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Conscious coupling: Can IMTA gain a foothold in Europe?

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Integrated multitrophic aquaculture – farming multiple species on one site – has advantages and challenges

An integrated multitrophic aquaculture (IMTA) system involves the culture of two or more species, of animals and sea plants, on one site with some symbiotic benefit for each product. Photos by (left to right): Seyma Tarkan; Tom McDermott; Marine Institute of Ireland; Scottish Association for Marine Science.

In aquaculture, sometimes one species' trash is another's treasure.

Last November, a team of researchers in the UK and Ireland found that juvenile lobsters could be grown in cages attached to salmon farms as part of an integrated multitrophic aquaculture (IMTA) system. The farming of two or more species on one site, while practiced for centuries in Asia, is somewhat novel to European shores.

Perhaps it's an idea that bears watching because the team's analysis has revealed that the lobsters directly fed on particulate waste from salmon production – and grew significantly as a result.

"Studies show that lobsters that are acclimatized in the natural environment following the hatchery stage have improved survival," said Anastasios Baltadakis, lead author of the **study** (https://www.int-res.com/articles/aei2020/12/q012p485.pdf) at the University of Stirling and Joanne Casserly, scientific and technical officer with Foras na Mara, the Marine Institute in Ireland. "It was hypothesized that growing lobsters in salmon farms would provide a source of food via the waste while the cages would shelter the lobsters from rough weather and allow them to acclimatize in the environment before being released."

An IMTA setup could take many forms and in theory could encompass a variety of species combinations – marine plants, crustacean and bivalve shellfish species and finfish, all in close proximity to one another. Sea plants like kelp can sequester carbon, while extractive species – detritivores like sea cucumbers – or filter feeding shellfish can remove some of the waste generated by higher trophic organisms so there are built-in bio-mitigation advantages. IMTA also maximizes the use of space while the diversity of species can offer extra economic benefits. Diversifying production may also provide additional food crops and/or an extra source of income while increasing the ecosystem services of aquaculture.

"**Advancing the ecosystem services of aquaculture (https://www.aquaculturealliance.org/advocate/advancing-ecosystem-services-aquaculture/?__hstc=236403678.578091f1016eafb6ed0b451658e6956f.1680750452438.1680750452438.1680750452438.1&__hssc=236403678.1.1680750452439&__hs

A time-tested tactic

In Asian countries, IMTA has been practiced for centuries. Rice-and-fish co-cultivation is probably one of the oldest forms, where rice fields provide the environment and habitat for fish and other aquatic animals while the fish contribute to nutrient cycling by feeding on invertebrates and other organic particles that are produced in the fields. But to Europe and the western world, IMTA is relatively new. Existing systems in those regions tend to be research-focused and commercial uptake hasn't yet happened on a significant scale.

Dr. Zengjie Jiang and Dr. Fan Lin of the Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences in Qingdao, China, work with the Marine Institute in Ireland as partners in the **IMPAQT project** (https://impaqtproject.eu), which is developing an intelligent management platform for sustainable IMTA production in Europe. They say that the scale of IMTA in China and Europe is determined by differences in the aquaculture industries of both.

"Features of Chinese aquaculture are species-rich diversity and lower-trophic levels," they told the *Advocate*. "The mechanization level for low-trophic aquaculture is relatively inferior compared to highly [automated] fish farms in the EU. But China's sufficient labor supply ensures a reasonable cost and profit for aquaculture practitioners. We also have a strong social/economic demand to pursue better spatial utilization and production efficiency, which encourages the aquaculture industry, government departments and researchers committed to promoting the industrialization of IMTA."

Maintaining communication between practitioners and researchers to share knowledge and techniques will enable Europe to develop suitable IMTA systems, while governments will be key to promoting the concept by establishing policies and organizing technical training with research institutions, they said.

IMTA is widely recognized as a way to enable more circularity in processes and more sustainable practices in aquaculture in general while maintaining and increasing productivity and the supply of quality product. This lies behind the IMPAQT project, which is part of the EU's drive to progress IMTA, according to Frank Kane of the Marine Institute in Ireland.

"The project works with six pilot sites across Europe, Turkey and China to design and implement cost-efficient technologies in IMTA monitoring and management to demonstrate optimal sustainable development based on ecosystem services and circular-economy principles," he said. "It's developing intelligent technologies for the smart management of IMTA, progressing models to better understand and plan IMTA set-ups, and utilizing pilot systems to demonstrate reduced environmental impacts, sustainability and socioeconomic benefits."

The theory and concept of IMTA are the same everywhere. It may just be a matter of how it can be localized accordingly.

Building confidence in IMTA

However, there is still very little information in Europe to inform decision-making on IMTA's associated interactions, risks and impacts. Kane says that this could result in significant delays and pose a barrier to the development of commercial-scale systems. The knowledge of commercial level IMTA regarding impacts, biosecurity and disease management and their potential to improve sustainability in an ecosystem setting are also not fully developed.

"The value of IMTA systems must be identified and quantified to inform stakeholders and consumers of the societal, marketing, environmental and economic benefits and to attract investors," said Kane. "The overall costs of IMTA compared to monoculture must also be considered on a greater level than simple economic value, while the intrinsic benefits on an ecosystem level must be highlighted in regulation."

"Another challenge is the lack of knowledge on how to farm in an IMTA setup," he continued. "A fish farmer would not have the skills and experience to farm shellfish or seaweed and vice-versa, so knowledge transfer or imaginative co-farming arrangements should be established, as well as deliberation on the selection of the appropriate species to be used to ensure that they're optimally compatible with each other and with production practices. Extra challenges that come with the production and processing of new or multiple species must be considered too, such as the drying of seaweed or de-purification of filter feeders."

Dr. Henrice Jansen at Wageningen Marine Research in the Netherlands specializes in low-trophic aquaculture (mussels and seaweed). She also works at the Institute of Marine Research in Norway researching salmon culture and IMTA development, in particular polychaete cultivation underneath salmon cages. Involved in the development of IMTA for the salmon industry for over a decade, Jansen says that one driver that has spiked interest in Norway is the government's principle requiring companies to be committed to solutions that reduce environmental impacts. IMTA is one such solution, she said.

"Fish aquaculture releases waste into the environment, and if you can capture part of those nutrients, the concept would fit quite well in salmon farming, especially if we think about the European Green Deal or circular economies," she said. "There is more industry interest now, which is great. Salmon companies are also starting up small businesses in seaweed, etc. and these could be coupled together."

While encouraged by other activities in Norway outside of IMTA, such as the development of seaweed and bivalve farming, Jansen also believes that IMTA could help in the feed industry's search for new ingredients amidst the limited availability and increasing prices of fishmeal and fish oil. There could be potential to include some of the biomass of seaweed, shellfish or polychaetes in feed, she said.

IMTA is a significant tool to facilitate the sustainable growth of aquaculture in marine and freshwater environments, said Kane.

"It can help increase productivity, employment and provide a more sustainable, circular product which is desirable to consumers and could command a premium price," he said. "Profitability can be increased by having multiple species, while the diversification of stocks increases the operation's resilience. Integrating low trophic species with other seafood is advantageous not only for nutrient requirement but also for sharing infrastructures and distribution channels. These factors, and many more, will help build confidence in IMTA."

"It's great to see projects like IMPAQT starting IMTA trials in the EU, accumulating knowledge, experience, methodology and developing management tools," said Jiang and Lin. "The theory and concept of IMTA are the same everywhere. It may just be a matter of how it can be localized accordingly."

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Correspondent Bonnie Waycott became interested in marine life after learning to snorkel on the Sea of Japan coast near her mother's hometown. She specializes in aquaculture and fisheries with a particular focus on Japan, and has a keen interest in Tohoku's aquaculture recovery following the 2011 Great East Japan Earthquake and Tsunami.