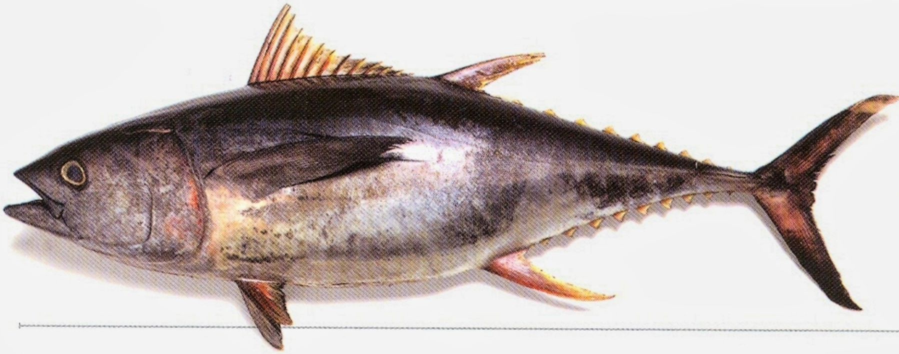
SALMON

THE FUTURE OF THE LAST WILD FOOD



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What seems to me more necessary is a move to reform the laws and practices that govern the salmon industry. Salmon aquaculture is still a very young endeavor, less than forty years old in most countries. It is not yet set in its ways, and it is not necessary that the worst practices of the past become the standard practices of the future. There is still a chance for incorporating all we have learned about the problems of terrestrial monocultures into the relatively new frontier of aquaculture.

In July near the end of my salmon research, I found the beginnings of this new way of thinking when I drove up the coast of Atlantic Canada to the town of St. George on the Bay of Fundy. It was there that I met Thierry Chopin, a cheery and optimistic French transplant to Canada who signs off his e-mails with an encouraging quote from Jules Verne: *Tout ce qui est impossible reste à accomplir*—All that is impossible remains to be accomplished.

Chopin works in conjunction with the largest fish farmer in Maritime Canada, Cooke Aquaculture, developing a practice called integrated multitrophic aquaculture, or IMTA. This method of farming combines species that require feed (such as salmon) with other species (such as seaweeds) that extract dissolved inorganic nutrients and species (such as mussels and sea urchins) that extract organic particulate matter, to provide a balanced ecosystem-management approach to aquaculture. Like Kwik'pak Fisheries, IMTA's basic concept is very old. The world's very first aquaculturists, the Chinese who farmed carp starting four thousand years ago, began as polyculturists. Early Chinese silk farmers found that carp would naturally congregate under the mulberry bushes where silkworms would spin their cocoons. Eventually it was discovered that carp could be a crop in and of themselves. This original two-way relationship expanded over time. Carp feces, it was found, would stimulate the growth of rice and other useful grasses, which the Chinese harvested. These grasses also fed ducks that could be slaughtered for meat. Thus a four-way polyculture developed, with silk, fish, fowl, and grain all coming out of the shared and multiply repurposed fertility of a single pond.

When modern-day salmon aquaculture was launched in the 1960s and '70s, the concept of polyculture for some reason got lost. Early farmers were so thrilled by the prospect of bringing a high-value species to market for very little money that feedlot-style monocultures quickly sprouted up in some of the most pristine salmon country along temperate coasts around the world. Little attention was given to the siting of farms, the effects of effluent, or the spread of disease. In time, places like the Bay of Fundy became practically open salmon sewers, where effluent was released unchecked, cloaking the bottom with the ooze of salmon refuse.

After facing a series of crises and opposition from environmentalists throughout the late '90s and early 2000s, the industry began to restructure itself. In 1996 there were early signs of the presence of infectious salmon anemia in New Brunswick. This caused the New Brunswick provincial government and the industry to develop and implement, in 2005, a system of bay management areas (BMAs) that more carefully allot salmon sites. The move reduced the density of fish per site, introduced biosecurity measures, and required portions of the Bay of Fundy to be left fallow on a regular basis.

All these changes in the aquaculture industry also opened up the door for Dr. Chopin, a seaweed expert who had been doing research on kelp in Atlantic Canada since 1989, when he moved from France to the University of New Brunswick–Saint John. Seaweed, it turns out, is an integral part of the food, cosmetics, and textiles industries and constitutes a $6.2 billion market. Chopin had been working on the production of carrageenans, the thickening or emulsifying agents extracted from red algae that are particularly useful to industry. In an "aha" moment Chopin saw that the inorganic waste from salmon farms could be used to grow those very valuable algae species.

"Coming here to Atlantic Canada, I realized, 'Wow, with all this salmon aquaculture, we have all these nutrients in the water,'" Chopin told me as we motored out to one of Cooke Aquaculture's IMTA sites. "Instead of wasting these nutrients, why not recapture them?" Chopin recognized that larger organic particulate waste would also have to be dealt with. Collaborating with Dr. Shawn Robinson, from the St. Andrews Biological Station of Fisheries and Oceans Canada, he discovered that mussels could recapture midsize waste particles suspended in the water column. Later they found that they could also add organisms feeding on the heaviest particles of all—the ones that fell to the bottom. Valuable sea urchins and sea cucumbers, it turns out, are particularly fond of this kind of waste.

Still, IMTA is very much a pilot project. Chopin and Robinson started their collaboration with two smaller salmon-farming ventures, one of which was Heritage Salmon. When Glenn Cooke, the CEO of Cooke Aquaculture, acquired Heritage Salmon in 2005, he decided to scale it up. The polyculture experiments are still only a tiny part of Cooke's overall footprint, but they are expanding.

As we left the circular salmon pens and motored past the rectangular rafts of seaweed, Chopin drew my attention to a series of cages supporting hanging socks of blue mussels. Grabbing a mussel and opening it with a knife, he pointed to the delicate shimmering meat inside—it was spread out almost to the edge of the shell. "You can see here, it has almost thirty percent more meat than mussels that are typically available in grocery stores. And the nutritional profile is very favorable, too. There are significant quantities of omega-3 fatty acids, particularly the heart-healthy ones, EPA and DHA." Mussels turn out to do another interesting thing on a salmon farm. Evidence suggests that they may absorb some of the infectious salmon anemia virus; adding mussels to the aquaculture equation could serve to break the disease cycle that is rife in some of these salmon-farming operations.

None of the polyculture species can do anything about sea lice, perhaps the most pernicious effect of salmon farming. Nevertheless, there did seem to me to be a better future, one where "feed-conversion ratio" would not be simply a matter of pounds of feed going in to pounds of salmon going out. Rather what would result would be an array of seafood products in a cycle. Even Chopin, who has a love of graphs and charts and PowerPoint presentations, can't quite get a handle on how much food could be generated from such an operation. "In the chart the arrows are going everywhere, and I just can't calculate it yet," he told me.

Finally, IMTA could lay the groundwork for the elusive "closed circle," the quest of quests for sustainable seafood producers, one where the inputs and the outputs emerge from a single unit, with *zero* feed having to go into the system. This may not be as far off as we think. As Rick Barrows, an experimental-feed developer for the USDA, explained to me, "Fish require nutrients, not ingredients." It turns out that the nutrients, particularly the omega-3 fatty acids, present in the oft-criticized wild-fish feeds can be duplicated by seaweeds. The omega-3 fatty acids that occur naturally in salmon ultimately derive from seaweeds that smaller fish ingest before being eaten by salmon.

In a sophisticated polyculture environment, salmon would bypass the smaller fish that eat seaweed and would eat feed pellets synthesized from seaweed directly. By feeding in this way, we would in effect be reducing the trophic level of farmed salmon, turning them from predators into something closer to filter feeders. This would result in fish markedly lower in PCBs than those animals fed with unpredictable wild-fish feed sources. And the beauty of the system is compounded by the fact that the waste those salmon generated would in turn feed mussels and also grow more seaweed. Fish meal and oil would still be needed as very early feed for juveniles and to maintain the health of broodstock fish, but these would be minimal compared to what is needed at present in a traditional salmon monoculture.

Some purists argue that this is a bastardization of a salmon. That a salmon is naturally a predator and should naturally eat fish. An oft-quoted trope of the anti-salmon-farming camp is that we shouldn't be farming the tigers of the sea." But as Rick Barrows at USDA pointed out, this is a question of perspective. "We *can* farm the tigers of the sea," he told me, "as long as we feed them hay."

The unavoidable truth is that way back in the Middle Ages, when the first attempts were made at domesticating salmon, we should have chosen something else. There were most definitely better, more efficient fish out there. But we simply didn't have the technology to tame those other fish. Salmon's large eggs, their responsiveness to human intervention, and a lot of applied breeding science has advanced the human/salmon relationship to a level of complexity not seen with other marine animals. Quite simply, we *know* the salmon better than most other fish on earth. We have mapped large portions of its genome, crossed its families, and studied its life cycle intimately. To start anew with a completely different animal at this point would mean many decades of backtracking.

the market in the first place. And where better to start this process than with the world's most commonly farmed fish, salmon? On the downside, it seems unlikely that the environmental community will succeed in dislodging the salmon industry from its dominant position in the farmed-seafood sector. On the upside, salmon do seem to have an adaptability to alternative feeds. Seaweeds and soy are increasingly forming the basis of salmon diets and could replace fish meal altogether in the not-too-distant future. As of this writing, at least one company has developed a completely algae-based feed that replaces the need for fish oil and meal in the diets of salmonids. The problem? Once again, cost. Here is another place for subsidies to play a positive role. Let governments make up for the difference in price between wild-fish meal and synthetic algal feeds until the industry has scaled up. It is an investment in the future.

5. Functional in a polyculture. If there is one lesson that has been learned from terrestrial agriculture, it is that monocultures of crops are susceptible to disease and can cause undue environmental degradation. Rather than starting from zero and redoing all of terrestrial agriculture's mistakes, we should start from a place of polyculture, where wastes are recycled as much as possible, where space is maximized for the growing of food, and where *systems* instead of individual species are mastered.

Five principles, then, to lead us to our selection of domesticated animals from the sea. The animals that could and should rightfully be called our "sea food."

As to what we should call wild fish in the future, I leave that to the marketers of what I hope will someday be a more informed and thoughtful fishing industry. But I would suggest that if we continue to eat wild fish, we need to find a new way of identifying them in the marketplace. A set of terms that implies an understanding of