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Feedlots of the Sea

by John C. Ryan

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On a typically cool and misty day on Canada's rugged rainforest coast, two unrelated events draw scores of tribespeople to the remote reservation town of Bella Bella, British Columbia. The annual All-Native basketball tournament brings teams from hundreds of kilometers away by ferry, fishing boat, and small plane to the homeland of the Heiltsuk Nation. The town's small gymnasium fills with tribal members cheering as Heiltsuk girls in baggy shorts with "Nation" printed across their behinds pound up and down the floorboards painted with traditional thunderbird and whale icons. Basketball is one of the main forms of entertainment in this isolated town of 2,000 residents with 80 percent unemployment and high suicide rates.

A more historic coming-together occurs that morning when chiefs of the Heiltsuk and Nuxalk nations meet on the waterfront of Ocean Falls, a mostly abandoned village about 30 miles up a roadless fjord from Bella Bella. Putting aside their historic quarrels, the chiefs lead a small flotilla of fishing boats into Ocean Falls to protest the construction of an Atlantic salmon hatchery there by Pan Fish of Norway, the world's second largest aquaculture company. If finished, the facility will pump out 10 million young Atlantic salmon a year to supply farms proposed for much of British Columbia's remote central coast. The coastal tribes have found common cause in vowing to keep salmon farms out of their overlapping territories.

"We have things in common that we have to fight for. We are struggling to save a way of life," Heiltsuk chief Edwin Newman tells the crowd of 150 protesters at the hatchery construction site. Alongside other chiefs dressed in their full regalia of button-blanket cloaks and carved cedar masks, Newman declares, "We do not want fish farms on the central coast."

Global Domination

Aquaculture—the raising of fish, shellfish, and other aquatic species—may be the fastest-growing sector of the world's food economy. While the catch of wild fish from the world's seas has been static or dropping since the late 1980s, and most of the world's major fish stocks are considered fully fished or overfished, aquaculture shows no signs of letting up its tremendous growth.

Between 1985 and 2000, global aquaculture output grew fourfold, to over 45 million metric tons. Aquaculture now provides one-third of the seafood humans consume. The vast majority of fish farms are

in Asia; they mostly raise plant-eating fish like carp, in freshwater ponds. They make an important addition to world food supplies and, overall, have relatively little ecological impact. But a small fraction of the world's fish farms raise carnivorous species—salmon, shrimp, trout, sea bass, and eels—using a highly resource-intensive practice that has impacts around the globe. No form of aquaculture chews through more of the world's marine life than does salmon farming.

Between 1985 and 2000, annual production of farmed salmon grew *sixteen-fold* to more than 1 million tons, surpassing the catch of wild salmon. People have pulled wild salmon from rivers and seas for millennia. Now, fish farms have replaced nature as the world's main salmon supplier.

Norway pioneered farming of Atlantic salmon in the 1960s, and it still dominates global salmon production today. But as the industry has expanded into the often depressed coastal hinterlands of Australia, Canada, Chile, Scotland, the Faeroe Islands, Iceland, Ireland, New Zealand, and the United States, it has almost unfailingly generated controversy over the impacts of its floating platform farms. The central British Columbia coast, one of the few places on Earth where economies and local cultures still revolve around wild salmon, sits at the center of the international controversy over the spreading farms.

Salmon Country

As we head up the British Columbia coast in a five-seat Cessna plane, the best antidote for the discomfort of the cramped quarters and buffeting of gale-force winds is to focus on the scenery below. We split the difference between a low ceiling of storm clouds and a jagged landscape of glacier-carved islands and mountain spines. The first few miles of rainforest-draped fjords are clearly visible; the glaciers and snowfields at the head of each fjord peek out only occasionally from beneath the clouds.

From time to time, a small grid of a dozen or so squares, in rows of two, appears on the sheltered coastal waters. Each grid is a salmon farm. Within each square, thousands of salmon, usually Atlantic salmon but sometimes a Pacific species like chinook or coho, swim closely packed inside the 10-meter nets suspended from each platform. Workers scatter feed pellets into the floating net pens and periodically check the fishes' condition and administer vaccines, antibiotics, and pesticides. Seawater flows freely through the cages, and anything smaller than the mesh size—feces, uneaten feed, drugs, microorganisms—flows freely out.

Past the northern end of Vancouver Island, signs of human civilization—towns, cabins, clearcuts, logging roads, fishing boats, salmon farms—punctuate the landscape less and less often. The land becomes an almost continuous green cloak of conifers. Islands dot the straits and bays like confetti. This is the southern end of the central British Columbia coast, ground zero for the aquaculture industry's planned northward expansion.

Farmed salmon is already British Columbia's largest legal export crop, but only three of the province's 85 salmon farms lie north of Vancouver Island. In September 2002, the province's newly elected pro-business government lifted a seven-year-old ban on new fish farms and began a push to quadruple salmon-farming output over a decade. With farms crowded in the southern third of the province and plagued by disease outbreaks (see "Canadian fish farms spread disease to wild salmon," Environmental Intelligence, May/June 2003), the industry has its sights on the central coast, the territory of tribes like the Heiltsuk.

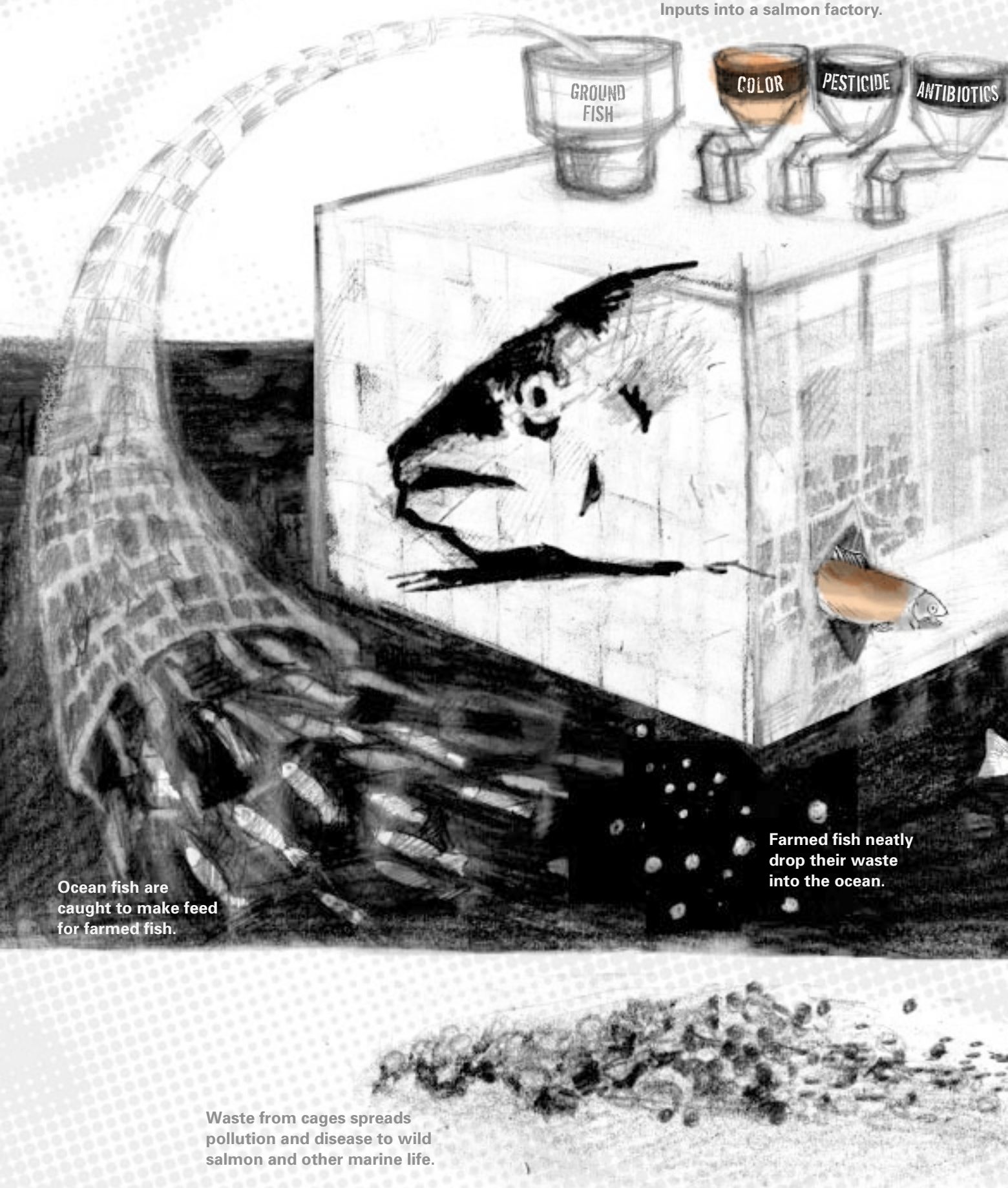
The lure of new jobs has caused divisions in British Columbia's impoverished indigenous communities. The Kitasoo Nation, to the north of Heiltsuk territory, has allowed a salmon farm to be built near Arthur Island, an area the Heiltsuk also use. A viral disease outbreak last year forced that farm to kill all its salmon and may have spread the virus to wild salmon and herring, both of which are important local food sources.

"Everyone needs jobs," Philip Hogan of the Heiltsuk fisheries program acknowledges. "But this threatens the economy we already have."

Heiltsuk territory is one of the rainiest places on the planet—ecologists call the zone's climate "very wet hypermaritime." The hemlock and cedar rainforests that grow to the water's edge depend not only on ample precipitation but on nutrients brought up from the sea by salmon. Though it spends most of its life at sea, each salmon ends its life in the same freshwater stream where it started out. By swimming upstream, it brings oceanic protein and nutrients ashore, fueling both human and natural communities. Scientists in Alaska have determined that forests near healthy salmon streams obtain one-sixth of their nitrogen, a key nutrient, from the decomposing carcasses of salmon.

"All our brothers and sisters," says Nuxalk chief Snuxyaltwa, "whether you're different races of people or whether you're the bear, the eagle, the raven, or anything else—everything survives on the salmon."

In pre-colonial times, salmon along the North Pacific coast from Alaska to northern California were so abundant that the region supported the densest, and possibly wealthiest, human populations in North America. For centuries, Northwest fishing tribes like the Heiltsuk pulled in more salmon than late twentieth-century fleets. When the Lewis and Clark expedition first encountered the salmon-filled Columbia River, seasoned explorer William Clark marveled, "The multitudes of this fish are almost inconceivable."



Inputs into a salmon factory.

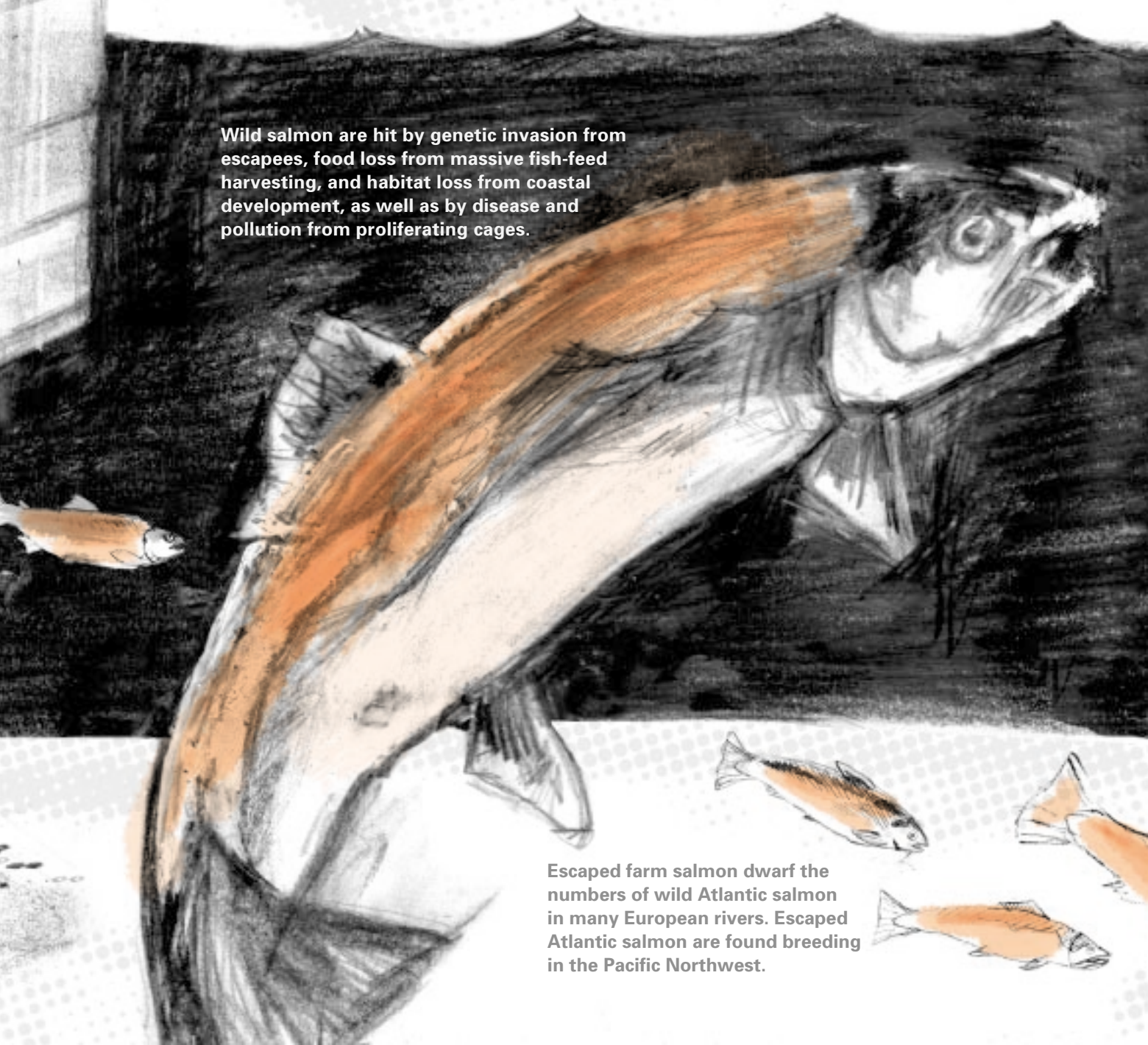
Ocean fish are caught to make feed for farmed fish.

Farmed fish neatly drop their waste into the ocean.

Waste from cages spreads pollution and disease to wild salmon and other marine life.

THE WONDERS OF
Aqua-Alchemy

How to produce 1 kilo of salmon from just 4 kilos of fish (and a few added ingredients)



Wild salmon are hit by genetic invasion from escapees, food loss from massive fish-feed harvesting, and habitat loss from coastal development, as well as by disease and pollution from proliferating cages.

Escaped farm salmon dwarf the numbers of wild Atlantic salmon in many European rivers. Escaped Atlantic salmon are found breeding in the Pacific Northwest.

Even in the early twentieth century, salmon was so abundant and cheap that it was the only high-protein food that many American families could afford during the Great Depression. But as overfishing—and then habitat loss and dam-building—decimated salmon runs, the fish became a delicacy that most people ate only on special occasions.

While the North Atlantic has only one species of salmon, compared to the North Pacific's six, the story of abundance squandered is the same in both oceans. Atlantic salmon once spawned in huge numbers in rivers from Portugal to Connecticut. But overfishing and habitat destruction have reduced the overall population of wild Atlantic salmon by more than 90 percent and eliminated the fish entirely from six southern European nations and southern New England. By contrast, the production of farmed salmon in the North Atlantic is 600,000 tons a year—*300 times* greater than the wild salmon catch.

The aquaculture boom has brought salmon full circle as a foodstuff—so much so that Helge Midttun, the CEO of Fjord Seafood Group of Norway, one of the world's largest aquaculture companies, could tell the industry newsletter *Intrafish*, "Salmon is possibly the cheapest protein product there is." But the transformation of salmon from seasonal delicacy to cheap global commodity has come at a price.

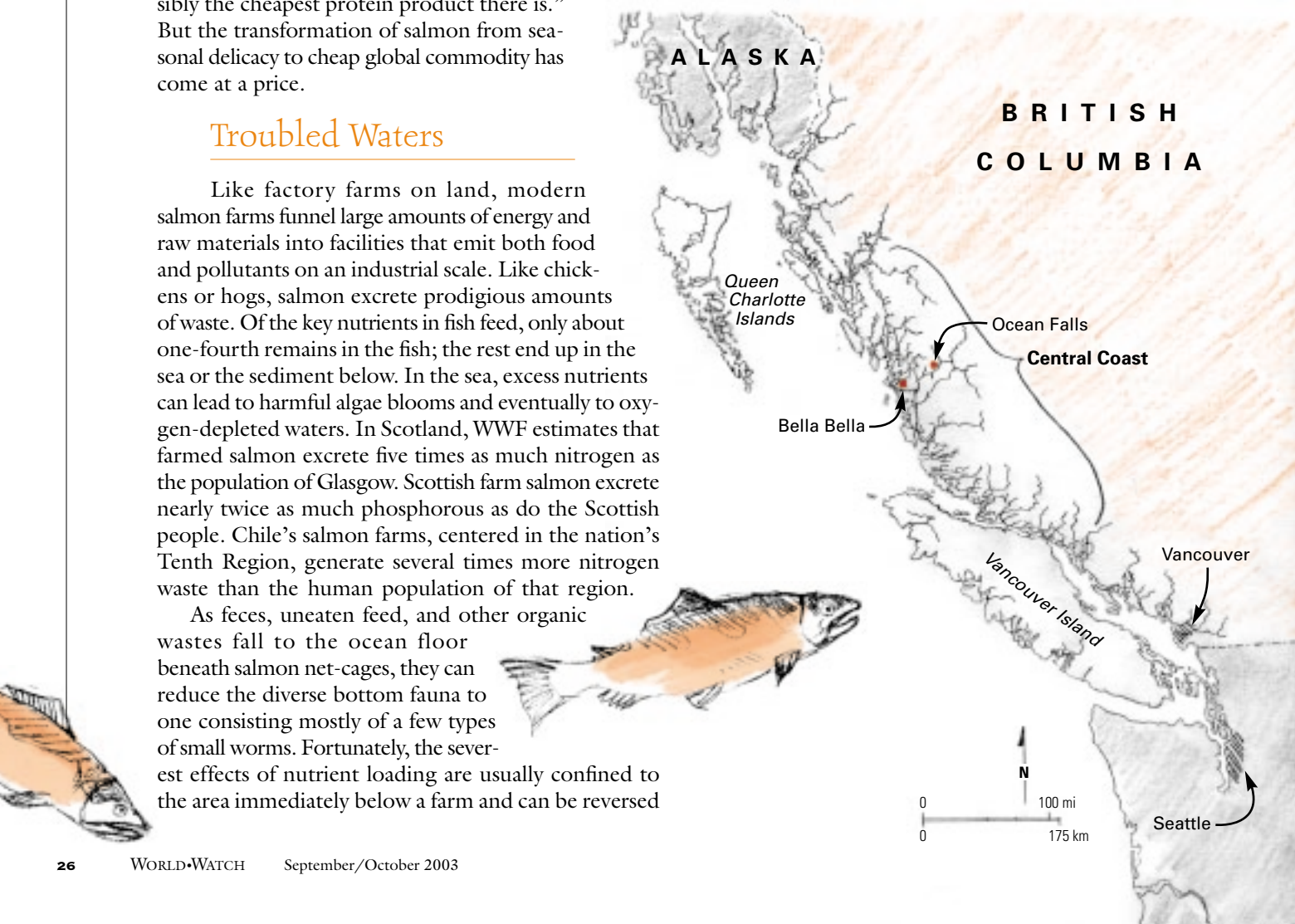
Troubled Waters

Like factory farms on land, modern salmon farms funnel large amounts of energy and raw materials into facilities that emit both food and pollutants on an industrial scale. Like chickens or hogs, salmon excrete prodigious amounts of waste. Of the key nutrients in fish feed, only about one-fourth remains in the fish; the rest end up in the sea or the sediment below. In the sea, excess nutrients can lead to harmful algae blooms and eventually to oxygen-depleted waters. In Scotland, WWF estimates that farmed salmon excrete five times as much nitrogen as the population of Glasgow. Scottish farm salmon excrete nearly twice as much phosphorous as do the Scottish people. Chile's salmon farms, centered in the nation's Tenth Region, generate several times more nitrogen waste than the human population of that region.

As feces, uneaten feed, and other organic wastes fall to the ocean floor beneath salmon net-cages, they can reduce the diverse bottom fauna to one consisting mostly of a few types of small worms. Fortunately, the severest effects of nutrient loading are usually confined to the area immediately below a farm and can be reversed if waste production is reduced. More lasting impacts come from the drugs, microorganisms, and fish themselves that emerge from the nets.

Infectious diseases plague the salmon farming industry, costing it hundreds of millions of dollars annually. Fish crowded into net-pens are susceptible to outbreaks of viral and bacterial diseases, as well as parasites like sea lice. Because diseases can spread like wildfire between farms, outbreaks often force farm operators to kill all their fish, bury them on land, and painstakingly sterilize all nets, boats, and equipment. Outbreaks of infectious salmon anemia in Maine and neighboring New Brunswick have killed nearly 5 million farm fish in the past two years. Diseases killed 10 million farmed salmon in Norway in 2001 alone.

Because farms are often sited along wild salmon migration routes, diseases pass easily between farmed and wild fish. Devastating outbreaks of sea lice in wild fish—with up to 98 percent mortality—in British Columbia, Scotland, and Norway have been linked to lice outbreaks on densely stocked salmon farms nearby. Some fish farm diseases can even spread to other wild species, including turbot, halibut, and sea trout.



While European salmon farms have been able to develop vaccines for some diseases and greatly reduce their antibiotic use, many fish farms continue to rely on heavy applications of antibiotics and pesticides. Large portions of each application end up in the environment. Chile's farmers use up to 500 tons of antibiotics a year, 75 times more per ton of salmon than Norwegian fish farmers. When used indiscriminately, antibiotics can generate antibiotic-resistant bacteria. Recent reports suggest that antibiotic resistance can spread worldwide within years, possibly through the transport of bacteria in ships' ballast tanks. Meanwhile, pesticides used to combat sea lice, which are tiny crustaceans, are especially worrisome to harvesters of other crustaceans like lobsters, crabs, and shrimp.

Escapees

Escaping salmon trouble biologists more than any other local impact of salmon farming. With only nets for walls, the typical salmon farm is vulnerable to the ravages of storms and predators as well as saltwater and ultraviolet light. Unless salmon are raised in saltwater tanks on land, escapes into the sea are practically inevitable. Though farm-raised salmon are less fit for survival in the wild, the sheer numbers in which they escape may give them a leg up over wild salmon.

In the Atlantic, only Norway publishes official estimates of salmon escapes. According to the Norwegian Directorate of Nature Management, at least 500,000 salmon escape every year from Norwegian fish farms, dwarfing the number of wild salmon (100,000 to 250,000) thought to remain in Norwegian waters. A half million escaped in a single incident in the Faeroes last year. Salmon have been escaping their nets in parts of Europe for so many years that more than half the salmon in some Irish rivers—and up to 90 percent in some Norwegian rivers—are farm fish.

In reality, the numbers of escaped salmon are simply not known—young salmon are measured by the kilogram, not by the head, so farmers don't even know exactly how many fish are supposed to be in their net-cages, and very few rivers are surveyed for escaped salmon. In British Columbia, no rivers are surveyed for escaped Pacific salmon, which actually present a greater ecological threat there than Atlantic salmon. Both types of salmon can spread disease and compete for habitat and food with native fish. But farmed Pacific salmon can easily interbreed with, and pollute the gene pool, of the wild members of their own species; Atlantic and Pacific salmon apparently do not interbreed across the species gap.

The state of Alaska banned fish farms in 1990 in order to protect its native species from the disease and pollution and invasive species they could bring. Yet according to the Alaska Department of Fish and Game, about 700 Atlantic salmon are caught annually in Alaskan seas. Most are caught near the British Columbia border, but some have been found 1,600 kilometers or more to the northwest in Prince William Sound and even around the Aleutian Islands. Atlantic salmon have also been caught ascending streams and rivers in Washington, British Columbia, and Alaska, and small numbers of juvenile Atlantic salmon, spawned in the wild, have been discovered in three rivers on Vancouver Island, including the perhaps appropriately named Adam and Eve River.

Net Loss

Aquaculture's ecological impacts might be less problematic if they were the cost of providing healthy protein sources to a hungry world or reducing the impact of overfishing on the world's seas. But salmon farming is in fact putting even greater strains on the world's fish stocks and their ability to meet human needs.

Living near the top of the food chain, salmon—both wild and farmed—consume prodigious quantities of smaller fish. In nature, if a population of salmon overconsumes its resource base, its own population will decline. On a farm, a salmon's food can come from anywhere on the planet, with few immediate checks on overconsumption.

Farm salmon live on pellets of compound feed composed primarily of fish meal and fish oil, which are produced by grinding up small, silvery, schooling fish like anchovies, mackerel, herring, and capelin. It takes about 5 tons of these fish to make a ton of fish meal, and about 10 tons to make a ton of fish oil. As a result, for every ton of salmon harvested on a farm, 3 to 4 tons of fish are removed the from the sea. Daniel Pauly, a marine biologist at the University of British Columbia who studies global fisheries, scoffs at salmon farmers' "we're-helping-to-feed-the-world" argument: "Are Angolans—after signing away the rights to their last fish to foreign fleets—going to import smoked salmon? It's absurd!"

Most of the so-called industrial fish fed to farmed salmon come from either the Pacific coast of Chile and Peru or the Northeast Atlantic, and these fisheries are seriously overfished. Over the past 15 years, overfishing of South American pilchard has reduced that species' stocks by 99 percent. North Sea nations' catches of blue whiting, also widely used for fish feed, remain at twice the levels recommended by marine scientists, and are all but certain to crash soon.

Only some of the small, bony fish that go into fish feed are deemed suitable for human consumption, but all small fish are prey for seabirds and marine mammals as well as for larger fish species like cod, that humans do eat. Excessive harvesting of small fish has wide-ranging

ecosystems effects and can affect human well-being both directly and indirectly. Blue whiting, for example, is an important prey for pilot whales, haddock, and cod; its depletion may help prevent overfished cod stocks from recovering. Fishmeal factories have made the city of Chimbote on the Chilean coast the nation's third most polluted city, while unsanitary fish wastes in the air and local waterways have reduced the city residents' life expectancy to 10 years below the national average.

One-third of the world seafood catch is processed into fishmeal, and one-third of fishmeal is used in aquaculture, with salmon farms the leading aquaculture consumer. While the bulk of the world harvest of industrial fish goes into livestock feed, fish make up less than 3 percent of an individual chicken's or pig's diet. And salmon farms' share is rapidly increasing. Salmon and trout farming alone now consumes more than half the world's supply of fish oil.

Fleets scouring the world's oceans for "industrial" fish also consume energy in large amounts, even more than the fleets that hunt wild salmon. Peter Tyedmers of Dalhousie University in Nova Scotia has calculated that for every kilogram of Canadian farmed salmon, 2.5 to 5 liters of diesel fuel or its equivalent is consumed. As William Rees of the University of British Columbia puts it, "the salmon farming industry expends large quantities of costly and increasingly scarce fossil fuel to do several jobs that wild salmon do for free, particularly foraging at sea to catch their food."

Shark Guarding the Fish House?

While aquaculture's impacts are well-known, governments in fish-farming regions are often so eager for hard currency and coastal jobs that they promote the aquaculture industry with much greater zeal than they oversee it.

In May, a U.S. federal judge chided regulators in Maine for their "regulatory hibernation" and imposed a number of environmental safeguards, including banning the state's two largest salmon farming outfits from using European strains of Atlantic salmon. The same month, Chile's National Environmental Commission signed an agreement with the Association of the Chilean Salmon Industry to allow the industry a large degree of self-regulation. "What we are doing with this agreement is trusting the players [in the industry]," Tenth Region administrator Patricio Vallespín told *Intrafish*. "Mistrust is very expensive for Chile…we can't have *armies* of people—as sometimes has been suggested—supervising and inspecting everything." Salmon represent 80 percent of the Tenth Region's exports, and 5 percent of Chile's total exports.

Vallespín's attitude seems to be the norm internationally. A review by the Atlantic Salmon Federation and WWF of seven nations' implementation of their treaty commitments to protect wild North Atlantic salmon from the impacts of fish farming found varying degrees of progress. But the nations earned an average score of just 2 out of 10.

In British Columbia, Minister of Agriculture, Food, and Fisheries John Van Dongen, who led the drive to boost aquaculture in the province, was forced to resign in January 2002 after the announcement of a criminal inquiry into his allegedly giving confidential information to a salmon-farming company. The Heiltsuk have filed a lawsuit against the British Columbia government and Panfish to stop the construction of the salmon hatchery inside their sovereign territory, and have staged protests to gain international attention. Along with local environmental activists, they hope that international pressure will help convince reluctant regulators and the multinational companies that dominate salmon farming to clean up their acts.

"We don't have the kinds of legislation or forest policies, or the Endangered Species Act, that Americans enjoy," notes the director of the Raincoast Conservation Society, Ian McAllister. "What Canadians have learned is that our only recourse is the international marketplace—and educating buyers like the Costcos and Fred Meyers of the world." Most of Canada's farmed salmon is sold in the United States, much of it at chains like Costco, which sells 300,000 kilograms of farmed salmon a week.

Activists are working hard to convince consumers that farmed salmon, with its artificial dyes and allegedly higher levels of pesticide and antibiotic contamination and saturated fats, is unhealthy, an allegation that industry representatives vigorously deny. They maintain, with a fair amount of supporting evidence, that farmed salmon are a much better source of protein and healthful omega-3 fatty acids than meat and the other types of fish, like tuna, that can have serious mercury contamination.

A white paper from the Alaska Department of Fish and Game reveals the strong feelings that farmed salmon arouse in wild-salmon country. "We realize," the paper reluctantly concedes, "that immediate closure of all salmon farms in British Columbia is simply not an option." Instead, the Department recommends that its southern neighbor allow no more fish farms to be built at sea and that, every time a farm in the boom-and-bust aquaculture industry goes out of business, its site be permanently shut down.

Despite its harshest critics' hopes, salmon farming, like aquaculture in general, is probably here to stay. Yet the industry is, by its own account, in serious trouble. "We are now seeing the consequences of the uncontrolled growth," top Pan Fish executive Atle Eide told *Intrafish* in June. "Production must be down-sized, and

as soon as possible if the industry isn't to suffer a state of total collapse." He wasn't speaking of ecological consequences, but of the industry's precarious financial condition. The world is awash in farmed salmon, and prices have collapsed in recent years as a result. Many salmon farming companies are losing money or going out of business and are eager to diversify into farming other carnivorous species like cod and halibut. The competition—fishers of wild salmon—have also been hit hard by the farmed-salmon glut. But, given the global scale of salmon farming's impacts, Eide's statement may not be far off-base from an ecological standpoint as well.

To its credit, the salmon farming industry has taken strides to reduce its ecological impacts. Instead of pesticides, Iceland and Norway now use millions of wrasses—"cleaner fish"—to pluck sea lice off salmon. In the early years, salmon farms would lose up to 20 percent of their feed, but well-run farms today lose less than 5 percent of their increasingly expensive feed, according to the British Ecological Society. "We monitor the amount of feed being dispersed to the fish with underwater cameras, so the amount of overfeeding and wasted feed is almost zero," says Mary Ellen Walling, director of the British Columbia Salmon Farmers Association.

However, the industry's phenomenal growth has swamped its efficiency gains. Norwegian authorities have managed to cut the proportion of salmon escaping from Norwegian farms in half, yet output has roughly doubled over the same time, meaning that the total number of escapees has remained the same.

Reduced farm output, perhaps in line with Alaska Department of Fish and Game's vision, would boost salmon prices, both reviving fishing communities and making the needed reforms of aquaculture more affordable. Though they are costly, self-contained fish farms on land are the only reliable way to keep fish, disease, and pollution from spreading into coastal waters.

Whatever happens globally, the Heiltsuk and Nuxalk are determined to keep fish farms out of their small part of the Pacific. At the Ocean Falls protest, Gary Haustie, a Heiltsuk fisherman, tells the crowd he's mystified by Canadian regulators' embrace of fish farming: "Why are they so intent on making the same mistakes other countries have experienced with fish farms?" He summarizes the Heiltsuk view bluntly: "The Heiltsuk people have zero tolerance for Atlantic salmon in our territory. We have zero tolerance for any farmed species. We have 80 percent unemployment in our community, but we choose not to pay the price of Atlantic fish farming."

Freelance journalist and former Worldwatch researcher John C. Ryan *lives in Seattle.*

Souped-Up Salmon

No genetically modified salmon are on the market today, but Aqua Bounty, a biotech company from Waltham, Massachusetts, has applied for approval from the U.S. Food and Drug Administration to produce genetically modified Atlantic salmon that can grow five times faster than genuine salmon. The company claims its salmon eat 10 to 25 percent less than ordinary farmed salmon and can reduce aquaculture's demand for feed. If FDA gives its approval, these super-fish could appear in stores as soon as 2004.

A panel of the U.S. National Academy of Sciences recently rated genetically modified fish a 'moderate' concern from the perspective of human health—they were concerned about the possibility of consumers having allergic reactions to introduced proteins. The panel was much more concerned about the wide-ranging ecological effects of fast-growing fish should they escape into the wild. With their accelerated growth rates, such fish might quickly out-compete salmon in the wild, even if they are less able to survive long-term.

Sharing such concerns, the states of Washington and Oregon have banned genetically altered fish in order to protect native fish. West Coast commercial fishermen are pushing California to ban genetically altered fish as well. "We cannot seem to contain genetically modified corn or wheat. So what happens when these fish get out in the wild?" asks Zeke Grader of the Pacific Coast Federation of Fishermen's Associations.

Much of the aquaculture industry itself, including the Federation of European Aquaculture Producers, is against the use of this controversial technology. Struan Stevenson, Scottish Member of the European Parliament and long-time aquaculture booster, opposes introducing genetically modified fish on the grounds that it would cause consumer demand to collapse. "Public opinion is against GMOs," says Stevenson, "and right or wrong, we must listen to public opinion. They are our customers."