Integrated multi-trophic aquaculture (IMTA) will also have its place when aquaculture moves to the open ocean

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AS the demand for seafood is rising worldwide, the aquaculture industry is looking at expanding into more exposed and open ocean locations due to the reduced availability of new and appropriate sheltered nearshore sites.

Moving to the open ocean has also been considered as a means for moving away from environmental and public perception issues in the coastal zone. However, open ocean development will also come under scrutiny by a more and more educated public. It is expected that, because of economies of scale, the open ocean farms of tomorrow will be larger than the present nearshore farms. Therefore, higher levels of waste will be generated.

Even if greater residual currents, deeper waters and lower nutrient baselines are expected to reduce impacts from open ocean operations through wider dispersion plumes of nutrients, as compared to similarly sized nearshore operations, there will be a point when open ocean ecosystems will eventually reach their assimilative carrying capacities. We thought the sea was so immense that we did not need to worry about fisheries limits, and this has proven not to be the case. We thought the "Blue Revolution" of aquaculture development was "green", and this is not always the case. Why should we think that open ocean aquaculture, the "last frontier", will be without its own borders/limits (i.e. function and resource limitations)?

Capitalise

Instead of taking the position that in open ocean environments the hydrodynamic conditions will be appropriate for dispersion and reduced environmental impacts (but at a significant cost of lost food), the aquaculture sector should capitalise on the by-products of fed aquaculture to recapture what is food and energy for extractive aquaculture, and, right from the beginning, engineer efficient open ocean integrated multi-trophic aquaculture (IMTA) systems with their built-in biomitigating functions. Trophic diversification is required from an environmental and economic perspective, with "service species" from lower trophic levels (mainly seaweeds and invertebrates) performing the ecosystem balancing functions while representing value-added crops.

The challenges will be numerous from the biological, environmental, economic, technological, engineering, regulatory and societal perspectives. Appropriate extractive species will have to be selected based on their biology, growing methods and harvesting technology, all adapted to exposed conditions. High valued-added markets will have to be found for these species to justify their culture within expensive infrastructures, as they will likely have a lower total value than fish.

Profitability

The profitability of open ocean IMTA systems will have to be demonstrated. Early bioeconomic models of nearshore IMTA indicate that economic stability (product diversification and risk reduction) is key in increasing the profitability and resilience of these systems over finfish monoculture. The same arguments can probably be used for open ocean IMTA operations. Moreover, if the environmental, economic and societal services and benefits of IMTA are properly estimated and internalised in aquaculture operations, they will represent significant incentives for the cultivation of extractive species.

If limitations to nutrient emission are put in place in the future, extractive species could be considered as nutrient (nitrogen, phosphorus, etc.) credits, similar to carbon credits, in the global economy, as the aquaculture sector moves to becoming more efficient and sustainable.

To reduce the entry costs and share the costs of developing technical solutions, open ocean aquaculture, including IMTA in its configuration, should team up with other sectors considering open ocean development, such as the development of wind or underwater turbine energy generation. Combining IMTA open ocean farms with wind power generating farms could be a means for reducing their cumulative footprint.

Gigantic projects for the production of biofuel with terrestrial crops are being developed, but the implications have not been clearly thought

One of Cooke Aquaculture's IMTA sites in the Bay of Fundy, Canada: salmon cages on the left, mussel raft on the right in the front, and seaweed raft on the right in the back

out, especially regarding the amount of farmland area and the level of irrigation that would be needed on a planet already suffering from water availability problems. Moreover, the price of some staple food crops used in traditional agriculture has already risen considerably due to announced competition for their uses as energy crops. Marine agronomy, with organisms already living in water over large areas, could be the real answer to biofuel production, addressing the interdependencies noted above. The aquaculture sector should seriously consider being involved in the elaboration of these large projects as a valuable partner, already having a lot of know-how and experience in cultivation and infrastructure development.

Beyond the biological, environmental, economic, technological, engineering and regulatory issues of such developments, the basic question will be that of societal acceptance. Are we ready to industrialise the "last frontier" of this planet and consider not only the challenges of the physical forces at sea, but also those of shipping routes, fishing zones, offshore gas and mineral extraction areas, migration routes for marine mammals, recreational uses, and then finally deal with the concept of zoning some portions of the oceans for large aquaculture parks, as sustainable food production systems for an ever seafood hungrier human population?

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Photo: Shawn Robinson

Harvesting of kelp at an IMTA site in the Bay of Fundy