SALMON REVIEW CANADA

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Integrated, Multi-Trophic Aquaculture being studied in Canada

Campbell River, B.C., Canada: Previously prohibited, researchers in both British Columbia and New Brunswick are now growing multiple species of fish and shellfish, as well as seaweed or kelp, at the same site. A land-based salmon farm in BC is also using fish farm waste to grow other crops.

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Many aquaculturists have seen pictures of a Chinese barn for pigs or goats mounted on pilings over a pond with various types of carp being grown from the vegetation produced by nutrients from the animal droppings, and the adjacent corn field that is fertilized with fish waste and trimmings produce food for the livestock and humans as well. Likewise, polyculture- where more than one species of aquatic organism are cultured in the same pond- has been practiced in Asia for more than 1000 years. Polyculture utilizes fish that live in different depths and locations in the water column and that have different feeding habits in proportions that effectively utilize the different food sources produced in the fertilized ponds. Typical species of fish grown in these systems would be;

- Plankton Feeders like silver carp or bighead carp
- Herbivores or plant-eaters like grass carp or Zillis tilapia
- Bottom feeders like the common carp or nile tilapia and even
- Piscivorous fish that feed on other fish (catfish, snakeheads and largemouth bass)

On a recent visit to one of Canada's new versions of aquatic polyculture, FishfarmingXpert was able to see first hand how an Integrated, Multi-Trophic Aquaculture system (IMTA) works. Located in Kyuquot Sound on the west coast of Vancouver Island, Dr. Stephen Cross operates a combination research/production facility that is licensed to produce a number of species of shellfish, kelp, sea cucumber and finfish. Dr. Cross has a long history of being involved in the aquaculture industry in Canada, both as an environmental consultant and as an owner/operator of shellfish farms. He owns Aquametrix Research, a company based in Courtenay on Vancouver Island that has been active in the environmental monitoring and research activities surrounding finfish waste and the regulatory development for this segment of the salmon farming industry in BC. Dr. Cross is currently a professor in aquaculture at the University of Victoria, BC's capitol.

The Kyuquot site consists of a set of 15m x 15m steel cages for the production of Sablefish (Anopoploma fimbria) and a parallel set of custom- made cages for shellfish grown in lantern nets. Strung between the steel cage structure and the shoreline are lines of rope seeded with kelp, and sea cucumbers are housed in a submerged tray lowered to the bottom of the Sablefish cages. The whole idea behind this project is to study the interactive effects of producing various types of valuable seafood in a way that reduce environmental impacts, while at the same time increase the growth rate of individual species. As an example, the kelp is expected to benefit from the dissolved nutrients coming from the waste stream of the Sablefish pens, and so will the shellfish and the sea cucumbers benefit from increased nutrient-loading.

Funded in part by a grant from the Natural Sciences and Engineering Research Council of Canada, the Kyuquot farm will be used to evaluate the difference in growth of shellfish, kelp and sea cucumbers grown in the vicinity of a fin fish farm compared with those living under natural conditions. Early indications show a 30-40 per cent increase in the growth of kelp near the Sablefish cages compared to kelp grown away from the farm. The level of uptake of waste from the finfish unit will also be measured, and the economics of this IMTA approach to aquaculture will also be evaluated. Shellfish species to be studied are Pacific scallops (a cross between the Japanese scallop and the local Weathervane scallop), blue mussels and oysters. The scallops are estimated to take two years from seed to harvest size, fetching a price of CAD$ 1.- apiece (~€ 0.65) and the mussels should be marketable after some 14 months in the sea.

Dr. Cross was able to circumvent the existing BC regulations that prohibit the harvest of shellfish within 125 meters of a finfish farm by documenting the food safety aspects of shellfish grown next to a salmon farm in two scientific studies conducted a few years ago at two separate locations in BC. A protocol for testing shellfish produced at the Kyuquot site was established, and he was off to the races.

The Sablefish introduced to the site in March, 2008 have shown a good rate of growth during the first year of culture, gaining close to a kilo in weight from the initial ~20 gram juvenile stocking size. The fish, which is native to the Pacific Ocean, typically inhabit relatively shallow areas of the coast in its first year or so where it grows very fast. Afterwards, it migrates to depths of 300 to 2,700 meters, where it feeds on other fish during a life that has been documented to last as long as 94 years (Kimura et al. 1998). The natural slowing in growth rate at this life stage is a challenge being addressed by a newly formed Pacific Sablefish Association, representing

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existing Sablefish producers and other interested parties. A natural tolerance to low dissolved oxygen levels make the fish suitable for sites abandoned by salmon farmers due to reoccurring toxic algae blooms. Problems incurred by the sole supplier of Sablefish juveniles in BC might force Dr. Cross to switch to Pacific salmon over the next production cycle.

Seaweed farming can also be lucrative, according to the Manila Bulletin of the Philippines. The industry contributes some $ 150 million (~€ 105 million) to the domestic economy, with China's requirement being about 80,000 metric tonnes of dried seaweeds annually, and this demand is growing by 10 to 14 per cent per year. Dr. Cross is aiming at producing a quality of kelp that will be acceptable to the cosmetic industry, which pays a high price for choice seaweeds.

Meanwhile, at a small farm in the agricultural district of the Fraser Valley east of Vancouver, Bruce Swift of Swift Aquaculture is practicing a different kind of polyculture. A former salt water salmon farmer, Mr. Swift now grows Coho salmon (Oncorhynchus kisutch) in tanks at his 5 acre piece of farmland near Agassiz, using fresh ground water pumped up from a local aquifer. A passionate fish culturist, Swift has developed a market for his salmon among some of the top seafood restaurants in Vancouver. While he acknowledges that the vast, bulk market for farmed salmon is appropriately served by conventional salmon farming, his method of producing a small quantity of a special product sold directly to the market can give him a premium price that enables him to make a profit by eliminating the middleman in the marketing of his fish. Coho salmon can be produced in fresh water, and Swift suggests that this fish can be used to satisfy a growing demand for a particular kind of sustainably farmed seafood. But along with the high quality farmed salmon, Swift Aquaculture sells its salmon along with a story of Integrated, Multi-Trophic Aquaculture that makes one's taste buds salivate.

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The tanks containing Coho salmon is only the beginning at Swift Aquaculture. Waste water from the fish tanks is screened through a rotary filter, where solid waste is separated and collected for use as a fertilizer for the production of garlic and beans. The screened water is then channeled into rows of wasabi, rice and watercress, and used to grow a variety of fruits, flowers and vegetables. Pools of algae enriched by waste water is used to feed a crop of Signal crayfish (Pacifastacus leniusculus)- a delicacy sought after by the many immigrants of Swedish decent living in and around Vancouver. The salmon being produced at Swift Aquaculture is reared in low densities and with a good, steady water supply which eliminates the need to use medicines, and by using natural sources of pigments, Swift is essentially following the guidelines for organic aquaculture as prescribed by European certifiers of cultured seafood. As of today, there is no Provincial or National organic classification available to Canadian aquaculturists.

A constant series of requests by visitors is a challenge for Swift Aquaculture, but an organized arrangement of Agassiz farm tours has helped ease the burden by sending visitors to a number of specialty farm producers in the area. This way, a certain day of the week can be set aside for visitors that agree to pay a small fee for the privilege of seeing the small but important entrepreneurs of modern agriculture and aquaculture in British Columbia's farm country. Environmental organizations are also eager to come for a

visit to show the world how salmon should be farmed, but Swift is still a strong supporter of salmon farming in net pens along the BC coast, and he will not be used as a tool for campaigns aimed at discrediting his former way of life.

The third Canadian initiative in Integrated, Multi-Trophic Aquaculture is taking place on Canada's east coast in the Province of New Brunswick, and under the watchful eye of Dr. Thierry Chopin of the University of New Brunswick, who explains the process as follows;

The Laboratory of Dr. Thierry Chopin is part of a large interdisciplinary team working on the development of Integrated Multi-Trophic Aquaculture (IMTA) systems. IMTA is the practice which combines, in appropriate proportions, the cultivation of fed aquaculture species (e.g. finfish/shrimp) with inorganic extractive aquaculture species (e.g. seaweed) and organic extractive aquaculture species (e.g. shellfish/herbivorous fish) to create a balanced ecosystem management approach to aquaculture for environmental sustainability (biomitigation), economic stability (product diversification and risk reduction) and societal acceptability (better management practices).

The aim is to increase long-term sustainability and profitability per cultivation unit (not per species in isolation as is done in monoculture), as the by-products (wastes) of one crop (fed animals) are converted into fertilizer, food and energy for the other crops (extractive plants and animals), which can in turn be sold on the market. Feed is one of the core operational costs of finfish aquaculture operations. Through IMTA, some of the food, nutrients and energy considered lost in finfish monoculture are recaptured and converted into crops of commercial value, while biomitigation takes place. In this way all the cultivation components have an economic value, as well as a key role in services and recycling processes of the system, the harvesting of the different types of crops participating in the export of nutrients out of the coastal ecosystem.

Contrary to monoculture, IMTA takes advantage of organisms functioning at different trophic or nutritional levels. It is based on an age-old, common-sense, recycling and farming practice in which the solution to nutrification is not dilution but conversion within an ecosystem-based management perspective. Production can then be diversified and remain environmentally responsible and economically profitable – thereby ensuring a sustainable aquaculture sector. Multi-trophic integration appears to be the logical next step in the evolution of aquaculture practices in New Brunswick and worldwide. The Laboratory of Dr. Thierry Chopin works on seaweeds, the inorganic extractive component of the IMTA system being developed in the Bay of Fundy, in Eastern Canada, taking it from experimental research, to development and scale-up commercialization (R&D&C from concept to adopted practice).

Dr. Chopin is working closely with the local salmon farming company Cooke Aquaculture in his research to fine tune the IMTA approach to sustainable aquaculture, using kelp and mussels as the additional species to be produced at salmon farming sites. The use of circular, HDP cages moored in a grid system allows plenty of room for the addition of mussel socks and kelp ropes.

The big question hanging over all of these IMTA initiatives is about profitability- will the distraction from basic salmon or sablefish farming be of a nature that will compromise the bottom line, or will the production of additional species add to the net income from a farm site. If species are selected that have a high enough value, and can be marketed with minimal complications, then the approach might have more than an environmental advantage, and Stephen Cross, Bruce Swift and Thierry Chopin may all represent a second wave of aquaculture pioneers from Canada.