Commentary

Integrated Multi-Trophic Aquaculture

What it is, and why you should care….. and don't confuse it with polyculture

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- Thierry Chopin

By Thierry Chopin

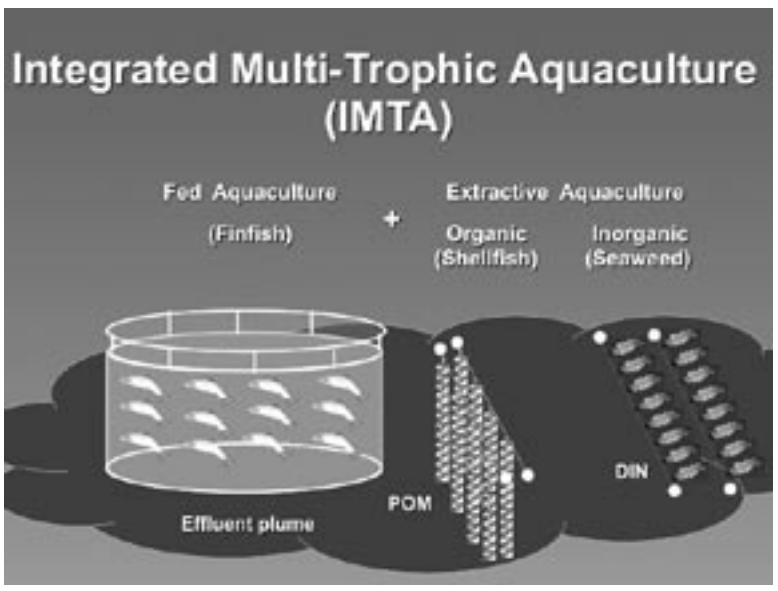
Six years ago, at the World Aquaculture Society Conference in Nice, France, my presentation describing integrated aquaculture seemed obscure to most participants who wondered what I was talking about. It is amazing how the situation has changed in just a few years! At the recent WAS Conference in Florence, Italy, integrated multi-trophic aquaculture (IMTA) was mentioned by Dr. Yngvar Olsen (Norwegian University of Science and Technology in Trondheim, Norway), during his plenary presentation and also in several other papers, sessions and posters. Several speakers indicated that IMTA was indeed a serious option to consider for the future development of aquaculture.

For us, it was very rewarding to see that what some had considered a "strange idea" six years ago, was now an identified research priority… After several years of preaching in the desert, it seems we are coming close to the oasis!

What happened to polyculture?

I know that some remain perplexed by the choice of the wording; why such a long expression as "integrated multi-trophic aquaculture" when the term "polyculture" already exists? Here is the reasoning: one can develop a polyculture system with, for example, three species of finfish - salmon-cod-halibut. However, they are all finfish, and they all share the same biological and chemical processes which could potentially lead to significant shifts in the ecosystem. With the multi-trophic approach, aquaculture of fed organisms (finfish or shrimp) is combined with the culture of organisms that extract either dissolved inorganic nutrients (seaweeds) or particulate organic matter (shellfish) and, hence, the biological and chemical processes at work are balancing each other. Moreover, the different types of aquaculture are integrated, i.e. operating in proximity to each other, but not necessarily right at the same location. Consequently, "integrated multi-trophic aquaculture" is really the shortest way to explain this practice. If it is too much of a mouth-full, you can always just say IMTA.

The IMTA concept is extremely flexible. It can be applied to open-water and land-based systems, and marine and freshwater systems. What is important is that the appropriate organisms are chosen based on the functions they have in the ecosystem and for their economic value or potential. For example, seaweeds are not important because they are my favorite pet organism, but because of their nutrient biofiltering role in the ecosystem. The present IMTA system we have developed in the Bay of Fundy presently has three components (salmon, kelps and mussels), but we know that it is a simplified system; there is room for a more advanced system with several other components for different functions and we hope to bring sea cucumbers, polychaetes, sea urchins, etc. into the picture. These organisms can have different functions, or similar functions, but in a different size bracket of particles, for example.



Conceptual diagram of an integrated multi-trophic aquaculture (IMTA) operation including fish, shellfish and seaweeds.

Balancing the system

What is quite remarkable is that we are doing nothing more than recreating a simplified, cultivated ecosystem that is in balance with its surroundings instead of introducing a biomass of a certain type we think we can cultivate in isolation of everything else. Moreover, IMTA goes beyond environmental sustainability; it provides economic diversification and reduces economic risk when the appropriate species are chosen, and it increases the acceptability of the overall aquaculture sector by using practices evaluated as responsible by the industry, the regulators and the general public. For example, we have learned that Denmark is reconsidering more finfish aquaculture development, with the condition that there is proper planning for bioremediation and the use of biofilters (seaweeds and shellfish). This means that extractive species have now become part of the license to operate in Denmark. This means that the goods and services provided by these organisms have finally been recognized and valued for their ecosystem functions. Now, we need to quantify these services rendered by extractive biofiltering organisms (for example, in Denmark, the cost of remediating one kilogram of nitrogen is estimated at 33). The introduction of a nutrient tax, or its exemption through the implementation of bioremediative practices (nutrient credits), would make the economic validity of the IMTA approach even more obvious.

Based solely on the value of the crops we are adding to our IMTA system, we have calculated that if 80% of the salmon farms in New Brunswick are suitable for IMTA and two-thirds are in production at any one time, adding kelps and mussels to the operations would generate CDN$44.6 million in extra revenues and create 207 jobs.

Effective policy

But for IMTA to develop at a commercial scale, we need the appropriate regulatory and policy framework. Present aquaculture regulations and policies are often inherited from previous fishery frameworks which have shown their limitations. To develop the aquaculture of tomorrow, we need to revisit the present aquaculture regulations and policies. We need adaptive regulations, developed by regulators with flexible, innovative minds, who are not afraid of putting in place mechanisms that allow the testing of innovative practices.

The aquaculture industry also has to play its role and be ready to help in the development of IMTA so that we can take it along the continuum of R&D&C (C for commercialization). A closer association between natural, engineering and socio-economic scientists and industrial partners is necessary and, in fact, is very rewarding when it works. Scientists must come down from their ivory towers and stop disparaging applied science, and industrial partners must understand that answers do not always come from short-term projects and are not always black and white.

Academic institutions need to get involved. IMTA is truly interdisciplinary in nature. A lot of people talk about the interdisciplinary approach to problem solving, but very few put it in practice and very few train students to be interdisciplinary minded.

Proof of concept

Our project, and similar ones in different regions of the world, have now accumulated enough data to support the IMTA concept. For example, our project supports the establishment of IMTA systems in the Bay of Fundy, in appropriately selected sites and with the appropriate selection of extractive species. Kelp and mussel productions increase by 46 and 50%, respectively, when cultivated in proximity to salmon sites. The crops have to be diversified to utilize site characteristics and market demand. Five years of accumulated data show the absence of transfer of therapeutants used by the salmon industry to the kelp and mussel tissues, and all analyzed samples have been below Canadian Food Inspection Agency, USA Food and Drug Administration, and European Community Directive regulatory limits for heavy metals, arsenic, PCBs and pesticides. IMTA brings increased social acceptability of the overall aquaculture sector by the general public, and our preliminary bio-economic model already shows that IMTA is profitable and helps reduce risks.

The next step for all these projects is the scaling-up of IMTA experimental systems and the establishment of the appropriate food safety regulatory and policy frameworks. This will be key to convincing practitioners of monospecific aquaculture to move towards the development of commercial scale IMTA operations.

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