagen, lvj@sund.ku.dk*

### Greening the fish farming sector

**Title:** Active sludge and intelligent disease control in Model 3 and FREA/RAS farms (*Aktivt slam og intelligent sygdomskontrol til Model 3 - FREA/RAS-opdræt*)

**Funded by:** Danish Fisheries Agency under the Ministry of Food, Agriculture and Fisheries

**Value of support:** EURO.97m (DKK7.2m)

**Period:** 04.03.2021 – 31.12.2023

**Partners:** University of Copenhagen, Royal Danish Fish A/S, Aqua-partners ApS, Technical University of Denmark, and Eurofish International Organisation

**Consultants:** Aquahouse, Aquamind

**Sustainably creating greater value** from European waters to mitigate climate change

# The future is the blue bioeconomy



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 817992.

The blue bioeconomy is an essential factor in a sustainable future. For those working in the blue bioeconomy, it is obvious that the solutions for the future are biobased, but we are still just scratching the surface of what is possible in the aquatic domain. For the future to be biobased, we need to understand the processes in our aquatic environments and how they will be and already are being impacted by climate change and other stressors.

To strengthen Europe's position in the blue bioeconomy and ensure sustainable growth, we need to improve the blue bioeconomy value chains. Funded by EU Horizon 2020, ERA-Net Cofund Blue Bioeconomy has for the past four years been working to identify new and improve existing ways of creating value from the blue bioeconomy. The partnership consists of a range of ministries and funding agencies

in Europe and has issued calls to underpin the development of new and existing value chains, funding 49 projects for EUR43 million. Many of the projects show promising results in creating high value products from marine resources like fish trimmings, algae extracts, or rearing of species that we have no tradition for in Europe.

To guide future progress, we have developed a strategic

research and innovation agenda (SRIA) on the blue bioeconomy. The SRIA can assist all actors in the blue bioeconomy, from businesses to national funding agencies, to work towards a sustainable and circular future. There are six areas with research and innovation needs in the blue bioeconomy that we believe are key to develop. They are the result of an 18-month foresight process, using scenario building and stakeholder engagement

from industry, government, civil society, and science.

## Social consensus critical to an equitable blue bioeconomy

The findings show that aquatic resources have the potential to be part of the sustainable European future, if we do it right. However, to ensure viable solutions we need further research and innovation in these areas:

**1. Blue balance:** The blue biosphere must be understood and tipping points for ecosystem services must be identified if we are to intensify utilisation of biomass. We must use new technologies to understand the effects of ecosystem manipulation and land-sea interactions. Nature based solutions must be part of sustainable use.

- **Opportunities:** Carbon sequestration, nature-based solutions, carbon credits.

**2. Societal balance:** The interplay between the blue bioeconomy and society is essential. Trust, understanding, and social legitimacy are essential to develop effective regulations, management plans and markets.

- **Opportunities:** Due diligence including social legitimacy, integrating culture and society in business development.

**3. Climate change:** Climate change will influence aquatic ecosystems. The direct and indirect effects must be understood and modelled, both to manage the socio-ecological system and to adapt and mitigate impacts.

- **Opportunities:** Climate adaptation, software development for climate modelling.

**4. Technological innovation:** There are numerous possibilities for the blue bioeconomy in technological innovation. Intelligent monitoring systems, genetic engineering, finding alternatives to antimicrobials, recirculating aquaculture systems, carbon capture, improvement of feed and food resources, and ensuring animal health and welfare are all important pieces of the puzzle.

- **Opportunities:** Multiple efficiency gains and automation possibilities.





## 5. Value chain development:

The production cycle must be closed to truly future proof the blue bioeconomy. We must optimise side-streams, minimise waste, understand the whole value chain ecosystem—both blue and green, and implement full-chain traceability.

- **Opportunities:** Decreasing cost of waste disposal, regional value chains, increased resilience.

## 6. Science for society:

Research and innovation will have no impact without uptake in society. We must understand how to promote links between science and decision making, improving education, empowering people, building capacity and promoting ocean literacy.

- **Opportunities:** Policy impact, improved R&D, more impactful products.



For industry actors working in the blue bioeconomy, there are innumerable possibilities for innovation and development. The opportunities are not limited to technological innovation in, for example, fisheries and aquaculture or monitoring and observation, but extend to engaging with society (coastal communities in particular) to fully implement sustainable value chains. There is no blue bioeconomy without a social licence. As climate change is ever more pronounced, all industry actors must also integrate adaptation and mitigation actions into their working practices, especially in aquatic landscapes.

### A solid foundation for future research activities has been laid

Despite the challenges, the future of the blue bioeconomy is bright,

with many opportunities for new value chains, both at local and global levels. And for proactive and strategic actors we present a research agenda for the blue bioeconomy of the future. Though the Blue Bioeconomy Cofund collaboration will end in 2024, many of the funding partners will continue to be engaged in collaborative efforts where further development of the blue bioeconomy is central, e.g. in the Sustainable Blue Economy Partnership and EU Mission “Restore our ocean and waters by 2030”.

*Ingeborg Korme, Majbritt Bolton-Warberg, Dennis Lisbjerg, Blue Bioeconomy Cofund management. Further information on the foresight and research and innovation needs identified can be found at [bluebioeconomy.eu](http://bluebioeconomy.eu) or by contacting [bluebio@bluebio.eu](mailto:bluebio@bluebio.eu)*

# LET'S TEAM UP

Eurofish partners with stakeholders in its member countries and beyond executing projects for the development of fisheries and aquaculture.

Team up with us by contacting [projects@eurofish.dk](mailto:projects@eurofish.dk) or visit [eurofish.dk/projects](http://eurofish.dk/projects) for more information.

STRATEGY  
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DEVELOPMENT  
GROWTH  
INNOVATION  
PARTNERSHIP  
MARKETING



**Farmed Mediterranean mussels** could be the next Turkish success story

# Growing interest in mussel production

The aquaculture sector in Türkiye has expanded rapidly over the last two decades. According to the Turkish Statistical Institute, over two decades production increased almost 6.5 times to 515,000 tonnes in 2022. Much of this increase can be attributed to the expansion in production of the main marine species, seabass and seabream. Output of rainbow trout, the main species produced in freshwater, also grew impressively increasing 3.7 times to 145,000 tonnes.

These increases pale into insignificance, however, when compared with the growth in production of trout raised in the Black Sea. From an admittedly low base of 1,200 tonnes in 2003, production of Black Sea salmon, as it is called, exploded to 45,000 tonnes in 2022, an annual growth rate of 20%. These four finfish species dominate Turkish aquaculture production accounting for 97% of the total. Their status tends to conceal the fact that 27 finfishes, four molluscs, two crustaceans, two gastropods and four algae are cultivated in Türkiye. Following the industry's success with farmed finfish production, the government is encouraging the production of mussels and other bivalves. The hope is that these species will become another success story for the Turkish aquaculture sector.

## Advantages of farmed mussels include predictability and safety

Bivalve molluscs have been consumed throughout history thanks to their excellent taste and the valuable nutrients they offer. More

recently, as foods and systems of their production are increasingly being evaluated for their environmental impact, bivalves stand out for their sustainability. In Türkiye several bivalve species are caught from the Mediterranean, the Aegean, the Sea of Marmara, and the Black Sea. The catches include clams, Mediterranean mussels, oysters, cockles, and scallops. Of these species, so far only Mediterranean mussels are farmed. Although the volumes are still small these are expected to increase as the government encourages production. In Türkiye wild catches of bivalves can be affected by pollution. More predictable production as well as greater consumer safety are among the reasons the government wishes to encourage farming. To increase the production of bivalves a fundamental factor is the availability of sites. In a 2020 paper<sup>1</sup>, Serpil Serdar and Sükrü Yildirim state that environmental parameters of a site, including the water quality, depth, temperature, and turbidity, presence of food, structure of the seabed, protection from waves, tides and currents, predators, and potential for fouling must all be evaluated to

## Aquaculture production in Türkiye (tonnes)

	2022	2021	2020	2019
<b>Carp</b>	293	171	173	203
<b>Rainbow trout</b>	144,347	134,174	126,101	113,678
<b>Seabream</b>	152,469	133,476	109,749	99,730
<b>Prawn</b>	19	4		
<b>Seabass</b>	156,602	155,151	148,907	137,419
<b>Mussel</b>	5,469	4,585	4,037	4,168

Source: Turkish Statistical Institute

determine its suitability. In addition, the potential for conflicts with other users and the site's accessibility must also be considered. Hereafter, in relation to the specifications of the site, the species and the production technology are to be determined. Finally, sales, marketing, and efficient administration are critical for a successful operation. Identifying sites is among the government's priorities. The ministry's latest strategic plan<sup>2</sup> for the fisheries and aquaculture sector also mentions the need to determine aquaculture sites and carrying capacities, though it cautions that there is a lack of scientific studies of potential sites as well as only limited cooperation between institutions and stakeholders. A further risk is the potential for disagreement

between the different ministries involved in the approval process.

But these challenges are likely to be overcome as both the government and the industry evince keen interest in developing mussel farming. In, for example, Balıkesir province, which has coasts along the Sea of Marmara and the Aegean Sea, 11 mussel farms with a combined capacity of just under 16,000 tonnes a year have been sanctioned and applications for a further 16 farms are in various stages of approval. Six hatcheries for mussels are also planned. The total capacity of projects awaiting approval is over 27,000 tonnes giving a potential (if all projects are approved) total capacity of 43,000 tonnes per year in just this one province.

<sup>1</sup> Serpil Serdar, Sükrü Yildirim, General perspectives of shellfish aquaculture in Türkiye, Marine Aquaculture in Türkiye: Advancements and management, Turkish Marine Research Foundation, 2020, Istanbul

<sup>2</sup> 2019-2023 Stratejik Plan, T.C. Tarım Ve Orman Bakanlığı



**Altug Atalay, General Director, Ministry of Agriculture and Forestry**

### Mussel farms in Brittany offer a source of inspiration

At the behest of the Ministry of Agriculture and Forestry Eurofish organised last year a field trip for representatives from the Directorate of Fisheries. The representatives, Altug Atalay, Director General; Turgay Türkyilmaz, Deputy Director General; and Tanju Özdemir, Head of Aquaculture visited four shellfish farming companies in Brittany, France, where they were introduced to shellfish growing techniques, were shown harvesting and depuration operations, heard about challenges facing French shellfish farmers, learnt about legislation and regulations governing the sector, and saw how shellfish was processed, packaged, and marketed. The visit also

resulted in a French consultant visiting Türkiye to advise the government on how to create the legal infrastructure to foster the industry while safeguarding consumers and the environment. This year Eurofish organises another field trip for a Turkish delegation, but this time to the Danish Shellfish Centre which is part of the National Institute of Aquatic Resources at the Technical University of Denmark. The delegation, which comprises representatives from the ministry and from industry, will learn about standard operating procedures along the entire mussel and oyster supply chain, diseases and their control, and regulation. The representatives will visit farms and a shellfish wholesaler for insights into production, processing, marketing, and sales of shellfish in Denmark.



**Turgay Türkyilmaz, Deputy Director, Ministry of Agriculture and Forestry**

Within the EU, an area where bivalve molluscs are harvested is classified A, B, or C depending on the level of *E. coli* detected in 100 g of mussel meat. A indicates the least and C the most

contamination. This classification determines the kind of treatment the product must undergo before it can be marketed for human consumption. Turkish legislation in this area is aligned with that of the

### Price of Turkish aquaculture products (Turkish lira/kg)

	2022	2021	2020	2019
<b>Carp</b>	28.49	15.95	11.23	10.34
<b>Rainbow trout</b>	53.97	24.14	17.6	15.34
<b>Seabream</b>	89.73	42.25	28.31	21.89
<b>Prawn</b>	240.00	100.00		
<b>Seabass</b>	99.21	48.8	29.53	23.41
<b>Mussel</b>	27.92	15.14	11.7	8.74

Source: Turkish Statistical Institute



**Farmed mussels are likely to become a more common sight in Turkish waters considering the number of project applications both approved and being processed.**



**Özerdem Maltas, Vice President, Central Union of Aquaculture Producers**

EU and this system of classification is also used there. Class A areas must be sampled at least 10 times a year and 80% of samples may not have more than 230 *E. coli*/100g and no sample may exceed 700 *E. coli*/100g. If these criteria are met the shellfish may be harvested for direct human consumption. In the case of Class B, a minimum of eight samples are required each year of which nine tenths may not exceed 4,600 *E. coli*/100g and none may exceed 46,000 *E. coli*/100g. To be released for human consumption the shellfish must be depurated in an approved facility; or they can be relayed for at least a month in a Class A relaying area; or they can be cooked using an approved treatment process. A Class C area must be sampled at least eight times a year and no sample may exceed 46,000 *E. coli*/100 g. Shellfish can be marketed for human consumption if they are relayed for a period of two months in a Class B area followed by treatment in an approved depuration facility; or if they are relayed for two months in a Class A area; or if they are cooked using an approved treatment process. Shellfish from areas with contamination levels consistently exceeding 46,000 *E. coli*/100 g may not be harvested. During depuration the shellfish are held in tanks with clean natural or artificial sea

water for the period necessary to bring the contamination down to acceptable limits.

### **Alternative sources of ingredients for carnivorous fish feeds are being studied**

Another species that is produced in Türkiye is Atlantic bluefin tuna. This high value fish is fattened or farmed as production involves catching young fish in the wild and feeding them for a period after which they are harvested. This activity started in 2002 with three companies and today five firms are involved in this business. According to Prof. Deniz Coban from the Department of Aquaculture Engineering at Adnan Menderes University in Aydın, fattening refers to when fish of 30 kg and above are kept in captivity in sea cages for 3-7 months, while farming signifies fish of 8-30 kg maintained for around two years. Full-cycle production of tuna has been accomplished in Japan and recently at the Spanish Oceanographic Institute. Turkish attempts to close the tuna cycle have met with some success at the experimental level. At Kilic, the biggest producer of farmed fish in Türkiye, researchers managed to keep the tuna fry viable until 10 g after which they

perished. The young fish were fed on seabass and seabream fry which made it too expensive to continue the trials. Prof. Coban suggests that breeding of bluefin tuna (as well as other species, that are under threat) should be the subject of a collaboration between research bodies, the private sector, and government institutions. In this connection he attended a meeting to discuss a fisheries and fish farming strategic plan for 2024 to 2028, where aquaculture-related issues included new production areas, new species, and farm management technologies. The results of the meeting will soon be announced by the authorities. An issue facing the fish farming industry concerns the feeds used for the main farmed finfish species. Seabass, seabream, trout, meagre, and Black Sea salmon are all carnivorous demanding a certain fraction of fishmeal and fish oil in their diet. As catches of the forage fish used in the production of these two ingredients fluctuate, and because

of economic, environmental, and social concerns associated with reduction fisheries, researchers in academia and the industry are experimenting with alternatives including insect-, microalgae-, and plant-based products. At the aquaculture and fisheries department, Prof. Coban and Dr Mehmet Güler are conducting trials with the US Grain Council to study the impact of feeds containing alternate ingredients on the FCR and wellbeing of fish.

### **Climate change is close to the top of the aquaculture industry's agenda**

Finding more sustainable ways of feeding carnivorous fish is among the initiatives the aquaculture industry is taking to reduce its impact on the environment. Warming waters, lower dissolved oxygen levels, droughts, floods, and other extreme weather events have provoked concern in the industry. Özerdem Maltas, Vice



**Dr Mehmet Güler (left), Prof. Deniz Coban, Department of Aquaculture Engineering, Adnan Menderes University**





Fish farmers, the administration, and researchers are all interested in alternative ingredients for fish feed that will reduce its environmental footprint as well as costs.

#### A body of scientists supporting Turkish fisheries and aquaculture

### The Aquaculture and Fisheries Association

The growth of the aquaculture sector in Türkiye and the increase in the number of graduates and postgraduates with degrees related to fish farming led in 1992 to the founding of the Aquaculture and Fisheries Association, a body of academics within the field of aquaculture and fisheries. The association's mandate is to support the private sector together with public institutions and organisations. The association has contributed to the sector's development by devising new technologies, providing consultancy services, and researching issues of interest to the sector. It currently focuses on sustainable development by encouraging research on educational, environmental, economic, and scientific issues that will contribute to reduce the environmental footprint of the industry. Thanks to the scientific research by its members and the close collaboration with industry, the administration, and other stakeholders, the association is a valuable partner in the formulation of policy for the sector. For more information about the association, visit <https://sud.org.tr/> or contact Prof. Deniz Coban, [deniz.coban@adu.edu.tr](mailto:deniz.coban@adu.edu.tr); or Dr Sükrü Yıldırım, [sukru.yildirim@ege.edu.tr](mailto:sukru.yildirim@ege.edu.tr)

the fish farming, he adds. Some producers are also adding renewable energy from solar panels, wind, and water to partly replace the conventional sort, prices of which have shot up because of the war in Ukraine. Altug Atalay, General Director for Fisheries and Aquaculture says that the ministry is considering postponing the start of the fishing season from September to October or even November as a response to the warming water. With regards to the inland aquaculture and fisheries sector the general directorate is closely monitoring the situation. In one dam lake, for example, where the water level is decreasing, we have stopped fishing and are trying to divert additional water to the dam since the water is used also for agriculture. We must take the interests of fishers, fish farmers, and crop farmers into account, says Dr Atalay.

### Farmed fish producers should add more value to their products

President of the Central Union of Aquaculture Producers, a union of regional associations, says that climate change and how to deal with it are the most important issues to be discussed at union meetings. One strategy the union has been following is to try and convince the government not to issue further permits for flow-through systems (typically used for trout farming), but to encourage farmers to switch to recirculation aquaculture systems to save water. A completely closed system is very expensive but given the right incentives the farmers could start with a semi-closed system, feels Mr Maltas, which would be a step in the right direction. We also encourage fish producers to balance their fish production with algae and mussel cultivation to offset the nutrients released by

The hostilities have had consequences for the aquaculture sector because fish exports to Russia have grown rapidly over the four years to 2022 making it one of the most important destinations for Turkish farmed fish. The war has reduced purchasing power in Russia making Turkish products more expensive, says Altug Atalay, General Director for Fisheries and Aquaculture who expects to see a drop in Turkish seafood exports to Russia in 2023. Much of what the sector exports is whole round or gutted fish either fresh or frozen and Mr Atalay would like to see greater value added to the raw fish by, for example, processing it into fillets, steaks, or other products that would allow the producers to earn more per unit weight. He is convinced that value rather than volume is the way forward for the Turkish aquaculture sector.

**Abalıoğlu**, a food and feed producer diversifies into aquaculture

# Expanding production sustainably

The seabass and seabream industry in Türkiye is arguably the most dynamic in the Mediterranean. Production is more than double that of the next highest producer (Greece) in the region, many of the big farming companies are vertically integrated along the production chain with hatcheries, grow-out, feed manufacturing, processing, sales, and marketing, and there is collaboration between the industry, administration, and research. The need to adapt to legislation has forced the industry to innovate and develop expertise that it now exports to other countries in the region.

One example of tougher regulation was the environmental law in 2006 that pushed the sea cages beyond the sheltered areas in the vicinity of the mainland. The need to farm fish in the open sea was initially opposed by the industry but over time it developed the knowhow and learned to exploit the advantages that farming offshore offered.

## Modern technology for better farm management

The zones allocated for aquaculture are determined by the Ministry of Agriculture and Forestry, with the participation of all relevant decision makers, stakeholders, producer organizations and NGOs, and especially the

Ministry of Environment, Urbanisation and Climate Change, the Ministry of Culture and Tourism, the Ministry of Transport and Infrastructure. Aydın, which has a coast to the Aegean Sea, is among the provinces where aquaculture areas have been determined and allocated. Abalıoğlu Fish and Foods Products Company, which produces fish, feeds, and food products operates in one of the four zones allocated to aquaculture in Aydın province in addition to zones in Muğla and Izmir provinces. Production capacity amounts to 22,000 tonnes of seabass and seabream with the former accounting for 60%.

Sea bream prefers warmer water and sites further south such as



**Mr Ismail Serpen, Aydın Farm Manager (left) and Dr Hayri Deniz, Abalıoğlu Seafood Consultant**

in Mersin and Antalya tend to favour its production while the slightly cooler waters around Izmir, Çanakkale and even in the Black Sea are better for seabass, says Ismail Serpen, the aquaculture engineer at the Aydın fish

farm. The company acquired the site last year and sea bass and sea bream production is currently 4,000 tonnes but is expected to grow over the next few years, thanks in part to the use of modern technology, says



**One of two feed barges that are used to dispense feed automatically to the cages.**



**Solar powered cameras reduce costs and make the production more sustainable.**





The feed used for the fish comes from Abalıoglu's own feed factory.

Mr Serpen. This includes underwater cameras to monitor the fish, automatic feeding systems, farm management software, and perhaps at some point in the future, robots to clean the cages.

### Aquaculture promises to be the next growth area

Abalıoglu Fish and Foods Products Company has a 54-year-old history in the agriculture business, but its fish farming operations only started a couple of years ago. Both Mr Serpen and Dr Hayri Deniz, who works as a Seafood Consultant for the company, have worked in the sector for many years and so bring with them a deep knowledge of the aquaculture industry. Most of the other employees also have backgrounds in the industry and together they are transforming the company, says Mr Serpen.

At the Aydın site there are 36 cages each with a diameter of 50 m located some 7 km from the shore for on-growing the fish. Smaller cages are used to transport the juvenile fish from the port to the grow-out cages. The site is designated a protected area and is characterised by strong currents, a high rate of water exchange, no pollution,

and clear water making it ideal for growing lean and high-quality fish. Two hatcheries, one in Aydın City, Soke District and one in the Mugla, Milas District, supply the juvenile fish. Before they enter the sea, the fish are moved from the hatchery to an adaptation unit where they grow to 15 g. Thereafter they are introduced to the grow-out cages in the sea where it takes seabass 18-22 months, a little longer than seabream, to reach market size. The company is certified to the GLOBALG.A.P. standard for seabass, seabream, meagre, and rainbow trout, as well for feed which is manufactured using raw material from Chile, Morocco, other countries in Africa, and, during the season, from the Black Sea.

### Use of technology promotes efficiency

The work is physically demanding as the workers in charge of the cages depart daily by boat at 08:00 to the cages and return at around 17:00. These trips are made every day, regardless of the weather. From the bait barge, divers inspect the cages, make necessary repairs, check the seafloor under the cages and monitor the fish. Their mission

is so important that two divers are on site 24/7. They also harvest when orders need to be fulfilled. Two bait barges automatically feed the cages at regular intervals, and the feeding behaviour is monitored by underwater cameras. The overhead cameras monitor the cages and the surrounding area from above the water. As with most farms of this scale, production management software controls feeding. As the fish grow, they are separated into other cages to maintain the correct density. The fish is usually harvested at 450 g and is mostly exported fresh whole (to the EU) or fillets (to other countries).

### Consciousness of the environment runs deep

The warming water due to climate change has Mr Serpan a little concerned. Higher temperature is associated with less dissolved oxygen in the water and lower feed consumption resulting in slower growth. Recognition of environmental issues and

the vulnerability of the marine ecosystem has prompted the company to take several measures to increase the sustainability of its operations: all plastic on the barges is brought back to base and recycled, waste is shredded and organized and stored in a way that is safe. We can only guarantee a high-quality product if we maintain the quality of the environment in which the fish grow, says Mr Serpen. Detergents used in the kitchen and in the vessels' toilets are also collected in bags and brought back ashore for disposal. After crew maintenance is completed, the use of engines and generators is minimised. Some components, such as cameras, are powered with solar panels. Dr Deniz says concern for the environment reaches the very top of the company. Training courses and workshops are held on how to minimise the company's and the individual's impact. If these efforts are replicated across the industry, they will further reduce the environmental footprint of farmed fish.

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#### Abalı Aquaculture Engineer:

İsmail Serpen

#### Seafood Consultant:

Dr Hayri Deniz

**Activity:** Juvenile fish production, fish farming, fish feed production, fish processing/packaging/smoking

**Species:** Sea bass, sea bream, meagre, trout

**Capacity:** 50 million juveniles of sea bass and sea bream, 50 million trout, 24,500 tonnes sea bass and sea bream production, 3.000-ton trout production, 20.000 tons processed/packaged fish

**Products:** Fresh chilled, frozen whole fish, fresh and frozen fillet, IQF frozen, frozen smoked

**Markets:** EU, USA, North Africa, Middle East

**Certifications:** HACCP, ISO-9001, GLOBALG.A.P., FDA, BRC, ASC, IFS



**Akua Group** specialises in fattening bluefin tuna destined for the Japanese market

# Increasing quotas are a mixed blessing

The Akua Group has been involved in bluefin tuna fattening for decades, first under the name Akua Dem and since 2010 under the current appellation. Today the Akua Group collaborates closely with another tuna fattening company, Aktuna. The two companies have joint management and operations, but separate ownership. They share boats and staff and fish for tuna together bringing the catches back to the three sites they own around the Karaburun peninsula, west of Izmir. Two of the farm sites are owned by the Akua Group and host ten cages while the third site has six cages belonging to Aktuna.

**T**una fattening involves catching tuna in the wild and then travelling very slowly with the fish in transport cages. The fish are brought back to the farming sites which are often hundreds of kilometres away from the catching grounds. Monitored by surveillance cameras and the watchful eyes of ICCAT observers, the fish are transferred to the fattening cages. Here they will stay for the next 5-6 months being fed on a diet of pelagic fish. In Türkiye the catching season is in May and June and feeding typically starts by mid-June or early July. The harvest is at the end of December or in January. Over the roughly six months that the fish are fattened they grow

from about 30 kg to 55-60 kg. Cenk Yurttaş, the Akua Group farm manager, explains that smaller fish grow at a faster rate than the larger specimens. A 30 kg fish will almost double its weight in six months, while a 250 kg fish will grow by only about 35%.

## Improved stock status results in higher quotas

Atlantic bluefin tuna stocks are managed by ICCAT, the International Commission for the Conservation of Atlantic Tunas. In the last few years, the status of bluefin tuna stocks in the Mediterranean has improved resulting in an increase in the total allowable catch (TAC).



**Cenk Yurttaş, farm manager of Akua Group and Aktuna, two of the five tuna-fattening companies in Türkiye.**

In 2023 the TAC is 40,000 tonnes, an increase of almost 15% compared to the year before, according to Mr Yurttaş. Türkiye's quota is 6.5% of the total or 2,600 tonnes, which is divided between the tuna fishing vessels. Higher quotas are something of a mixed blessing, says Mr Yurttaş, because when there is too much fish on the market, the price falls. The government divides the quota between some 25 of the 125-130 fishing vessels in the country. The boats are grouped by criteria such as length, weight, and tonnage and 25 vessels are selected in a random draw. The winners are then removed from the draw for the remainder of the cycle. The cycle lasts 5 years to allow all the vessels to be assigned quotas at least once.

The boats assigned quotas may belong to fishing companies, for example, Akua Group has two, but they are also often independently owned. In this case the owners make agreements with the tuna companies to catch and supply the fish. In 2023 Akua Group obtained 370 tonnes from Turkish boats, but also bought 366 tonnes from Moroccan-flagged vessels. Today there are five Turkish tuna fattening companies. Once the fish have arrived at the fattening cages they are fed on small pelagic fish like sardines and mackerel. Akua Group imports 75-80% of this fish frozen from Morocco and sources the balance—mainly anchovies and small sardines—locally. This is then thawed on board the supply



**Small pelagic fish on board a support vessel being pumped into a cage for the tuna to feed on.**



**Umut Turuplu (left) and Hakan Borucuoglu from the Izmir Provincial Directorate of the Ministry of Agriculture and Forestry.**

vessel by the simple expedient of letting water flow over it. The thawed fish is then pumped into the centre of the cage holding the tuna. A consignment of about 42 tonnes of frozen small pelagics is enough to feed the tuna in two cages. We use 100 tonnes of forage fish a day to feed the tuna in the Akua Group and the Aktuna cages, says Mr Yurttaş. But during the first two weeks after the fish arrive at the farm site, he uses 135 tonnes a day. We feed the fish to maximum capacity for the first couple of weeks until they settle down and become acclimatised to the new environment, explains Mr Yurttaş. Thereafter the feeding is reduced to 100 tonnes a day.

In general, the price of the fish is determined by its weight with bigger fish fetching a higher unit price. However, feeding the fish to capacity throughout the fattening period is expensive and will result in too much fat which is undesirable. A balance must therefore be struck between fish growth and the fat level.

### **Turkish vessels catch tuna in three main fishing grounds**

The cages are monitored every day by divers who check the ropes, the nets, the weights, and all the joints to make sure the cages are secure. The divers

also monitor the fish behaviour as they feed to ascertain that everything is normal. The cages are not monitored with cameras, says Mr Yurttaş, because of the turbidity in the water as well as the size of the cages. These are very large—66 m in diameter and with a depth of 18 m at the wall and 32 or 33 m in the centre—and are known as stable cages, says Mr Yurttaş. In addition, we have 50 and 60 m cages, that we tow to the catching grounds place the fish inside and then tow them back. The 66 m cages are too big to tow, which is why they are known as stable cages. There are three main fishing areas where Turkish vessels catch tuna. These are in the eastern Mediterranean around Cyprus and off the coast of Syria, in the Gulf of Antalya, and in the area between Malta and Tunisia. The catching season in the Eastern Mediterranean is from 15 May to 25 June, while in the Western Mediterranean it starts on 25 May and closes on 30 June. The staggered dates allow vessels to fish in both areas if they cannot fill their quota in the Eastern Mediterranean. From these areas the fish are brought to the west coast of Türkiye because,

Mr Yurttaş explains, this is where the cages are safest. Thanks to the geography of the area, they are protected from strong winds, storms, and currents which could damage or destroy the cages. Towing the filled cages slowly (at 1 knot) back to the farm site from the eastern Mediterranean takes about a month, while from Malta it takes 4-5 weeks. This year Akua Group sourced all its tuna from the Eastern Mediterranean, but in 2021 and 2022 it also had to get fish from the Malta Tunisia area.

The stable cages for tuna, like those holding other fish species, must be anchored a minimum of 0.6 nautical miles from the mainland in water of at least 50 m depth and with currents of at least 0.2 knots to conform to regulations governing the impact on the environment. These conditions also favour the fish as the currents force the fish to swim constantly improving the consistency of the flesh. In December and January the fish are harvested primarily for sale on the Japanese market. Processing vessels with super freezing (minus 60 degrees C) capabilities from a big Japanese trading house arrive at the site to collect the slaughtered fish



**The tuna are harvested and transferred to Japanese vessels where they are frozen on board at minus 60 degrees C and then sailed to Japan.**



**A small volume of fish is processed, packed in styrofoam on ice, and shipped by air for sale as fresh tuna. The fish is on the market typically 48 hours after harvest.**

which are then processed, frozen, and stored on board. Almost the entire production is sold whole round, says Mr Yurttaş, with perhaps 3-5% sold fresh. In this case the fish is headed, tailed, and gutted, and placed in large styro-foam boxes on ice for despatch by air to Japan. Within 48 hours of harvest this fish is on the market, notes Mr Yurttaş, but the cost of airfreight has rocketed since the pandemic, so we prefer to sell the fish to the processing vessels. The company is affected by the high rate of inflation and the unstable prices of energy which fluctuate every day. Although the bait fish used as feed is imported against hard currency, fish sales are in Japanese yen which makes it easier to manage the company's finances. Japan has historically been the biggest market for tuna fattened in the Mediterranean.

The Japanese processing vessels collect fish from fattening sites in different countries in the region, Spain, Croatia, Türkiye, Malta. But demand for tuna in Japan is stable, it is not increasing, says Mr Yurttaş. If the quota in the Mediterranean increases the price is likely to fall. In addition, the Japanese population is ageing rapidly and people from the younger generation consume less fish than their parents—and may even prefer salmon to tuna. We hope we can persuade the Chinese to start eating tuna, says Mr Yurttaş.

### Warming water is likely to affect the industry

The tuna fattening industry also faces challenges from the impacts of global warming and in particular the rising water temperature. In the Aegean Sea where

temperatures above 25 degrees centigrade have been recorded this year, the increasing temperature is a cause for concern. According to Mr Yurttaş, the bluefin tuna can handle water of up to 28 degrees C, but beyond that it can be a problem. The fish will move to deeper waters, he predicts, since there is a difference of 3 degrees between the surface and 10 m below. In the future this may call for cages with greater depth or indeed cages that

can be submerged. Hakan Borucuoglu, from the Izmir Provincial Directorate of the Ministry of Agriculture and Forestry mentions that the ministry is in the process of establishing a new department that will bring together specialists in animal health, aquaculture, agriculture, and other fields to focus on how best agriculture and aquaculture can mitigate and adapt to the impacts of climate change.

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**Farm manager:** Cenk Yurttaş  
**Product:** Frozen tuna, fresh tuna  
**Market:** Japan  
**Volumes:** 1,600 tonnes  
**Employees:** 55  
**Vessels:** 27 (9 purse seiners for catching, 6 support vessels, 12 towing vessels)

A.vet Su Ürünleri pioneers the aquaculture of **blue crab in Türkiye**, and possibly the world

# An invasive species but also a resource

The blue crab (*Callinectes sapidus*) is native to the western Atlantic where it is found from Nova Scotia in Canada to Argentina. In the 20<sup>th</sup> century it was introduced to European waters. An increase in the surface water temperature and its ability to tolerate a wide range of temperatures, salinities, and habitats may have contributed to its prevalence in the Mediterranean and Black Sea. It is also characterised by strong swimming abilities, aggressive behaviour, and high fecundity—traits which undoubtedly aid its propagation.

In the Mediterranean and the Black Sea it is seen particularly in changing environments such as shallow marine and brackish water lagoon systems, and estuarine and coastal ecosystems, according to a paper<sup>1</sup> by Guillaume Marchessaux and co-authors. As with some other invasive species blue crabs are associated with habitat

modification and biodiversity loss and thus have an impact on the functioning of the ecosystem.

### Two veterinarians see the potential of soft-shell blue crabs

However, the blue crab is also a resource with global catches of some 75,000 tonnes in 2021,

according to FAO. The USA accounted for over seven tenths of the total. In Türkiye too there is a small fishery for this species which resulted in 80 tonnes in 2021. In an interesting development a Turkish family-owned company, A.vet Su Ürünleri, recently began to farm the species to produce softshell crabs. The crabs are harvested

immediately after they moult so that the shell does not have time to harden. Azer Gökçay and his wife Esra Gökçay, the owners of A.vet Su Ürünleri are both fish veterinarians with a company that imported fish vaccines and offered health and vaccination services to the seabass industry. The fish were grown up to 15 g in tanks on land, vaccinated and

<sup>1</sup> Guillaume Marchessaux et al, 2022, <https://www.frontiersin.org/articles/10.3389/fmars.2022.1055404>





**Esra Gökçay and Azer Gökçay, pioneers in the closed cycle farming of soft-shell blue crab.**

then sold to companies for on growing in sea cages. This activity started in 2005 and continued to 2012 or 2013, says Azer Gökçay. For the last two years the company has maintained a hatchery for rainbow trout where the fish are grown to 10 g and then sold.

But the main activity today is the cultivation of blue crab. The seeds of the idea were planted in 2008 when A.vet Su Ürünleri was buying blue crabs caught from an estuary by fishers and selling them to hotels and restaurants. The couple thought it may be possible to grow the blue crabs in their existing facilities. The first time they tried the crabs lived for a week. However, due to other commitments no further efforts were made until the end of 2019 when a berried female was procured, and the eggs hatched. The larvae did not survive the first time nor the second. For two years Mr and Mrs Gökçay tried different parameters— salinity, temperature, water depth—to increase the

viability of the larvae. Among the challenges was the lack of any details about production of this species. There were some papers on the subject on the internet, says Esra Gökçay, but they were very academic and did not offer any practical guidance on how to breed the animal. Finally in 2021 they managed to get the larvae to survive and moult.

### **Exploiting the crab lifecycle to create a new product**

Blue crab larvae go through seven stages called zoea that last 31-49 days. The larvae are equipped with a hard outer shell and moult as they go from stage to stage, casting off the old shell. Immediately after moulting the larval body is soft but then it absorbs water and swells up. The minerals in the sea water harden the outer covering forming a new exoskeleton. The larva releases the excess water and shrinks giving it space to grow within the new exoskeleton. Following the last larval

stage the crab enters a megalops stage which last 6-20 days and is the first step to acquiring the typical crab form. The megalopa becomes a tiny crab which moults several time becoming bigger with each moult until it reaches adult size of 130 to 139 mm. The growth with each moult depends on several environmental factors including water temperature and salinity<sup>2</sup>.

At A.vet Su Ürünleri, the Gökçay's efforts were followed by aquaculture officers at the Milas/Muğla provincial directorate of

the Ministry of Agriculture and Forestry. The success of getting the larvae to survive and moult unlocked support from the ministry for the couple to continue their trials. The support was used to construct a larger facility that could house a hatchery and a vertical system as well as a floating system for growing the crabs. The trials revealed not only that the soft-shell crab was tastier than the hard shell variety, but also that the yield was much higher because by and large the whole crab, shell and all, can be eaten. In the US and Europe,



**The horizontal system of blue crab production. The boxes must be monitored every two hours around the clock to know when the animal has moulted.**



**Different varieties of microalgae are produced in the live feed unit. They are used to feed the larval stages of the crab.**

<sup>2</sup> Florida Fish and Wildlife Conservation Commission, <https://myfwc.com/research/saltwater/crustaceans/blue-crabs/life-cycle/>



With a vertical system of production, boxes with the crabs are placed on top of each other to save space. Mr and Mrs Gökçay are experimenting with different kinds of boxes to determine which works best.

however, the mouth, gills, and eyes are typically removed before the crab is eaten. The time it takes for the crab to reach harvest size depends on the customer's requirements. Depending on the water temperature the animal reaches 50 g in 7-8 months and 100 g in 12-13 months. Because they are highly cannibalistic crabs are kept individually in boxes and are monitored manually to know when they moult. Mr and Mrs Gökçay are experimenting with different feeds to establish what gives the best results in terms of growth rates and taste. Microalgae, rotifers, and artemia are used during the larval stage, while as adults the crabs are given fish and pelleted feeds. As far as we know, we are the first to cultivate this species commercially from the hatchery stage, says Esra Gökçay, and the first to supply the market with farmed soft-shell blue crab. Breeding the crabs is not without risks of diseases and parasites, but in general these have not been an issue because the water is from the ground and is cleaned, filtered, and analysed before it is used.

### Exports to follow once production volumes increase

Today the company's sales are primarily to hotels and restaurants in Türkiye but plans to export the product are also being developed. We need to ensure that production is regular and in the volumes needed before we start exporting, says Mr Gökçay. Within the country the product is not well known, but we are developing the market, he adds, so that high end restaurants are not the only outlet. The soft-shell variety has a further advantage over the hard shell in that it can be prepared in many different ways. But for A.vet Su Ürünleri the main reasons behind investing in blue crab were that it was found in Turkish waters and because it is a marine species it could be grown in the company's existing facilities which are supplied with sea water of the appropriate temperature and salinity. The company has borrowed technology used to produce crab species in other countries and has adapted it for the blue crab. The animals are housed in plastic boxes furnished with

holes to allow the passage of air. The first set of boxes were based on mud crab production and were imported from India. But they turned out to be too small, so Mr and Mrs Gökçay designed a new box which is manufactured in Türkiye and now they are testing four varieties of the box. Despite these refinements the work is still highly dependent on manual labour. Every two hours, 24 hours a day, the boxes must be checked to see if the crabs have moulted. The Gökçays have two production systems one horizontal, where the boxes float on the surface of a water-filled tank, and another where the boxes are stacked vertically to save space.

When the animals moult the shell they shed is currently being discarded. In the future however there are plans to sell the shells to factories where it can be made into poultry meal. This will contribute to the ultimate goal of zero waste from the production. When the crabs reach the desired size, they are harvested after moulting, trimmed, and frozen at minus 40 degrees. They are packaged in 1 kg boxes which are stored at minus 18 degrees to give a shelf life of 2 years. Esra and Azer Gökçay's attempts at soft-shell blue crab farming have been characterised by several ups and downs, but their efforts are starting to pay off.

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**Owners:** Esra Gökçay  
**Product:** Soft-shell blue crab  
(*Callinectes sapidus*)  
**Brand:** Softy & Hardy  
**Market:** Hotels, restaurants  
in Türkiye



Türkiye plans to become a successful **producer and exporter of bivalves**

# Exploiting the Marmara Sea's potential

Nora Su Ürünleri specialises in harvesting and processing mussels for consumption in Türkiye and for export. The company is among those helping fulfil government ambitions to increase domestic production of mussels and other bivalves.

**N**ora Su Ürünleri is a Turkish mussel producing and processing company that owns three farm sites. It operates on the Turkish and foreign markets selling live mussels on the former, while exporting processed products to Europe and the Middle East. These include canned, cooked, or frozen mussels in their shells or as mussel meat. The company is part of a group, of which other parts deal with the import and export of industry-related electronics and with catering services. However, the mussel farms are what Nora is best known for and what accounts for most of the company's turnover. Today their farms have an annual capacity of 3,000 tonnes while production is 1,000 tonnes a year.

## Massive expansion in mussel production envisaged

According to the Turkish Statistical Institute, Türkiye produced almost 5.5 thousand tonnes of mussels in 2022. The goal of the Ministry of Agriculture and Forestry is to increase this number to 50 thousand tonnes in 2-3 years. For a new industry, just 3 to 5 years old, that employs around 10,000 people, this seems like an ambitious goal. However, as the trends show, one that might be possible due to the country's legislative and marine environment.

Nora's various farms are located in Balıkesir, a province in Türkiye. All three sites have access to



From left, Erdil Uzunoglu, Nora Aquaculture; Ayhan Aydinol, Balıkesir Provincial Directorate, Ministry of Agriculture and Forestry, and his son, Mert Aydinol; Hayrettin Savur, Mahmut Erturan, Nevzat Ekmen, Nora Aquaculture; Ahmet Gokhan Coskun, Merve Erdogan, Metin Sit, Balıkesir Provincial Directorate

different regions of the Marmara Sea, which is located between the Aegean Sea and the Black Sea. Being a kind of "middle-ground" creates the perfect environment for increased biodiversity of fish and other marine species due to the different currents and water salinities. This area has the added benefit of an average temperature of around 20 degrees Celsius which is optimal for mussel farming. This increases the mussels' chance to survive, even during warmer periods.

Moreover, Nora tries to engage many local residents and businesses in its activities to embed itself in the local community. The company owns two harvesting/seeding boats, each of which is

operated by a team of 5-6 people. The company also employs several aquaculture engineers who plan the harvesting and spat fixing operations as well as monitor the weather and other factors that may impact the production. Most of them are from the area. Moreover, Nora co-operates with numerous local businesses from where the necessary accessory equipment like ropes or net bags are sourced.

## Three ministries responsible for farm approvals

The government plays a big role in the process of production. In particular, three ministries, the Ministry of Environment, Ministry of



Long lines extend for 100-150 m and are held at the surface by buoys. Ropes 6-12 m long are suspended from the lines at intervals of about 4 m.





**Mussels growing on a rope are thinned out at intervals to give them space to grow.**

Tourism, and Ministry of Agriculture and Forestry are involved in planning and permissions for the industry. The Ministry of Agriculture and Forestry has support programmes for industries whose development it wants to promote. In addition, they monitor hygiene levels and the quality of the products. Nora is legally obliged to regularly collect samples to control the microbiological quality, as well as to analyse them for the presence of various bacteria and viruses. Türkiye has implemented EU food safety and other criteria into its own legislation to facilitate its exports to the EU.

The quality and sustainability of new mussel harvesting sites are monitored from the earliest stages. Before the spat collection can begin, the water and the surrounding land must be carefully examined by government officials and independent experts to determine the suitability of the area. Only then, can the farming

process begin. The experts will consider criteria such as the impact of the farm on marine traffic, marine biology, the existence of archaeological sites on the

seabed, and sources on land that have the potential to pollute the farms. They also make sure that the farms would not negatively affect tourism or recreational

fisheries in the area. The minimum distance from the shore that the farms must respect is 200 meters. Moreover, throughout the production process, officials take weekly samples to investigate the marine microbiology and the presence of bacteria such as *E. coli*. Every six months the presence of heavy metals in the water is checked. Should the results reveal levels that are outside official tolerance limits, the farm can be shut down immediately.

All the supervision is done in accordance with European standards to ensure that the products are safe for domestic consumption and export. Additionally, the government classifies the mussels from A to C, depending on water and mussel quality, to ensure that the mussels pose no danger to consumers. Class A mussels can be directly sold on the domestic market live or processed. Class B mussels need to be purified in a specialised depuration facility, while Class C must be cooked before consumption.



**A rope of mussels is washed to remove fouling that can be detached with a jet of water.**

## New Zealand mussel farming technology provided inspiration

To harvest the best quality of produce, the mussel farms utilise techniques and systems encountered by Hayrettin Savur, Nora's co-owner, on a field visit to New Zealand. There, farms use long lines extending for around 100-150 meters along the surface of the water and connected to buoys keeping them afloat. From each of the lines, every 4-5 meters, a 6 to 12-meter-long rope is suspended. The yield depends on the total length of the suspended ropes; 6-8 kilograms of mussels can be harvested from each meter and a total of 400-500 meters of ropes are suspended from each line.

Farming starts with the collection of spat (an immature adult stage with a shell length of 0.9 mm to 1.5 mm) on ropes suspended in the water. The spat is floating in the water and attach naturally to the ropes. This process takes place twice a year: in May and in November. As the mussels grow they are thinned out to reduce the density on the rope. Mussels are removed from the rope, sorted, and placed in a tubular net or sock around a new production rope. The sock keeps the mussels in place as they attach to the new production rope. The next mussel growth period is 12 months or more, while being thinned out and retubed every 6-8 months. They are then harvested and processed for domestic and international consumption.

## Warming water threatens the industry

Despite modern equipment and effective production techniques, the development of the Turkish

mussel farming industry is threatened by global warming. The mussels' maximum temperature tolerance is 25-27°C, while the ideal temperature for them is 17-18°C. If the water reaches 29°C, the mussels will die. Throughout the mussels' gestation period, the water's temperature will vary by 5-6°C. Mussels can survive a single summer at 25°C, but beyond that, it would impact their development or even kill them. Since the whole process, from spat collection to harvest, lasts almost 2 years, its timing must be arranged carefully. For example, the spat is less vulnerable to high temperatures than adult mussels, so this will be taken into consideration when planning the production. However, continuing rise of temperatures may retard or even stall the growth of industry. Apart from threatening the mussels directly, the increase in water temperature also leads to another challenge—higher activity of tube worms. Tube worms attach to the mussel shells and while not harmful to the mussels are unsightly, and infested mussels cannot be sold. The worms proliferate more quickly and become more aggressive in warmer environments. Unfortunately, we can do nothing about them on a commercial scale, says Mr Savur, just pray. Pray that the warmer temperature does not lead to a spread of this pest. Once the mussels reach market size, usually between April and August, they are harvested, cleaned, graded, and packaged in nets.

## The future holds more than just mussel farming

Currently, Nora focuses on the production of Mediterranean mussels (*Mytilus galloprovincialis*). But like most of the other



The mussels take about 15 months to reach market size and contain a high proportion of meat.

farms in the area, it is not producing at full capacity yet. Once it achieves this the company plans to expand its production to include oysters, clams, and sea cucumbers, which Mr Savur hopes to export to countries in East Asia.

Nora is also expanding its processing operations. Currently, it owns one depuration centre in Izmir and a separate processing plant, but a new facility in Erdek, Balıkesir is currently being built that will combine both the depuration and processing operations. It will also be suitable for handling other

bivalves like the clam species, *Ruditapes decussatus*, *Ruditapes philippinarum*, *Venus verrucosa*, and *Donax trunculus*. The facility will offer its services to other producers, becoming a completely new business venture. Mr Savur expects to employ around 70 staff at the new facility and thereby contribute to the economic and social development of the local area. Nora Aquaculture can rightly claim to be among the drivers of a new wave in the Turkish aquaculture industry.

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**Co-owners:** Hayrettin Savur,  
Nevsat Ekmen

**Activity:** Production of Mediterranean mussels  
**Volumes:** 1,000 tonnes/year  
**Capacity:** 3,000 tonnes/year  
**Products:** Live, canned, cooked, frozen  
**Markets:** Türkiye, EU (for canned, cooked, frozen), Middle East  
**Projects:** New depuration and processing facility in Erdek, Balıkesir





Fishers contribute to **Denmark's green transition**

# Sustainable practices build stock resilience

The Danish Small-Scale Low-Impact Fishers' Association and Producer Organisation assists small-scale fisheries adjust to environmental changes brought on by climate change and prepares them for the green transition.

**F**oreningen for Skånsomt Kystfiskeri Producentorganisation (FSK-PO), or the Danish Small-Scale Low-Impact Fishers' Association and Producer Organisation, is an association of small-scale fishers who practice low-impact fishing. More precisely, the organisation represents fishers who use lines, hooks, pots, seines, and nets, and whose vessels do not exceed 17 meters in length. FSK-PO is one of three producer organisation representing commercial fishing in Denmark. Through its involvement in political committees FSK-PO advises the government and the Danish Parliament on fisheries-related issues. And through its membership of LIFE (Low Impact Fishers of Europe), an umbrella association representing 33 organisations of small-scale fishers in 15 EU countries, FSK-PO represents and advocates for low-impact, small-scale fisheries at the European level. Its primary goals are to protect the livelihoods of small-scale fishers while also promoting the sustainable development of coastal fishing to defend both the marine environment and future generations of low-impact coastal fishers.

Fishing sustainably has become ever more important as it contributes to fish stock resilience in the face of climate change and other pressures on the stocks. David Lange, FSK-PO's director, and Tine Hansen, the organisation's

communications director, say the most notable impact of climate change for fishers has been alterations in the species composition in Danish waters due to rising sea temperatures. As waters warm rapidly, fish are forced to migrate to regions where water temperatures remain within the limits they are accustomed to. In fact, the highest sea temperature ever measured in Denmark was recorded this April, Mr Lange said. These changes affect FSK-PO's members more than other types of commercial fishery because temperature changes are more apparent in coastal environments where small-scale fishers operate. In the Baltic, the most notable change for fishers has been the challenge to find enough fish. A further impact FSK-PO's members have noted is the change in oxygen and salinity levels.

## Cod's decline makes waves in the sector

Small-scale fishers have reported that sardines and large stocks of mackerel have entered Danish waters, as has the Atlantic bluefin tuna, a species that hasn't been seen in Nordic waters since the 1960's. Perhaps the biggest change experienced by FSK-PO's members has been the decline in cod populations in Danish waters. Cod has traditionally been the most popular fish caught by these fishers, so the decline in cod quotas



**David Lange, Director, Foreningen for Skånsomt Kystfiskeri Producentorganisation (Danish Small-Scale Low-Impact Fishers' Association and Producer Organisation)**

has had a significant impact on the entire sector. In the last five years, cod quotas have decreased by more than 90%. Since 2022 quotas for cod exist only for bycatch, there are no quotas for a dedicated cod fishery. Fishers need to find replacements for cod, and while they are trying to do so with turbot, brill, and high value flatfish (Dover sole, lemon sole), the process is, of course, difficult. Though it is easier for small scale, low-impact fisheries to prevent bycatch than larger commercial fisheries, because of the high selectivity of the fishing-gear, preventing bycatch while fishing for alternative species has been an additional challenge.

Quotas for plaice in the Baltic Sea, on the other hand, are increasing.

However, according to Mr Lange, this has not been reflected in the experiences of fishers. In fact, he reports that FSK-PO's members are unable to catch even 20% of the quota. He suggests that plaice populations are still too small and individuals too young to catch and hopes the plaice populations will grow as predicted. However, the discrepancy between legislative and scientific recommendations and the actual experience at sea has made the jobs of fisherman even more challenging.

## Small-scale fisheries prepare to go green

Denmark is committed to a 70% reduction in CO<sub>2</sub> emissions from 1990 levels by 2030 and the



**NaturSkånsom**

**To use the Danish government backed NaturSkånsom label, fishers must fulfil several criteria, including gear type, vessel size, and trip duration, that contribute to the green transition.**

small-scale fishing sector is well positioned to contribute to these efforts. We stand at the forefront of any green transition because our vessels don't require much fuel, explains Mr Lange. As such, with spikes in fuel prices in recent years, the small-scale fleet has had a slight advantage over other forms of commercial fishing which require more fuel. Across the industry there are discussions on electrifying vessels, but electrification is slowed by concerns associated with ensuring that larger ships will not be stranded at sea. Because small-scale vessels operate close to the coast, the sector does not share these concerns, and thus it will more readily electrify its fleet. Electric vessels are already used in Norway, and though there is still a way to before Danish vessels are electrified, Mr Lange believes the small-scale fleet is well on its way in this direction. Many small-scale vessels already have the capacity to run on biodiesel or biofuels (made from biomass or other renewable

sources), however, they are ten times more expensive than regular fuels, says Mr Lange, so for now this is not an option for small-scale fishers. However, the pelagic fleet, he says, which catches higher volumes of fish is considering charging a higher price for products fished with biofuel which would accelerate this fleet's conversion to more sustainable fuels.

A European Commission report on the energy transition for fishing and aquaculture also mentions e-fuels (produced using sustainable electricity), hydrogen, wind, and solar power, and batteries as energy sources for ships that are expected to become increasingly common in the near to medium future. These alternate fuels are likely to be deployed on larger ocean-going vessels initially before their use trickles down to the aquaculture and fishing sectors. Another possibility mentioned in a UK report on electrifying the fishing fleet is hybrid diesel electric systems that could be based on existing technologies. The EU programmes Horizon 2020 and Horizon Europe as well as the EMFF and EMFAF support several projects that develop renewables to power shipping which will result in knowledge and innovation that may be transferable to the fishing and aquaculture sector. Already now several European fishing vessels, as well as some used in the aquaculture sector, are powered with hybrid diesel electric propulsion or pure electric motors. LNG (liquefied natural gas), hydrogen, solar power, and wind are other energy sources that are being used by some fishing vessels in the European fleet, solutions which could also be applied in Denmark. The commission report points out that it is not just propulsion systems that can make a difference to emissions. Fishing techniques too

can be optimised to yield savings in fuel consumption and thereby fewer emissions. For example, lighter nets and larger mesh sizes reduce drag, innovations in trawl doors, more efficient onboard systems for compressed air, and the use of LED lighting all contribute to reducing energy consumption. The use of apps can help skippers avoid unwanted catches and reduce discards, cut down on waiting times by optimising arrival and delivery to the market, and use AI to better plan sailing routes. Modifications to the hull is yet another area that can contribute to greater fuel efficiency by reducing vessel drag. And over time the Danish small-scale fishing fleet will benefit from these developments.

### **New Danish grant programmes to aid the green transition in fisheries and aquaculture**

Denmark's green transition is not yet focusing major projects on the fishing sector specifically. There are, however, EU projects on the horizon to support the green transition of Europe's fishing industry. Mr Lange suspects that within Denmark specifically, the green transition of the fishing sector will stem from developments in a larger industry, like the shipping sector for example, and the innovations will be adapted for the fishing sector. The Danish Fishers Producer Organisation (DFPO) which represents over 1,000 fishers and 600 vessels, says that the industry has already reduced emissions by 62% compared to 1990 and expects to reach the targeted 70% reduction with adjustments to the fleet and investments in new climate friendly technologies. The organisation has suggested the launch of two grant schemes,

one to support the development of new technologies including the electrification of the coastal fleet as well as the testing of new ways of propulsion for the ocean-going fleet. The second scheme would support the deployment of existing technologies that can reduce emissions from the fishing sector. In response, Jacob Jensen, Minister for Food, Fisheries, and Aquaculture, announced in July three grants totalling EUR19m (DKK138m) to support the green transition in fisheries and aquaculture. Of this EUR11m is dedicated to developing and testing technologies that reduce emissions in the fishing sector as well to investigate the possibility of targeting new species such as the greater weever (*Trachinus draco*), and of developing new ways of optimising catches.

While environmentally friendly fishing gear, for example, biodegradable nets, is being developed, small-scale fisheries are continuing to use the gear for they have trusted for decades. Though this may not sound very innovative, instead of using resources to replace our gear, using the same gear we have been using for years is about as green as you can get, claims Mr Lange. One transition the sector is considering is the implementation of regenerative farming in coastal areas. Various seaweeds, mussels, and oysters have the capacity to mop up nutrients in the water. Such species may have a future within the sector as a source of food for human consumption providing a new source of income for small-scale fisherman, while also improving water quality.

Some FSK-PO members use the NaturSkånsom (Naturally Low-Impact) label on their catches. NaturSkånsom is government-backed, giving the label a high





**As the impacts of climate change become ever more apparent the small-scale fleet is looking at ways to reduce its emissions and thereby contribute to Denmark's 2030 target to reduce emissions by 70% compared to 1990 levels.**

degree of credibility in Denmark. Criteria that the fisher and the vessel must meet to use the label contribute to lowering emissions in the fishery. For example, fish must be caught from healthy stocks with low-impact gear, the vessel cannot exceed 17 m in length, and 80% of its fishing trips in a calendar year must be less than 48 hours. Many of these criteria also contribute to the green transition. Currently, however, only 10-15 of the organization's 100 members use the label. Introducing a new label suffers from the chicken or egg problem, says Ms Hansen. When first introduced, awareness of the label is low, so fishers are not interested in using it. Yet awareness will only increase if the fishers start to use it, thereby creating a contradiction. However, FSK-PO is hopeful that with time and with close cooperation between the government, fishers, markets, and consumers the label will become better recognized and established.

### **Denmark's offshore wind projects could be a blessing or a curse for the industry**

As Denmark develops more offshore windfarms for its green transition, FSK-PO views turbines as both a threat and an opportunity. The placement of the windfarms determines whether their effect on the sector is positive. Turbines built in spawning sites or high value fishing grounds can be detrimental. In contrast, if they are not placed in these sensitive areas, the turbines can function as artificial reefs which are underwater structures that provide space for marine life to flourish thus creating new fishing potential. There is debate within the fishing industry as to whether artificial reefs play a role in increasing fish populations or if they simply attract fish from other areas with no net increase in numbers,

and while it is still scientifically uncertain, Mr Lange explained that many FSK-PO members believed the presence of reefs results in growing populations. DFPO too acknowledges the need for offshore windfarms if Denmark is to meet its emission reduction commitments, but it recommends regular dialogue between the fishery and the windfarm industries to safeguard the interests of both. This could take the form of a marine planning forum that would include all the different stakeholders to develop solutions acceptable to all parties.

DFPO also seeks more international initiatives involving the countries around the Baltic Sea to combat anthropogenic causes of oxygen depletion, increased acidity, and pollution. These are not issues that can be solved by one nation alone and the organisation encourages Denmark to take the lead in an ambitious multi-nation effort to improve the ecosystem in the Baltic Sea. Another point DFPO mentions is the extraction of raw materials from the sea. This activity should not be permitted in fish breeding grounds as it will have an impact on fish stocks and by extension on the fishing industry. By increasing the resilience of fish stocks these initiatives could reduce the need for fishers to travel as far or for as long in search of fish and could thereby contribute to the green transition.

### **Sustainable energy production should harmonise with fishing activity**

In addition to offshore windfarms, Denmark also has plans to build two "Energy Islands," a project expected to produce unprecedented amounts of energy from

windfarms placed even further offshore than existing windfarms. Unfortunately, their construction requires the extraction of materials from the ocean floor. While the project is on pause for financial reasons, Ms Hansen expressed concern about the impact that this sort of project could have on marine ecosystems and thus small-scale fisheries. With plans like the development of extensive windfarms and Energy Islands, there is much concern surrounding the ocean's "tipping point." Ms Hansen explained that many Danes believe that forces like climate change and pollution have pushed the ocean towards a critical moment, and even though these projects are intended to save the environment, it is also possible that the disruption that they pose to life beneath the ocean's surface could very well push the ecosystem into a lethal spiral from which there is no recovery.

In February 2023, the Danish government amended its "open door" policy following advice that it could be in breach of state aid rules. The original policy enabled manufacturers to circumvent lengthy assessments and permitting procedures to quickly develop wind farms. Abundant and cheap sustainable energy is critical to produce the e-fuels that can contribute to the greening of the fishing industry. But Mr Lange feels there was little consideration regarding the turbines' placement and that these structures could have a negative impact on the small-scale fishery. Despite these hiccups the fishing industry will continue to do its bit to contribute to the green transition in Denmark in collaboration with the other players in the field.

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Linimatic's zinc sinkers are non-toxic, long-lasting, and environmentally friendly

# “Sinkers” replace lead sinkers in Denmark’s fisheries

Linimatic, a Danish die casting company, produces a variety of zinc products, including lead-free, zinc sinkers for the fishing industry. Lead has been banned from use in sports fishing equipment in Denmark since 2002, and in 2007, an executive order from the Danish government banned the use of lead in commercial fishing equipment. This legislation was implemented because lead is a toxic metal: significant concentrations of lead can have detrimental impacts on marine ecosystems. Lead is particularly harmful to marine invertebrates which serve a vital role in the entire trophic food chain. More specifically, lead can impact the fertilization and larval development of marine vertebrates, and it can also inhibit their reproduction and result in mortality. It also affects seawater chemistry, and because lead is not biodegradable it can permanently contaminate water.



**Zinc is a more environmentally friendly material than lead, but economically there is little to distinguish the two.**

**J**an V. Jørgensen, managing director and Jürgen A. Haberl, sales manager, explained that the implementation of this legislation by the Danish government inspired Linimatic to lead a project to develop a lead-free sinker for fishing nets. Sinkers are weights, typically made of lead, used in recreational and commercial fishing to control the depth of a fishing line or net

and the speed at which they move through the water, and they range in size to assist the varying needs of fishermen. Unfortunately, lead sinkers are often corrosive and frequently are lost in the ocean, so they pollute the water. Linimatic's project, starting in 2006, was backed by the Danish Environmental Protection Agency, in cooperation with researchers at the Technical University of

Denmark (DTU). The result of the project was zinc sinkers, which Linimatic markets as “Sinkers.”

## **Making the switch from lead to zinc sinkers**

Linimatic's project revealed that zinc can be used to replace lead in most kinds of fishing equipment, including sinkers used for trawl, seine, and other sorts of industrial

fishing. In fact, zinc is superior to lead in many respects. The downsides to zinc use are that it is about 10-15% more expensive than lead, and more sinkers are required to achieve the same effect because zinc is less dense. However, the sinkers last 5-6 times longer; zinc is more resistant to impact, so zinc sinkers suffer less abrasion, making their lifespan longer than that of lead. From a purely economic





**Linimatic's zinc sinkers' smooth edges limit the erosion and wear they suffer, contributing to their longevity.**

perspective it is difficult to distinguish sinkers made from lead from those made of zinc.

The most notable advantage of switching to zinc sinkers is the environmental benefit that it has. Trawlers drag the sinkers across the sea floor when fishing. This erodes the sinker, leaving tiny particles in the marine environment. When corrosive lead sinkers are used, the particles left in the ocean are toxic. In contrast, the zinc sinkers are relatively harmless because zinc and the other metals used in Linimatic's sinkers are non-toxic and have little or no negative effect on the environment. To ensure, however, that zinc sinkers do not cause harm to the marine environment, it must be ensured that the proper zinc alloy is used. The wrong alloy could contain heavy metals like lead, tin, and cadmium which would crumble and corrode and pollute the water.

### **Legislation is crucial for an international transition towards Zinc**

By outlawing lead in fishing gear, the Danish authorities have pushed the fishing industry into substituting lead fishing tools with tools made of other material. Lead sinkers are still being phased out, explained Mr Jørgensen, so lead fishing

products can no longer be purchased legally, but those that are still in circulation can still be used. So, as lead sinkers are phased out, Linimatic's sales of zinc sinkers have gradually increased.

Mr Jørgensen stated that the company's sales are almost exclusively to Danish companies that produce fishing gear, mainly nets, who then distribute their products to fishermen. He further explained that the legislation which has promoted the sales of zinc sinkers in Denmark is not universal across the EU. Though neighboring countries like Sweden, Iceland, and Norway all have similar policies when it comes to concern over the environment, they still do not regulate the use of lead in fishing gear. Mr Jørgensen predicts that environmental demands will eventually be the driver for change in Scandinavian countries and hopes that legislation will cause a shift in market demand.

Linimatic has been in contact with Norwegian net producers, and some of them are interested in converting from lead to zinc sinkers, but it would require convincing their customers that the price difference and the need to use more sinkers per net is worthwhile. Mr Haberl said that in Norway, fishermen are primarily

concerned with the price of the sinkers, and he does not foresee a shift in their use from lead sinkers until policy changes are made. He added, however, that Linimatic recently had a buyer from Italy who was more interested in the product's quality and delivery time than in the price. This could indicate a market for zinc sinkers in Italy, thinks Mr Haberl.

### **A promising future for the zinc sinker market**

Mr Jørgensen is optimistic that the market will expand, particularly because of universal concern for the environment. Denmark's transition to a greener fishing industry includes support for new technologies that push the industry in a more sustainable direction, and which could promote the use

of Sinkers. Linimatic's production process is machine driven in contrast to the production of lead sinkers which is largely manual. Manufacturing by machine ensures that the weight and quality is consistent, and the sinkers are without any sharp edges, so no damage is done to the nets, increasing their lifespan. In contrast, lead sinkers made by hand are not uniform. The material is not only harmful to the marine environment, but also to the workers who fabricate the sinkers manually, says Mr Jørgensen. He believes demand for zinc sinkers will likely only increase significantly if the proper legislation is implemented in other parts of Europe. The time is right, says Mr Jørgensen. Everybody is concerned about the climate, and everybody knows about the toxicity of lead. It would not be at all difficult for other governments to follow in the footsteps of the Danish government. The zinc sinkers already exist, and they offer many benefits over lead. But as is the case with so many other environmental issues, making substantial change is much more complicated than simply swapping materials. Despite this, Linimatic is hopeful that zinc will continue to grow as a key part of the fishing industry across Europe.

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**Products:** Zinc sinkers  
Other parts for applications, including industry, design, automotive, aerospace, and medical devices

**Function:** Zinc die casting and manufacturing to produce a variety of complex, precise, and detailed parts.

**Markets:** Denmark  
(for sinkers exclusively)



**Farmed shellfish**, a bright star on the Danish aquaculture firmament

# New possibilities in triploid oyster farming

In Denmark, as in many other EU countries, the aquaculture sector has grown very slowly due to restrictions and red tape. This contrasts with the rest of the world where aquaculture is in healthy growth providing jobs and food security.

The fish farming sector in Denmark has been in steady decline, but farmed mussel production has increased from 1,000 tonnes in 2009 to 10,000 tonnes production in 2022. The increase in mussel farming is due to a more positive regulatory framework where it was possible to get permits. The seaweed cultivation sector has seen much interest, but only nine tonnes have been harvested in total so far despite investments of more than EUR15m in different seaweed farming development projects. Now, interest is building in a novel species for Denmark—the triploid Pacific oyster (*Crassostrea gigas*). Due to the triploidy the farming of this alien species is risk free for the environment, where

feral Pacific oysters are already abundant all over the country. It has taken more than 10 years to process the permit to farm triploid Pacific oysters, but now the Danish Environmental Protection Agency seems to be ready to issue permits for farming.

## Pacific oyster is a high value species

The reason the triploid Pacific oyster is a potential candidate for aquaculture is that it commands a high price; the farmgate price for Pacific oysters in the EU is EUR4.7/kg (Eurostat) and the price for Pacific oysters imported to Denmark is EUR7.5/kg (Statistics Denmark). In contrast, mussels are EUR0.5/kg. In addition,

the Pacific oyster is resistant to diseases like bonamia, a parasite that can cause lethal infections in shellfish, that has been wreaking havoc among companies trying to farm flat oysters. Lastly, the growth is nothing less than spectacular—the market size of 100 g is reached within two summers, while the slower growing flat oyster takes four years to reach same size.

In Denmark there are no tides. The traditional way to farm oysters in France and Ireland on tables in the tidal zone is not possible in Denmark. Instead, cultivation must be in floating bags that can be prone to storm damage, or lantern nets that need frequent pressure washing to keep them clean. The cost of labour in Denmark is very high making production that involves much manual work economically unviable. To cut costs, production using bottom-culture has been trialled with very encouraging results in selected areas in Denmark. This method removes the need for manual

labour because it is possible to mechanise to a large degree the harvest and care of the oysters. They oysters are re-laid in deep water at 10 g in spring and grow to 100 g by the autumn. The meat quality is decent and losses from predation by brown crabs and starfish are acceptable at 10-20%.

## Sector struggles with opposition from affected communities

The authorisation system in Denmark for mussel and oyster farming has been put on hold for the last three years while the Fisheries Agency mulls how to deal with the tidal wave of NIMBYism that torments the regenerative aquaculture sector. How long it will actually take to process applications to farm triploid Pacific oysters, among other species, remains unknown.

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Danish shellfish farmers can look forward to growing triploid Pacific oysters once applications to cultivate this species are approved.

### The advantages of triploids

Triploid oysters have three sets of chromosomes and are attractive for the commercial aquaculture industry because of their potential for fast growth, superior meat quality (also in the summer period), year-round harvestability, and low environmental pressure on wild populations due to their sterility.



User interests intensify competition for land at sea

# Offshore wind power and fisheries: Partners or adversaries?

Offshore wind power is one of the central pillars of EU climate policy, which, as stipulated in the Paris Climate Agreement, envisages a 55% reduction in greenhouse gases by 2030 compared to 1990. The expansion of offshore wind power, however, requires drastic changes in the use of sea space, which will further exacerbate conflicts among user groups that have been smouldering for some time now. Downturns threaten fishing in particular.

Europe's climate protection goals are increasing the competition for space at sea where there is a struggle for every square meter in the North and Baltic Seas: traditional users such as fisheries have long been fighting with ship owners, raw material suppliers, the military and environmental and nature conservationists over the scarce sea space. Now offshore wind farm operators have been added to that list, who are asserting their interests with arguments for climate protection and the energy transition. They are supported by many EU politicians, because the European Union is striving to become climate-neutral by 2050. The ambitious goal of the European Green Deal envisages expanding offshore wind energy capacity from the current 12 GW to at least 60 GW in 2030 and up to 300 GW in 2050. More than three quarters of this wind energy is to be generated in the North Sea and Baltic Sea areas, which are particularly attractive for offshore wind fields due to stable wind conditions and shallow water. There are already 110 offshore wind farms with over 5,000 individual turbines in UK and EU waters. Too little, say politicians; too much, however, protest a number of other users who are supposed to accept more and more restrictions.



**Wind farms play a critical role in contributing to Europe's climate goals, but they add to the already fierce competition for space at sea.**

Although the offshore wind industry cannot complain about a lack of support and reports record expansions almost every year – in 2020, for example, a capacity increase of 7.1 GW was recorded – it too is increasingly reaching its limits. For “mega projects” with more than one GW of capacity, there is often a lack of space, because a regulatory framework that adequately takes into account the needs of all user groups has so far been lacking. If the EU targets for the expansion of offshore wind energy by 2050 are implemented one-to-one, the land requirement would increase by a factor of 15! This simple fact alone gives an idea of the enormous potential for conflict with other

users, including fisheries, which have long complained about the lack of attention and help from politicians. Neither does it help much that the EU Commission, in the directive on maritime spatial planning (2014/89/EU), calls on all member states to take the interests of fisheries and aquaculture into account in addition to the development of the energy industry. Fishermen and aquaculture producers should have a say in where wind turbines are built, says Dutch MEP Peter van Dalen. New wind turbines should not be built until it is clear what impact they are likely to have on the economy, the environment and biodiversity. However, it remains questionable

whether the legitimate demand can actually influence decisions. There is a significant concern that the approval procedures for wind farms, which already pose a major challenge for the expansion of the offshore wind industry, could further impede progress.

## **Traditional fishing rights are increasingly being curtailed**

Space is getting tight in the North and Baltic Seas, even though both seas combined cover an area of a good 950,000 km<sup>2</sup>. In the medium term, however, almost 10% of this is reserved for wind farms and is therefore hardly accessible for



**Wind farms create new ecosystems in the sea that have a positive effect on the biodiversity of the local environment.**

other maritime activities. Fishing, in particular, is to be restricted, as fishing grounds are increasingly being lost as a result of massive offshore expansion. Because trawling is banned in wind fields, fishermen miss out on some of their traditional bottom fish and crustacean catches. In view of the record investments in the energy industry in Europe – 26.3 billion Euro were invested in offshore wind farms in 2020 alone – the losses suffered by fishermen are likely to be only a marginal matter for politicians, especially since the direct and indirect costs of the loss of fishing grounds cannot be precisely quantified. However, the displeasure of fishermen and other user groups is growing and can no longer be ignored. Attempts are being made to defuse the impending permanent conflict and to achieve a kind of “peaceful coexistence” between the interest groups through participatory maritime spatial planning. That should be difficult, as even conservationists are protesting fearing long-term damage to marine ecosystems, marine fauna and flora and migratory birds. They call for turning the tables and looking for areas for wind power expansion before new wind fields are decided upon. Certainly, offshore energy plays a crucial role in meeting our energy needs. However, it is vital to establish limits and ensure responsible development. The North and Baltic Seas are already full to the brim. After

all, wind farms already take up several hundred square kilometres of sea surface and drastically change the appearance, not just visually. Marine ecosystems are indeed facing numerous challenges due to various human activities. Factors such as climate change, eutrophication, pollution, shipping, gravel and sand quarrying, as well as oil and natural gas extraction, have collectively placed significant stress on marine ecosystems.

Conservationists have concerns about the potential negative impact on marine biodiversity and endangered species due to the continued growth of offshore wind turbines, while fishermen frequently express worries about the potential harm to their economic well-being. Fishing is taboo or at least severely restricted in wind farms and within a radius of a few hundred meters in almost all EU member states. Even where fishing would theoretically be possible, fishermen often do without it. The risk of the boat ramming into a facility and damaging it or of the fishing gear getting caught and lost is far too great. Insurance premiums for vehicles that are allowed on wind farms are hardly affordable and without insurance cover the areas are effectively closed to fishermen. These restrictions mainly affect smaller fishermen who cannot switch to more distant fishing grounds or exchange fishing gear at short notice.

## Both negative and positive effects

The installation, operation and maintenance of offshore wind turbines can all have harmful effects. This affects some fish species, marine mammals and benthic communities on the seabed, whilst above the water, sea and migratory birds may be disturbed during their migration season or sometimes even collide with the turbine rotors. During the construction phase, the noise from pile-driving the foundations and the resulting turbidity plume will without doubt drive marine animals from their traditional habitats temporarily. The increased noise level of the wind turbines is also expected to have a certain deterrent effect later on during operation. It cannot be ruled out with absolute certainty that important resting and many feeding areas will be lost. However, it is disputed whether such fears are actually justified. On the other hand, many scientific studies give the all-clear: the consequences of laying the foundations of wind turbines can only be verified in the short term and are comparatively minor.

The sediment turbulence during the construction phase drives flatfish such as plaice and sole out of the sediment only for a short time. They leave their hiding places in the ground and show increased swimming activity. Pelagic zone species such as mackerel and horse mackerel leave the areas but quickly return once the agitated sediment has settled. In the meantime, there are increasing reports that the marine fauna and flora benefit greatly from the scour heaps and the introduction of large stones to protect the plant foundations. The hard substrates act like small reefs on which algae and mussels settle, which then subsequently attracts

other inhabitants, especially crabs and other crustaceans as well as small fish species from gobies to sea scorpions. Within the North Sea and Baltic Sea, which are typically characterized by sandy and soft sea beds, these hard substrate islands serve as “magnet points” that inexplicably attract sizeable fish species, including cod and pollock. This stands out in an otherwise relatively poorly structured marine environment. This effect can certainly be compared to the use of the controversial FAD (Fish Aggregation Device) in tuna fishing. These are clear indications that some fish species use the wind farms as retreats, perhaps even as a “nursery” for their offspring, which would also benefit life in the surrounding area. Experts refer to such relationships as the “transfer” or “spill over” effect.

## Rock fills for foundations enliven the undersea environment

A study by the University of Ghent provides evidence that the plaice in the North Sea is one of the beneficiaries of wind energy. The flatfish find optimal feeding conditions near the artificial reefs, which have a positive effect on their development and growth. The study was able to show that they stayed in the vicinity of the turbines during the summer months and even preferred certain wind turbines. The population of edible crabs (*Cancer pagurus*) has also increased significantly around the rocky scour protection of the foundations and could be a worthwhile fishing resource if there were more demand. One of the essential prerequisites for this is, of course, that suitable concepts for fishing co-use of the offshore wind fields with passive fishing gear such as pots are developed. The joint use of these areas could



be a first step towards defusing spatial conflicts. In Great Britain and also in Denmark, passive crab fishing with fishing baskets in the vicinity of wind farms is actually already permitted. Such possibilities are being examined in Germany, however until now, any fishing within the safety zones has been prohibited. Among other things, with the argument that the wind energy areas also serve to protect nature.

In fact, this cannot be completely dismissed. On the one hand, many experts assume that the construction of the wind farms will not cause any serious changes in the diversity and wealth of species in the North Sea or Baltic Sea. On the other hand, it cannot be denied that the wind farms are creating new ecosystems in the sea that have a positive effect on the biodiversity of the local underwater world. The placement of rock-fill around the wind turbines area actually creates an artificial reef, which serves as a valuable habitat for a wide variety of animals and plants. For many environmental organisations, however, this is far from enough. If they have their way, at least half of the North and Baltic Seas should be free of any economic use. They regard fishing and shipping as the main threats to the marine environment. Given the current tense spatial utilization situation, achieving this requirement appears to be quite unrealistic at present. However, the EU Commission's offshore strategy also suggests increasing the proportion of marine nature protection areas to 30 percent in alignment with the EU biodiversity strategy. A third of this should be strictly protected, i.e. free from human influences. So far, this only applies to one percent of all the areas.

### **Implementing a co-use policy can contribute to the resolution of ongoing conflicts**

These few examples highlight the challenging and complex nature of developing comprehensive and holistic space utilization concepts that successfully address both ecological and economic considerations. There is a great danger that legitimate interests of the supposedly smaller users, which unfortunately include fisheries, are not adequately taken into account. The need for co-use, which involves a meaningful integration of various usage requirements, is becoming increasingly evident as it becomes challenging to address the numerous issues associated with the division of sea space without it. The energy transition, climate protection, and nature conservation are important societal goals, but it's equally valid to consider the needs of the fisheries. There is no reason why aquaculture, such as algae and mussel farming, or passive fishing for high-quality fish and crab species, couldn't be compatible with wind farms. In fact, in the Netherlands, efforts are under way to reintroduce oysters on the foundations of wind turbines. Belgium has already initiated modest aquaculture experiments in its wind farms.

However, disagreements and stand-offs often arise in situations where there is no consensus. In France, for example, a wind farm project in the Brittany Bay of Saint-Brieuc faced opposition and was blocked due to local protests. The project lacked sufficient public discussion and there were concerns about the absence of an environmental impact study. Many projects fail due to the resistance of fishermen and coastal communities, whose power and influence in France

should not be underestimated. Banc de Guérande, an 80-turbine field off Saint-Nazaire in the Bay of Biscay, went into operation in November 2022 as the first offshore wind farm in France. Similar challenges are faced in the United States, where establishing offshore wind farms is also not easy. In Maine, construction is even prohibited by law, primarily due to concerns raised by local fisheries and environmental factors. Except for the relatively small Block Island offshore wind farm, there are no other commercial-scale projects along the US coasts.

### **Floating wind farms provide a promising solution to these challenges**

By anchoring turbines in areas with water depths exceeding 100 meters, located further offshore, new opportunities emerge. Previously, water depths of around 60 meters were considered the upper limit for fixed-foundation wind farms. The steep drop-off of the seabed near the coast limits the construction of new wind fields in many areas. Floating systems, on the other hand, offer the advantage of being deployed in deeper waters, where wind conditions are more consistent, and conflicts with other users are minimized. Potential suitable areas for floating wind farms include the west coast of Ireland, the Portuguese Atlantic coast, the Mediterranean, and California. While still considered a niche technology, floating offshore wind farms have gained significant interest from energy investors. There are 230 projects with a total planned capacity of 185 gigawatt around the world. Great Britain leads the way with 33 gigawatts (GW), followed by Sweden (21 GW) and Ireland (19 GW). The excellent performance of floating offshore wind farms

further supports their viability and potential. Hywind Scotland, probably the world's first floating field, achieved the best result of all wind farms in Great Britain for the third year in a row with an average utilization rate of 57.1 percent.

This convincing performance has also debunked the primary argument of the remaining sceptics, particularly their claim that the technology is still prohibitively expensive. This notion is crumbling as the current price development demonstrates the increasing cost-effectiveness of floating offshore wind farms. In addition, floating systems have the advantage that they can be assembled inexpensively on land and then towed to their anchorage. This approach also allows for the easy return of floating systems, such as during scheduled maintenance work.

Relocating offshore wind farms to more distant areas from the coast would result in a reduction of the offshore wind footprint. This shift could potentially benefit fisheries by freeing up traditional fishing areas that were previously occupied by wind farms. However, it remains questionable whether this will actually take place if the EU biodiversity strategy and nature conservation stand in the way of this action. Another aspect that raises uncertainties is whether the dismantling of wind turbines would also require the removal of the stone foundations. These foundations, which function as artificial reefs, have proven to have a positive and revitalizing impact on marine ecosystems. Experts acknowledge the planned dismantling of wind turbines despite the positive impact of the stone foundations, as offshore wind turbines typically have an estimated average service life of 25 to 30 years.

*Manfred Klinkhardt*



Careful management of Falkland's fisheries boosts local economy and protects the region's ecosystem

# Sustainably managing a productive fishery in the Southwest Atlantic for economic viability

The Southwest Atlantic is home to some of the most productive fisheries in the world. This favourable environment forms the basis of a thriving economy within the Falkland Island, with the licensing of local fisheries (two species of squid and eleven species of finfish) accounting for 64% of GDP.

## Fisheries in the Falklands

The Falklands are an archipelago consisting of 778 islands situated on the Patagonian shelf, 480 km east of Argentina in the Southern Atlantic Ocean. The islands lie at a latitude of 52°S, with approximately 1210 km of ocean separating them from the northernmost tip of Antarctica. They are a UK Overseas Territory that are, home to about 3,700 people, most of who live in the town of Stanley on East Falklands. Due to the remoteness of the islands and its proximity to Antarctica, the islands are a haven for a host of marine life

including many cetacean and pin-niped species, as well as breeding populations of penguins (gen-too, king, magellanic etc.) and other seabirds like albatrosses and petrels. Most of these species are attracted to Falkland waters due to upwellings caused by cold northbound waters meeting the continental slope to the south of the islands. These upwellings bring nutrient-rich waters to the surface that forms one of the most productive areas in the southwest Atlantic that many fish and squid rely on for feeding and spawning.

These rich fishing grounds were only properly exploited and

managed from 1987 with the introduction of the Falklands Inner Conservation Zone (FICZ) and a proper management regime. This was expanded in 1990 with the introduction of the Falklands Outer Conservation Zone that extended out to 200 miles from the islands' coastal baselines, following the islands exclusive economic zone (EEZ). This was initiated after local concerns of stocks being increasingly exploited by trawlers flagged in Spain, Poland and the Soviet Union. The provisioning of licences to fishing vessels resulted in the local government increasing their revenue by 500%, leading to the Islands becoming financially

independent from the UK excepting foreign affairs and defence. As a result, the fisheries industry now accounts for over 60% of the GDP. In 2022, annual revenue generated from the fishing license fees totalled £30.5 million. Meanwhile, exports of fishery products to the EU between 2014 and 2020 brought in an average revenue of £143.7 million.

Three fishing methods operate within the fishing zones: jigging for Argentine shortfin squid (*Illex argentinus*), demersal longlining for Patagonian toothfish (*Dissostichus eleginoides*) and bottom-trawling for Patagonian



The Falklands host 70% of the global population of the black browed albatross.



Licensing jiggers is a valuable source of revenue for the government of the Falkland Islands.





**Jiggers target Argentine shortfin squid from February every year. The bright lights attract plankton which in turn attract the squid. These are caught on hooks hanging from the vessel.**

squid (*Doryteuthis gahi*) and various finfish species (including pink cusk-eel *Genypterus blacodes*, Argentine hake *Merluccius hubbsi* and Patagonian cod *Salilota australis*). Presently, a fleet of 135 ships flagged in Taiwan, Spain, Korea, Vanuatu, and the Falkland Islands frequent the waters around the Falklands every year at various times, depending on target species. The fishery is predominantly based on squid, with the Argentine shortfin squid and the Patagonian squid (calamari) accounting for roughly 75% of all catches. Consequently, approximately 50% of the calamari consumed in Europe originates from Falklands waters.

## Fisheries management prioritises the marine environment and a competitive seafood sector

The Falkland Island Fisheries Department (FIFD) oversees the fisheries within the waters of the Falkland Islands Conservation Zones. Management of these zones depended on a system of Individual Transferable Quotas (ITQs) which was introduced in 2006 after the implementation

of the 2005 Fisheries Conservation and Management Ordinance. After around 15 years of operation the government and industry decided to review the success of ITQ since its implementation. Following this review, politicians decided they would provide for a new type of ITQ (known as ITQB), this ITQ would effectively reboot and provide secure access for a period of 25 years subject to the ITQB holding companies meeting a number of key criteria. These criteria ultimately improved the effective control, active involvement and economic efficiency of the Falkland Island partner in downstream joint ventures. In order to ensure aligned goals and strong collaboration between the fishing industry and the government, a Fisheries

Accord was drafted and signed in 2020. Sitting under the Accord is a shared Action Plan which is reviewed every six years and progress against which is reported to the politicians on a biannual basis. The Accord has five core pillars and a suite of objectives and actions to ensure a successful outcome. A key goal is that we build a competitive seafood sector whilst ensuring the health of the marine environment and the safety of crew members working on the fishing vessels.

The Fisheries Department also works closely with industry partners to maximise the economic potential of the fisheries while maintaining relationships with scientific institutes such as the Southern Atlantic Environmental Research Institute (SAERI) and Falklands Conservation, as well as international partnerships with universities in the form of PhD programmes, to ensure the fisheries can be managed as sustainably as possible.

The high seas fishing grounds east of the Patagonian Shelf are one of the few areas around the world with important fishery resources for which there is no effective regulation under any Regional Fisheries Management Organisation (RFMO). The absence of an RFMO is largely due to the geopolitical situation between Argentina and the Falkland Islands. In previous

years, bilateral work between the two countries existed through workshops, joint research cruises, and the development of the South Atlantic Fisheries Commission (SAFC). The SAFC, initiated in 1991, facilitated the exchange of fisheries data, the co-ordination of joint research cruises and scientific analysis, and provisioned conservation advice to the respective governments. Although not a consistent timeline, the SAFC worked effectively and had the potential to develop into an RFMO for the Southwest Atlantic. However, difficulties in communications between the Falkland Islands and Argentina in recent years have postponed discussions, straining management efforts.

## Licensing squid jiggers is a substantial source of revenue

The jigging fleet is composed of up to 106 vessels flagged in Taiwan and Korea that target Argentine shortfin squid from February every year. This fishery currently sits outside the ITQ property right system and vessel apply on an annual basis to access this fishery.

Jigging consists of attracting plankton with bright lights, which attracts squid onto hooks hanging in the water around the boat. With a native range extending far north beyond the Falklands' zones

## Catches in the Falkland Islands (tonnes)

	2017	2018	2019	2020	2021	2022
Patagonian squid	64,677	79,996	81,908	60,732	95,627	101,166
Argentine shortfin squid	67,445	54,603	43,449	62,663	172,300	73,053
Patagonian toothfish	1,519	1,259	1,317	1,246	1,094	1,140
Argentine hake	15,589	27,023	53,378	43,327	59,177	62,829
Patagonian grenadier (hoki)	4,053	4,439	7,407	7,643	1,914	2,326
Skates	3,189	1,995	1,504	1,397	1,574	1,203
<b>Total catches</b>	<b>168,183</b>	<b>187,749</b>	<b>201,579</b>	<b>182,575</b>	<b>338,165</b>	<b>246,192</b>



**The abundance of squid is thanks to upwellings caused by cold northbound waters meeting the continental slope to the south of the islands. These upwellings bring nutrient rich waters to the surface on which the squid rely.**

into the high seas, managing the Argentine shortfin squid straddling stock can be difficult, as recruitment of the stock varies from year to year and occurs outside Falkland waters. In recent years, the establishment of a Maritime Authority, subsequent implementation of the maritime ordinance (Port State inspections) combined with a change in the licensing process for this fishery, has resulted in significantly improved health safety and wellbeing for the crews of these vessels. As a result of these changes there has been a significant reduction in the number of operational and wellbeing issues across this fleet.

Due to the sheer number of vessels jigging for this species of squid, licensing revenue accounts for half of total licencing revenue despite more Patagonian squid being landed in the Falklands than the Argentine shortfin squid.

## Managing semelparous species

With a single-year lifecycle and a single spawning per individual throughout this lifecycle, squid

require careful and ongoing stock assessments throughout the fishing season, to ensure the population remains stable. This is important for ensuring healthy recruitment of the stock in the next seasons. As a result of this fragile and short lifecycle, squid stocks are susceptible to intra-annual environmental changes. With the help of scientific observers collecting biological data and scientists analysing this data, the two Patagonian squid seasons are monitored closely to ensure sustainable exploitation using the depletion model. This model calculates an estimate of population abundance over time by evaluating what levels of abundance and catchability must be present to sustain the observed rate of the catch. For example, in 2019, the second Patagonian squid fishing season was closed early as biomass estimated from the depletion model was projected to fall below the conservation threshold. Management decisions like these, that come about as a result of short chains of communication between science, management, and industry have allowed catches to remain stable over the years and stocks to remain healthy. As

a result of this cooperation, the Patagonian squid fishery here in the Falklands is considered to be one of the best managed squid fisheries in the world.

The Argentine shortfin squid fishery has the same potential but heavy fluctuations in recruitment from year to year remain understudied as the stock straddles different EEZs and the high seas, and international cooperation on management regimes are difficult to achieve at present.

## Shifts in the finfish trawling catches

The finfish trawl fishery of the Falklands has experienced several shifts since the start of the monitoring programme: from a dominance of southern blue whiting (*Micromesistius australis*) in the 1990s, to longtail southern cod (*Patagonotothen ramsayi*) from the mid 2000s into the mid 2010s, and the current dominance of Argentine hake. These changes may be indicative of large-scale changes in the environment, niche shifts, and/or overexploitation of shared-stock species with South-American countries.

Argentine hake is an ecologically important fish currently supports the largest groundfish fishery in the southwest Atlantic. However, relatively little is known about their ecology and distribution within the Falkland Islands. The species has experienced large increases in abundance in the last several years in the water surrounding the islands although it is unknown what fraction of the population migrates into the fishery. Data collected from research surveys around the Falkland Islands suggests that there may be possible variations in migratory behaviour between males and females as well as differences in distribution depending on the age and size of the fish. As hake are relatively fast growing, aging the species is particularly challenging, so internal research aims to shed light on growth trends by assessing hake from different areas of the fishing zone to better understand their ecology.

## Managing stocks of fragile species

Patagonian toothfish, also known as Chilean seabass, is a



**All squid trawlers are obliged to accommodate an external observer for the duration of the Patagonian squid fishing season to document seabird and marine mammal interactions with vessel gear.**



highly prized deep-water fish that can grow upwards of two meters long. This slow-growing species with low reproductive rates is vulnerable to overfishing, and is unsustainably fished in the Southern Ocean by illegal, unregulated, and unreported (IUU) fishing. Patagonian toothfish stocks in the Falkland Islands are managed at sustainable levels using longlines which have minimal impact on the marine environment. As a result, the fishery was certified as compliant with the MSC Fisheries Standard in March 2014, and recertified in November 2018, effective until May 2024. Since 2007, Patagonian toothfish have been targeted using bottom longlines with umbrellas (a net covering that protects the hooks), which reduces the direct access of marine mammals and seabirds to the fishing hooks and consequently their predation of fish caught on the longliners. These umbrellas have been crucial in mitigating seabird mortality during line setting when birds dive to approach the baited hooks—no seabird hookings have been observed since 2005.

## Reducing the collateral damage of fisheries: SEDs

The Falklands harbour over 63 species of seabirds, 70% (500,000 pairs) of the world's population of black-browed albatross (*Thalassarche melanophrys*), and are important breeding grounds for the Southern giant petrel (*Macronectes giganteus*). A major target area for fisheries management in the Falklands is seabird and marine mammal monitoring and bycatch mitigation. The main legal instruments are the Marine Mammal Ordinance 1992, which prohibits the killing or taking of marine mammals, and the Fisheries Ordinance 2005, which sanctions the implementation of measures to prevent or mitigate mortality or injury of marine mammals and seabirds during fishing operations. As a commitment to these legal frameworks, mitigation measures employed by fishing vessels within the zone include "tori-lines" and "fixed aerial arrays".

Following a marked increase in seal mortality in 2017, the FIFD carried out trials of different

mitigation measures targeted at marine mammals. This led to the requirement of trawlers targeting Patagonian squid to install seal exclusion devices (SEDs) inside the fishing nets to allow for the effective escape of seals that become trapped in the net during fishing activities. The use of standardised SEDs is regulated under licencing conditions and seal mortalities have remained negligible since the first implementation of SEDs in 2017. Under licence conditions, vessels have to facilitate the escape of seals while the fishing gear is still in the water.

Concurrently, all squid trawlers have since been obliged to accommodate an external observer for the duration of the Patagonian squid fishing season to document seabird and marine mammal interactions with vessel gear. Furthermore, mitigation measures also extend to discard regulations on vessels. This comprises the ceasing of discards during the deployment and hauling of nets, thorough cleaning of nets before every deployment, and discarding in batches rather than continuously while the vessel is trawling. A new discard policy was implemented in January 2021 making it mandatory for all vessels to have a storage tank for discards to diminish interactions with both seabirds and marine mammals.

## New fishery patrol vessel brings improved control capabilities

During 2022 the Falkland Islands Government embarked on a procurement exercise to replace the aging fishery patrol vessel Protegat (a converted fishing vessel). At the end of April 2023 FPV Lilibet, a Damen 5009 coastguard class vessel owned and operated

by Laurus Dominicus Ltd arrived in the Falkland Islands. This is a new build with modern command surveillance technology on board. The vessel is smaller and lighter than previous patrol vessels, but this has resulted in an almost 100% improvement in speed capability. The vessel will operate according to the weather, but can currently achieve a limited (by UK flag) maximum of 19.7 knots. Once she is flagged in the Falkland Islands the maximum speed should be as certified at just under 29 knots. Speed along with a number of other key capabilities including the single manned bridge and rear deployed rib system means that she will deliver significantly greater capability for the Falklands fishery (as well as search and rescue efforts as needed).

Whilst the Falkland Islands Fishery may be seen as a relatively young and small fishery in the global context, it is clear to see that it is continually evolving and growing its economic return to the Falkland Islands. Today the Falkland fisheries can be recognised as a significant member of the global fisheries family. Moving the fisheries management to a stable long-term system is key to building collaborative relationships with both industry and third-party research institutes, ensuring that the success of our fishery continues is maintained for future generations of Falkland Islanders.

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The nets of trawlers fishing for Patagonian squid are installed with Seal Exclusion Devices to protect these marine mammals.



**Ukraine's fish farming business:** Impacts of Russia's war against Ukraine

# Ukrainian aquaponics farm survives war damage with imagination and personal strength

AquaFarm is the only company in Ukraine that combines the production of fish and vegetables in an aquaponics system. The company was established by a lawyer couple who wanted to start a business that their two children would inherit and that would provide fresh, natural, locally produced vegetables and fish all year round for their customers and themselves. The couple studied agrarian business and travelled to different countries for ideas and inspiration for their start-up.

This is the third in a series of articles in the Eurofish Magazine dedicated to seafood businesses in Ukraine and how they work and survive during the war.

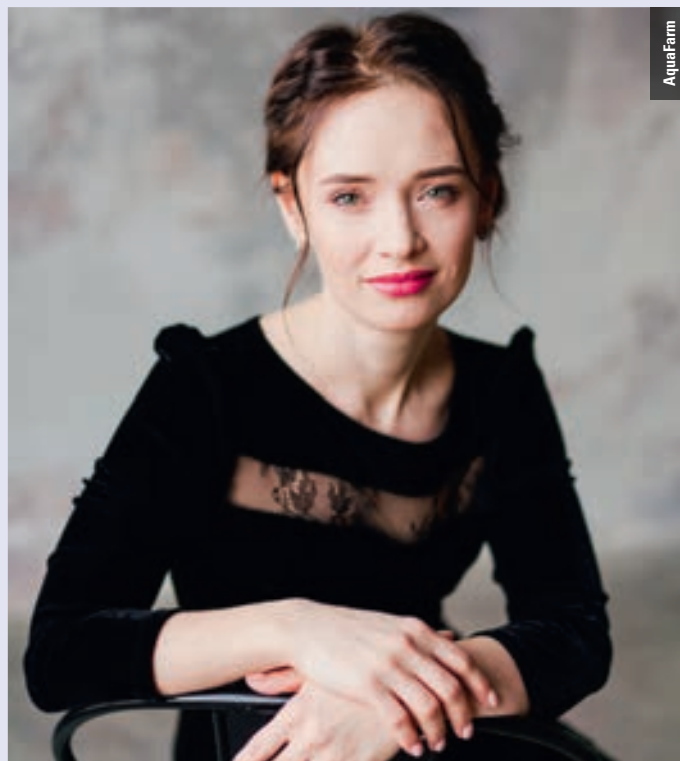
The couple chose aquaponics because it is a compact, energy- and water-saving production process that can be established in a city. Ukraine's dependence on fish imports, which increased after the illegal annexation of Crimea in 2014 and the subsequent closure of many Black Sea and inland fishing grounds, also motivated their interest.

## Integrating vegetable growing and animal raising in a single unit

The farm's construction started in 2016, says Ms Oksana Prokosa, AquaFarm's founder and director, and currently includes 3,500 square meters of greenhouses, a fish farming facility, and two processing units, for a total area of 0.86 hectares. The latter are "cold" and "hot" facilities: in the cold one fish are slaughtered and prepared for either the retail sector or for further processing in the hot shop – primarily smoking and dry-curing. Tomatoes, basil, and various green salads

are grown in the greenhouses, while African catfish and tilapia are farmed in the recirculation aquaculture system (RAS). The company uses solar batteries and has its own boiler house to supply additional energy and heating - depending on the season and weather conditions. Both catfish and tilapia require a water temperature of around 26 degrees C. The nutrient-rich effluent water generated in the RAS is cooled by 1-2 degrees and supplied to the greenhouses. AquaFarm has a HACCP plan in place and is certified to the ISO 22000 standard, ensuring the products' quality and safety at each step of production. On average, production of catfish reaches 200 tonnes, while for tilapia it is 20 tonnes per year.

In the beginning, fish fry and broodstock were imported from the Netherlands. However, the covid restrictions made such imports impossible and the company started their own hatchery to provide enough stock for year-round production.



**Oksana Prokosa – director and founder of AquaFarm – the one and only aquaponics producer in Ukraine.**

The most difficult issue in aquaponics is to keep the right balance between two units, fish and plants, explains Ms Prokosa. Each of them requires water that meets certain criteria, and these criteria must be continuously monitored to ensure the successful coexistence of the two.



**AquaFarm's greenhouse before the war and after the shelling in spring 2022.**

### **Sales grow as products are fine-tuned for specific market channels**

AquaFarm started fish processing at almost the same time that they produced the first harvest. Fish sold as a raw material is not as competitive and does not have the same consumer demand as processed fish, explains Ms Prokosa. We like to make the lives of our customers easier by offering them semi-processed fish so they will spend the minimum effort to cook a meal. Our catfish is processed into fillets while tilapia, due to its smaller size, is sold whole/gutted or as fillets. All these products are either chilled or in MAP packaging – never frozen, to ensure the customers get the original taste of the fish and that no nutrients are wasted. Catfish fillets are also dry-cured or smoked – cold or hot – sometimes with spices and herbs. Recently AquaFarm started producing catfish pates with adding various ingredients like pumpkin, bell peppers, aubergines, tomatoes, or soft cheese.

The distance between the town of Vasylkiv, where the production is located, and Ukraine's

capital Kyiv is only 25 kilometres, which makes farm-to-store transportation time very short. The company has its own refrigerated trucks which also helps to minimise the delivery time and ensure the freshness of the products. Fresh fish is distributed through large retail chains, while smoked products, which are the company's speciality, belong to the premium segment and are sold exclusively to restaurants, pubs, and shops selling craft foods. The HoReCa sector is the largest customer for AquaFarm's tomatoes and greens, while smaller volumes are sold through craft stores.

### **The Russian war damages but doesn't destroy operations and business confidence**

At the beginning of the war when Russian troops were in the Kyiv region, Vasylkiv was severely attacked as it hosts a military airfield. For security reasons, the blackouts became obligatory for both businesses and residential areas during the night, and the power for streetlights was cut off. We were preparing for spring planting, recalls Ms Prokosa,

but due to the power shortage all the sprouts died. Later, as a result of the attacks, the greenhouses were heavily damaged. All female workers with their children moved to safer areas leaving only Ms Prokosa's husband and three other men to keep the facilities functioning, as the fish need constant care and food.

Already on the third day of hostilities, AquaFarm's men began helping the army. The local military unit needed hot food supplies, and the employees started to cook for them. First, they used their own fish and groceries from the company's small store. When the stocks were emptied, the local people started bringing carrots, potatoes, beetroots – whatever they could, to continue providing for the defenders. Everybody realized the importance of such support and contributed their fair shares making it possible to supply the army with hot meals for three months. AquaFarm also donated two tonnes of their fish to a processing company that was producing canned fish for the Armed Forces of Ukraine.

The power cuts were not the only problem. When the war began, infrastructure was disrupted and there was no access to the Kyiv region. AquaFarm had some stocks of fish feed, but only enough to last for a relatively short time. The company was on the brink, but then Russian troops were forced out from the region, and it became possible to replenish the stocks, so no fish were lost.

### **Restoration requires business innovation as well as personal strength**

As the Kyiv region became relatively safe AquaFarm began to restore the greenhouses and today the vegetable production is almost

back to what it was in pre-war times. However, things are not the same as they used to be. Production costs have increased due to surges in the price of fish feed and energy. Repeated power cuts have forced the company to use its own power generator and buy expensive diesel fuel. These costs have influenced the end-price for consumers. Although about 8 million Ukrainians have moved abroad during the war, AquaFarm's sales revenues, due to the proximity to Kyiv and purchasing power of Kyivans, have not shrunk significantly, yet the company wants to sell more and continues to work on it.

Last but not least, is the emotional and physical toll on Ukrainians: night attacks interrupt their sleep, bringing fear and anxiety. It can be very difficult, Ms Prokosa says, to get up in the morning completely exhausted after a sleepless night. You have no energy or even emotions, but you have to pull yourself together, gather your wits, and appear in your usual mood to communicate with colleagues, suppliers, and customers — to keep going.

### **Can a war teach anyone anything?**

Yes! Ms Prokosa replies without a second's hesitation. The war demonstrated to me — a mother and wife — that the single greatest value is having your family together, alive, healthy, and safe. Business, competition, and daily domestic problems recede into the background. Speaking as a citizen, it is very important to me that Ukraine wins, and we all will return to our normal, peaceful life, developing our businesses and our country.

*Aleksandra Petersen,  
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