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Making Sense of the Chilean Salmon Industry: Economic Boom or Environmental Doom?

By Peter Keller

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PUERTO MONTT, Chile–Salmon are sexy. Salmon fly. Salmon are dollars. Salmon are healthy and fat. Or at least that's what advertisements by the Chilean salmon industry tend to promote. Billboards and magazine ads display images of salmon in the sky (air-cargo business), a woman kissing a salmon (feed company), salmon tinted dollar green (another feed company) and robust salmon in the sea (pharmaceuticals). My own initial image — and one that I ate — was a filet on a plate, until one sleepless night. That night, orange-tinted flood lights, sounds of diesel engines and the thud of crates hitting the ground filled my hotel room on the shores of Chiloé Island. In the morning I stumbled through the dining room in search of a reason for my baggy eyes. The owner told me that last night's racket, just like every night, was from salmon workers on a dock across the bay.

What began two years ago as simple curiosity as to what salmon workers were doing, led me to my own personal investigation. Each question led to more questions, such as: What were the trucks delivering? Are salmon native to Chile? What is the process of farming salmon? Where are they exported? Complaints by environmental groups caught my attention in particular. These included criticisms of salmon-farming impact on aquatic life, water quality, shoreline aesthetics and general sustainability issues. On the other hand, the salmon industry presented popular images as an economic savior with relatively benign environmental consequences. Which was I to believe? From utter confusion, I set out on my own course to make sense of this fishy business.

Welcome to the Salmon Zone: A Primer

Chile is the world's second leading producer of salmon and trout (behind Norway), with sales of $973 million in year 2000. In terms of fish numbers, if each salmon sold weighed an average of nine pounds, that would be more than 75 million fish. The Chilean salmon- and trout-farming industry is dynamic and complex. New methods and equipment are perpetually sought to increase growth rate and decrease production time. Systems constantly change, thus the processes and statistics I write about in this newsletter could be out-of-date in a matter of months. Because of this fluid nature, a conversation about salmon, especially with an industry insider, can be an engulfing discussion. It's like a black hole of time, a twilight zone where minutes quickly slip into hours, meals become work sessions and salmon statistics flow like food from an automatic feeder. Nearly everyone in Puerto Montt, the salmon capital of Chile, has family, friends or a direct connection with the salmon industry. In my shared house alone, three of my six housemates earn a living from salmon. It is easy to become sucked into the flow and begin to babble salmon talk. Thus, without further delay, welcome to "the salmon zone."

Prior to my arrival in Chile, I don't recall knowing much about salmon. As a matter of fact, it was news to me when former ICWA Fellow and Honorary Trustee Albert Ravenholt told me he thought the best salmon available in Seattle was Atlantic salmon grown in British Columbia. Ravenholt, an eclectic man who re-

ported on the Chinese civil war in 1948 and helped invent the Pacific region's Magsaysay Awards, has developed a wealth of agriculture knowledge. He started a cherry and wine-grape farm in Washington state and keeps close tabs on just about anything that grows fast, whether it's trees, fruit or fish. Ravenholt wanted to know more about salmon from Chile and so did I. Besides, I was puzzled: Why, Atlantic salmon would be present in the Pacific Ocean?

In taxonomy terms, salmon, trout, charr and grayling are within the Salmonidae family. These fish are generally characterized by their anadromous nature of spending most of their adult life in the ocean, but spawning in fresh-water streams and rivers. Two of the four genuses in the Salmonidae family are integral to understanding the division of Atlantic and Pacific stocks of salmon (as listed below).

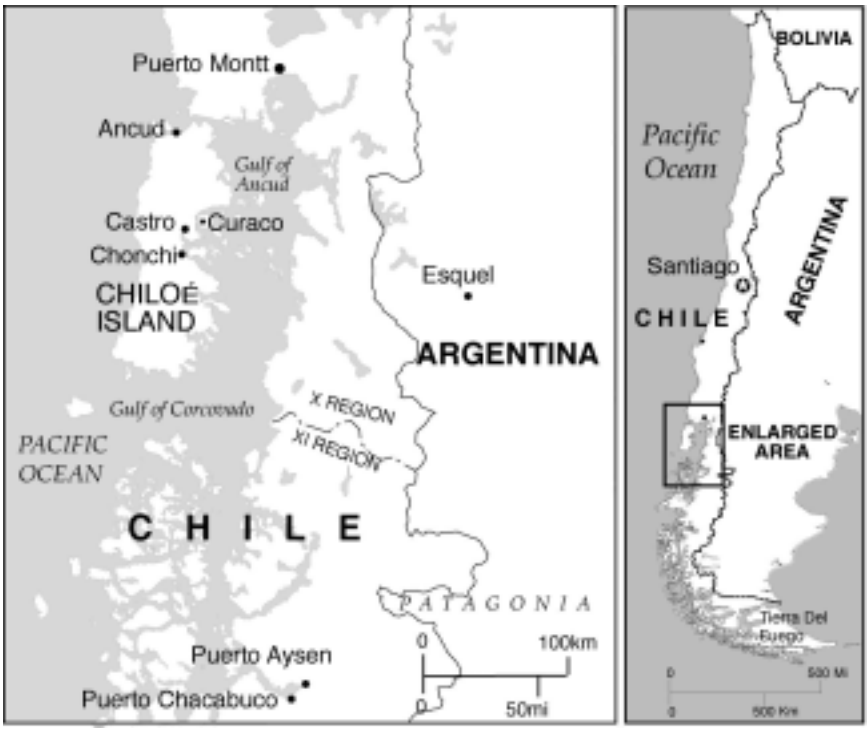
Genus *Salmo*

Atlantic salmon (*Salmo salar*)
Brown trout / sea trout (*Salmo trutta*)

Genus *Oncorhynchus* or generally referred to as Pacific salmon

Chinook or King Salmon (*Oncorhynchus tschawytscha*)
Coho Salmon (*Oncorhynchus kisutch*)
Sockeye or Red Salmon (*Onchorhynchus nerca*)
Pink Salmon (*Oncorhynchus gorbuscha*)
Chum or dog salmon (*Oncorhynchus keta*)
Japanese salmon (*Oncorhynchus masou*)
Rainbow or Steelhead trout (*Oncorhynchus mykiss*)
Cutthroat trout (*Oncorhynchus clarki*)

One difference between the two genuses is that Atlantic salmon spawn more than once and Pacific salmon, except for Steelhead trout, die after spawning. Atlantic salmon are indigenous in North America from Cape Cod to Labrador and in Europe from Portugal to northern Russia. Due to over-fishing and habitat destruction, many runs (the cycle of swimming



Salmon Short Course: From plate back to egg

July 28, 2001, 8:42 p.m. San Diego, California

Kim and Vic Flake had just finished a birthday celebration with marinated baked salmon at their Oceanside home in San Diego County. As the sun began to set, Vic reached for another bottle of Chilean red wine and happened to notice the salmon packaging was from the same country.

"Kim, did you know the salmon was from Chile too?" asked Vic.

"Is that right?" said Kim.

"I would never have guessed, since it seemed so fresh."

Served everynight in Anywhere, U.S.A., a salmon meal from South America makes a long journey to a diner's plate. The itinerary:

July 28, 2001. 9:00 a.m. LAX International Airport

Flown in daily, fresh salmon arrive in Los Angeles and Miami from Santiago, Chile, after eight to ten hours in flight. Following Customs inspection, salmon are delivered to market by refrigerated truck and/or airplane.

July 27, 2001. 11:00 p.m. Santiago, Chile. Pudahuel International Airport

Refrigerated shipping containers arrive by truck around the clock after a 14-hour trip from Puerto Montt. Insulated boxes of fresh salmon are transferred from containers to cargo flights.

July 27, 2001. 1:00 a.m. Processing Plant, Puerto Montt

Filled with salmon, ice, salt and sea water, cubic-meter-sized bins arrive on flat-bed trucks throughout daily double shifts. At the processing plant, salmon are headed, gutted, filleted and trimmed to order. From arrival to departure, the entire process can take between eight and 24 hours.

July 26, 2001. 8:00 a.m. Salt Water Salmon Farm, Chiloé Island

Fed and monitored for 12 to 14 months in floating pens with nets, salmon are harvested weighing four to five kilos. Twenty hours later, via barge and truck, they arrive at a processing plant.

Three days generally lapse from Chilean sea pen to consumption in the United States.

June, 2000. Fresh-Water Salmon Farm, Lago Chapo near Puerto Montt.

Salmon fed in fresh water floating pens for five to six months are transferred to sea water farms.

December, 1999. Fish Hatchery.

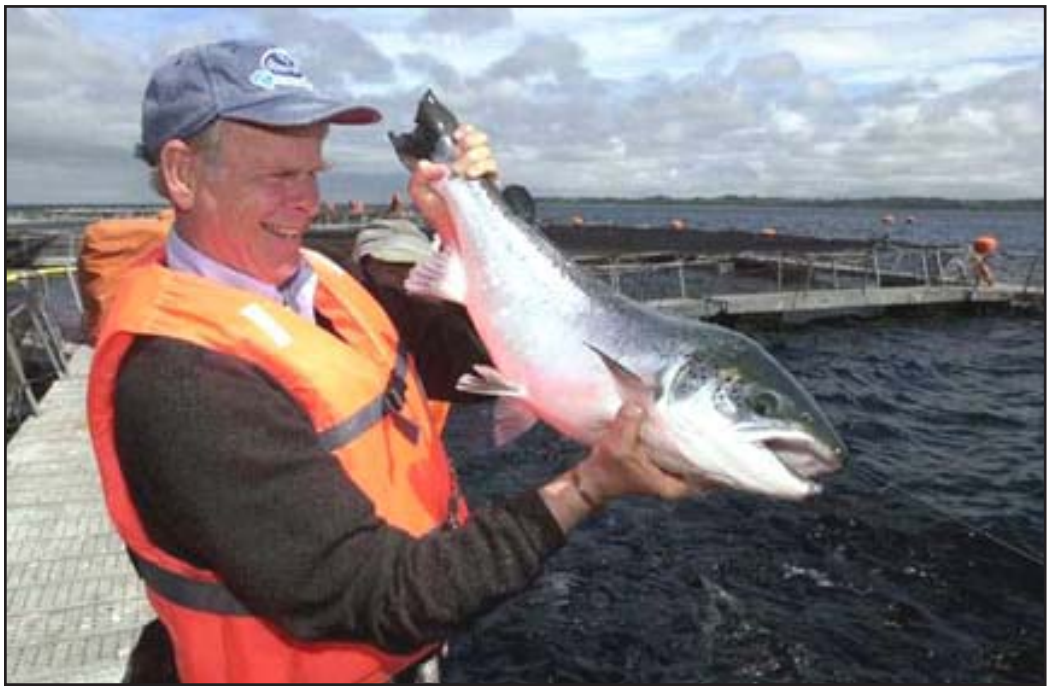
Fed and monitored in state-of-the-art hatcheries, salmon "fry" are moved to nearby lake pens when they reach a weight of five grams.

May, 1999. Fish Hatchery.

Selected mature salmon fertilize eggs to initiate a 24-26 month life cycle.

from fresh water to ocean and back) of Atlantic salmon are now reduced or finished. In spite of this fate on the east coast, they are a hardy fish and have been stocked outside their natural range in places like British Columbia.

Which of these fish listed above, you may ask, are native to Chile? The answer is none. In 1905, Rainbow trout were the first salmonids introduced in Chile by way of eggs from Europe. By 1946, Atlantic salmon and Brown trout were cultivated in a Chilean hatchery and stocked in lakes and rivers. For the next four decades these introduced fish established "wild" runs. Like other salmon in the northern hemisphere, they have similar life stages that include: mature fish spawning in streams, fry growing in fresh water, smolts migrating to the sea and adults returning to spawn where they were hatched.



Fjord Seafood Chile CEO Thomas Kehler inspecting an Atlantic salmon before harvest. Courtesy of Fjord Seafood.

In 1981, *Fundación Chile* (a joint venture between the Chilean government and the U.S. ITT Corporation) began to develop aquaculture activities on Chiloé Island and the surrounding isles. Aquaculture is the farming of fish in a controlled environment. They first bought a hatchery in Curaco de Vélez on the island of Quinchao. The objectives were to develop the hatchery and reproduce fish that would be grown in controlled fresh-water and salt-water sites. In 1985, *Salmones Antárctica*, the company established by *Fundación Chile*, was successful in bringing to market farmed Atlantic salmon. That year they exported 300 metric tons of fresh salmon. During the following 15 years the salmon-farming industry grew in Chile to a level of exporting 300,000 metric tons a year, a one-thousand-fold increase. What happened in the meantime? An entire industry grew out of almost nothing, at exponential rates.

What has made salmon farming successful in Chile are a variety of natural and logistical conditions. First, the Humboldt current flowing north brings clean water and provides relatively constant water temperatures. In addition, a jagged coastline of fjords and islands creates an ideal setting for protecting aquaculture sites from rough seas. Chile has several logistical advantages; primarily that fish-meal (a principal element of salmon feed) is made in Chile. Also, in an area with less than 600,000 people, along a coastline of 600 miles, the industry has had room to grow — but not without complaint.

A Fjord in His Future

First-time visitors to the Puerto Montt region might be tipped off to the presence of a fish-farming industry by all the floating, stationary fish cages visible in the bays and lakes throughout the region. If that doesn't do it, they will soon become curious about why hundreds of trucks carrying fiber-glass containers have oxygen tanks attached to them, or why a daily procession of trucks carrying large plastic bins emit a somewhat fishy fragrance. In these trucks is the new "gold" of southern Chile — Atlantic salmon, Coho salmon and Rainbow trout — the principal species cultivated here (for reasons of brevity, I will refer to salmon and trout-farming as simply salmon-farming). In the process of bringing the highest-valued "gold" to market, dozens of businesses contribute to a common objective: growing salmon in the most efficient manner possible with the least amount of stress upon the fish.

Currently, over 30 moderate- to large-sized companies are active in the Chilean salmon-farming business. Multinational companies have a large presence, and many of the world's leading fish and seafood producers, such as Nutreco, Fjord Seafood and Stolt Sea Farm, are operating in Chile. Through contacts, I was able to interview the CEO of Fjord Seafood Chile, Thomas Kehler, and spend a week with his staff touring field sites. Fjord Seafood is a Norwegian-based company, which is currently the world's third-largest salmon producer.

Kehler, a North American, originally came to Chile to get into the fruit business. "However, when I arrived and saw how developed the business was, I realized that I was about ten years too late," chuckled Kehler. "Luckily I happened to meet someone from *Fundación Chile* who was developing salmon-farming techniques." Kehler saw the

potential for salmon-farming and started Salmoamerica in 1987, managing the company to sales of $30 million before it was bought by Fjord Seafood. Fjord asked him to stay on and manage the Chilean company, which was the consolidation of two mid-size businesses that now have nearly 1,450 employees and an annual payroll of $10 million. Even before he arrived in Chile, Kehler was no stranger to fish or developing businesses. In 1960 he graduated from college and began teaching at a prestigious prep-school in New England. After a year he was fed up with the stuffy nature of boarding-school life and wanted to get as far away as possible. He went to Africa. Eventually he became a fishing guide on Lake Albert, which is the border between the current-day Democratic Republic of the Congo and Uganda. There he led fishing trips for Nile perch. During this work, he befriended a man who taught him about economic-development theories and entrepreneurship. This led Kehler to the Harvard Business School, and afterward he accepted an MIT fellowship that sent him to Colombia. As a specialist in rural economic development, he started several companies. One in particular flowered — literally. He managed Floramerica for ten years, a cut-flower greenhouse producer with exports to the United States.

Some commonalties are shared between the fresh-flower and fresh-salmon businesses. Both require rapid delivery to market and tight quality-control measures. They are also prime for consolidation. "A few years back I could see the trend of consolidation in the global salmon market," remarked Kehler. "So in 2000, when Fjord Seafood President Paul Birger Torgnes made an offer [to buy Salmoamerica], I accepted." With the addition of another company, Tecmar, Kehler oversaw the tripling of production levels in one year to 32,000 metric tons.

Salmon Farming Process

When I met Mr. Kehler my intent was to learn about the salmon industry from fish egg to plate. He provided ample opportunities: I saw three hatcheries, one fresh-water site, two salt-water sites, two processing plants, a water-treatment plant and one unexpected tour of a fish-food plant. Generally, the level of technology and sanitary conditions impressed me. After many occasions of donning protective garb and walking through disinfectant tubs, I began to think fish were clean and humans were disease-ridden creatures. Hence, your tour of salmon-farming begins logically — at the hatchery — with appropriate outer clothing of a plastic smock and rubber boots.

From April through June, hatcheries are busiest, when brood stock (mature fish) are stripped of eggs and milt (sperm). Mixed together, the fertilized eggs are placed in large, water-filled plastic containers with a bed of gravel. When the eggs hatch, they develop into "Alevins." At fingernail length, they feed on an attached, nutrient-rich yolk sac. Alevins become known as fry when they absorb the yolk sac. For the next four to five months these fry are fed protein-rich food in the form of pellets and undergo disease-prevention treatments.

At the Huillinco Hatchery on Chiloé Island I met Fjord Seafood's Head Veterinarian, Paolo Palacios. He took me on a tour of the hatchery, where seven to twelve million salmon are raised annually. "Generally, the survival rate is 60 percent from the egg stage to when they reach the sea," Palacios told me. The survival rate obviously depends on fish health, which includes such factors as the source of the eggs, sanitary conditions and medicinal treatments with antibiotics and vaccines.

Concerns about salmon health and human consumption has led Chilean resource-conservation groups like *Fundación Terram*, and *Ecoceanos* to raise food-safety issues. To pre-empt criticism, salmon-industry leaders petitioned the government to introduce laws establishing health standards. Subsequently, fish-egg importation and sanitary laws were passed. Nearly 30 percent of salmon eggs are imported. This was viewed as an opening for exotic new diseases, so foreign eggs can now be imported only from hatcheries certified disease-free. The use of antibiotics and vaccines at Chilean salmon farms has been controversial, to say the least, compared with other countries.

According to a report published by *Fundación Terram*,[1] antibiotics use in 1993 was 75 times greater per kilo of salmon production in Chile than in Norway. The report cited statistics from 1998 that the Chilean salmon industry used 100 metric tons of antibiotics. In comparison, Norway, a country with strict controls on antibiotic use, officially used only 0.6 of a ton.

"The situation is different in Chile," Meyling Tang told me. As a reporter for the Chilean Salmon Association magazine, Tang explained to me that "Norway's salmon are affected by only one major disease and a vaccination was developed early on. Thus, use of antibiotics dropped significantly." Antibiotic use is decreasing in Chile, according to a report by the University Austral in Puerto Montt. In 1999, Norway used eight milligrams of antibiotics per ton of salmon produced, while Chile used 200 milligrams per ton (25 times greater than Norway). Another factor skewing statistics is that not everyone reports every drop of antibiotics used. This means the numbers could be even higher, possibly in both countries.

Paulo Palacios of Fjord Seafood has been concerned about the use of antibiotics for years, and told me, "We've reduced antibiotic use significantly compared to the mid-1990s, as vaccines become more readily available. Even though vaccines are more expensive than antibiotics, they pay off in the long run." He continued, "Our company policy is to not apply medical treatments on salmon two months prior to harvest." Most treatments are performed when salmon are young. At the two-to-three gram stage, fry are immersed in a solution to control a variety of

[1] *La Ineficiencia de la Salmonicultura en Chile: Aspectos socials, económicos y ambientales. Fundación Terram, 2000.*

Young salmon at the fry stage being vaccinated against certain kidney and pancreatic diseases.

bacterias and some are vaccinated against infectious pancreatic necrosis, among other diseases.

Obviously, it is in the interest of the Chilean salmon industry to control use of treatments if they want to maintain FDA approval of exports to the U.S.A. and avoid what happened during the 1989 Chilean grape scare. Chileans are acutely aware of the consequences if exported products are tainted; memories of the 1989 Chilean fruit embargo are still fresh. The FDA embargoed two million crates of Chilean grapes for 11 days because of traces of cyanide in two grapes. Thousands of Chileans lost their jobs and the U.S. was sued for $330 million as a result. Whether the cyanide was injected into the grapes while in Chile or the U.S. is still unknown, but the ripple effect from media warnings significantly damaged all fruit sales from Chile at the time.

Salmon farmers work to ensure clean, healthy salmon at every stage of production. New sanitary regulations require companies to develop a tracking system for treatments used, and many already do. Doris Soto, a professor at the Puerto Montt campus of University Austral, thought these regulations were a good start, but cautioned: "The main problem in Chile is to make sure regulations are really followed. How can they be enforced in the field?" Soto continued, "Most companies do a good job, but the government doesn't have enough inspectors. We need to work with companies early before problems develop."

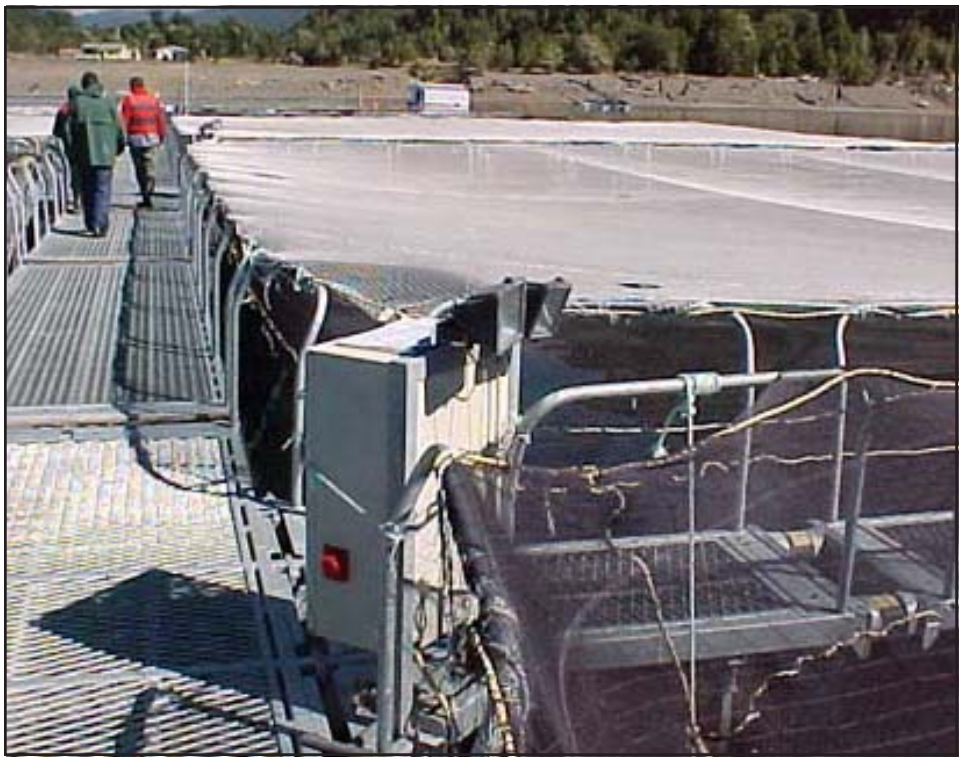
Medicinal treatments are also placed in salmon feed, promoting optimal growth conditions. Salmon growth is controlled by manipulating water temperature, oxygen content, light "photo period" and feed type. Application of these factors is particularly important to adjust the growth rate. For instance, Atlantic salmon are harvested all-year-round at a weight of four to five kilos, but hatch only between April and June. Thus, feeding conditions are manipulated to maintain growth rates so that Atlantic salmon will grow to harvest stage throughout the year. A grading machine separates salmon into different size classes several times at the hatchery and fresh-water sites. The salmon are grouped correspondingly to size at each life stage, and are given different combinations of food, oxygen, water temperature and light, depending on the desired growth rates.

When salmon fry reach a weight of five grams they are transferred from the hatchery to lakes, and remain there until they reach a weight of 90-100 grams. They are placed in floating pens, with nets below to hold fish in and mesh fabric above to keep preying birds out. During these final months in fresh water, salmon are known as smolts and undergo a series of physiological and morphological changes that allow them to adjust to salt-water conditions.

In these lakes, salmon grow quickly, aided by lights and nutrient-rich feed. Just as lights are used in chicken coops to accelerate growth, flood-lights are used above and below water to spur salmon growth. Lights are used

Fjord Seafood employees Jorge Vega, Miguel Jarpa and Luisa Vidal discuss growth projections for Salmon fry at the Rio Blanco Hatchery.

(Right) A simple light system used by Fjord Seafood at Lake Chapo. In addition, other fish farming companies use underwater lights to accelerate salmon growth. (Below) Fish feed pellets are distributed to salmon either by hand or through automatic feeders. The size of the pellet increases as salmon grow larger.



at night for ten weeks, cut off for four weeks and then applied 24 hours a day until smoltification is complete, usually in four more weeks.

"In the future, smoltification will probably take place on land in larger hatcheries instead of in lakes — like other countries do it," noted Palacios, the veterinarian. The distinct advantage of salmon smolts raised on land is the ability to control environmental conditions such as water quality and temperature. This is a step environmentalists would like to see too, because fish-farming reduces water quality by adding high amounts of nitrogen and phosphorus — causing eutrophication, as evidenced by algae blooms. Eutrophication denotes the aging of a lake. Most lakes in the region are oligotrophic, or "youthful," with low amounts of accumulated nutrients. However, algae blooms are beginning to occur more frequently in some of these lakes. Blooms prevent light penetration and oxygen absorption, necessary for underwater life and maintaining biodiversity.

A recent study by Professor Soto found that feces and uneaten fish feed accounts for nearly 15 percent of water-quality reduction. Erosion runoff (mostly as a result of deforestation) and waste from cities account for even more reduced water quality. If salmon are moved from fresh-water pens to land sites, where water recirculation and waste-water treatment systems are used, it improves water quality.[2] However, a major move to land sites is still five to ten years away; in the meantime, fresh-water pens and fry-salmon hatcheries continue releasing excess levels of phosphorus and nitrogen into lakes and ponds.

According to Chile's new sanitary regulations (January, 2002), water quality at all cultivation centers will be monitored. Currently, only a scattering of companies monitor water quality and that only at known problem areas. The policy at Fjord Seafood is to let a cultivation center lie fallow after harvest for three to 12 months. "Sometimes the 'shadow' of salmon pens from nutrient buildup on the sea or lake bottom disappears after three months. However the average is about six months," said Kehler.

Besides water-quality issues, salmon also have a negative impact on native fish species. Introduced populations from the early 1900s of brown and rainbow trout compete for food with native fish. "In some streams of southern Patagonia and Tierra del Fuego there is nothing but brown trout. No native fish remain," remarked Professor Soto. She continued, "Aside from introduced species for sport fishing, impacts on native species from salmon farming mostly occur when salmon escape."

During heavy storms in 1995, several million fish escaped from broken pens. The escaped fish compete for food with native fish like merluza and robalos. Sometimes escaped fish, mostly Atlantic salmon, return to feed outside the nets as food drifts down to the sea bottom. An escape of millions of salmon can provide good sport fishing — although, as fishing guide Gavin MacPhail told me, "Escaped salmon are sort of dumb in that they

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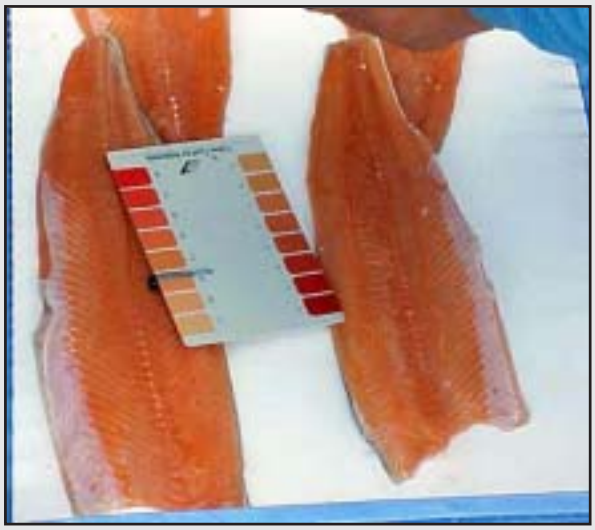
[2] Much of the attention on fresh water resources by environmental groups results from the fact that 97 percent of our planet's water is saline. Of that which is fresh, most occurs as ice (1.97%) or groundwater (0.61%). Only 0.014 percent of Earth's water occurs in the biosphere. (La Riviere, J.W.M. 1989. Threats to the world's water. Sci. Am. September: 80-94.)

Fishy Fish Food

By far the most expensive cost of producing salmon is the feed they consume. Up to 60 percent of production costs are for fish food. "The aquaculture industry has an anti-cannibal dogma of not feeding the same animal to the animal being produced. That's how the livestock industry got into trouble with mad cow disease," commented Fjord Seafood's Technical Manager Miguel Jarpa over dinner one night. Although no salmon byproducts are in salmon feed, many other fish are a part of the mix. In wild conditions a salmon's diet includes other fish and crustaceans. Half of fish-food content is fish meal, which is a mixture of fish and fish oil from mackerel, sardines and anchovies. With the Pacific Ocean at its front door, Chile is the world's second largest producer of fish meal after Peru.[3] Other ingredients in fish food include a mixture of potato starch, gluten and flour from wheat, soybean, corn and feathers. Feathers? Yes, imported from Argentina, feather flour is a rich source of amino acids. Nutritionally, fish food comprises proteins, lipids (which provide essential fatty acids), ashes and fiber, with additives of minerals, vitamins and pigments. This nutrient-rich mix makes for fast-growing fish, converting every two kilos of feed into 1.8 kilos of additional body weight.



Salmon flesh color is classified on a scale from zero to 16. Darker red has a higher value at the market. These salmon filets are part of a control study of color loss when salmon are frozen. Freezing reduces pigment color intensity, in turn lessening the market value of the salmon. Both salmon companies and pigment producers are trying to figure out how to maintain color intensity during the freezing process.

What makes salmon meat pinkish red? Astaxanthin, a naturally occurring pigment that is synthetically produced and added to fish food. Proportionally, this is one of the most expensive ingredients in salmon food and will continue to be unless finicky salmon eaters take a liking to white salmon meat. Most crustaceans are tinted red due to accumulated astaxanthin in their systems from feeding on microalgae, which produce carotenoids — the source of color hues in nature. Higher up in the food chain, animals like salmon and flamingos exhibit pinkish tones as a result of eating crustaceans. Currently, pigment manufacturers are experimenting with the fermentation of pink yeast to replace cost-intensive, synthetically produced astaxanthin. However, it's not yet commercially available.

Producing fish food can be a stinky business. A Canadian-built device (above) removes foul odors at the Biomar/Ecofeed plant in Pargua prior to emission of exhausts from the production process.

Production of fish food and additives is a lucrative business. Two of the world's largest pharmaceutical and chemical companies, Swiss-owned Roche and German-started BASF, have developed labs near Puerto Montt to supply vitamins and pigments to fish-food factories. Three of the four most prominent fish-food companies have built (or are building) plants (Dutch Alitec, Danish Biomar/Chilean Ecofeed and Dutch Trouw Chile) side by side in Pargua, a once-sleepy town overlooking Chiloé Island. These companies have set up plants strategically located for access to shipping routes and the future opening of a bridge to Chiloé — the heart of salmon-farming areas. The proposed 2,634-meter long bridge (700 meters longer than the Golden Gate) is a public-works project to celebrate Chile's bicentennial in 2010. Projected to cost of $314 million and billed as Latin America's largest bridge, it will save 45 of the minutes it takes to cross the channel via the current ferry system.

[3] Incidentally, Chilean and Peruvian fish meal, like many other feeds, is currently banned from the European Union because of fears by officials there that a relation might exist between a dioxin causing mad cow disease and fish meal.

are easier to catch and don't put up much of a fight." MacPhail remarked, "Farmed salmon are easy to identify because their tails are not as developed and somewhat stunted [from being trapped in nets with thousands of other fish prior to escape]."

Fly fishing guide Gavin MacPhail demonstrating the true art of the sport and making a difficult cast look easy.

Escapes also take place when sea lions break through nets to get an easy meal and consequently let thousands of salmon swim free. To reduce the sea-lion threat, several tactics have been used, from towing a plastic replica of a Killer whale (Orca) through the bay, to shooting sea lions, to using double nets. The most efficient and socially acceptable system (killing sea lions is illegal and a public-relations nightmare for the industry) is the use of double nets. In the case of Fjord Seafood's salmon farms, the mortality from sea-lion predation has dropped to almost zero by having an outer net angling away from the pens and an inner net holding the crop.[4]

Salmon live in what looks to be a haphazard placement of *balsa jaulas* (Spanish for fish pens), for 12 to 14 months until they reach harvest size. The manner in which *balsa jaulas* dot the seascape begs questioning if any planning is done and whether they can be placed anywhere at any time. As it turns out, placement of cultivation centers is important for salmon productivity. Ocean currents and daily tides help to recirculate water in the pens. Authorization for use of fresh- and salt-water areas for aquaculture operations is granted through government concession permits, and not at the drop of a hat. "The process to obtain a concession takes five to six years," Fjord Seafood's Thomas Kehler told me. "In the case of sea-water sites," he continued, "the application must be approved by the National Fisheries Service, the Ministry of Economy's Fisheries Subsecretary and the Navy. Plus, the application requires an environmental-impact study and a series of technical reviews. Finally, after all this, a decree is signed by the government permitting use," sighed Kehler.

The Fish Doctor On Call — at Sea

On a trip to the Lin Lin Cultivation Center, Fjord Seafood Technical Manager Miguel Jarpa invited me to join him and two representatives of Biomar/Ecofeed for a "house call." Biomar/Ecofeed is a Danish/Chilean company that supplies 30 percent of Fjord Seafood's fish food. Jarpa, a veterinarian trained at the University of Chile, began his career with *Fundación Chile* in the mid-1980s when the salmon-farming industry was just beginning. Lin Lin's site manager summoned Jarpa to provide a diagnosis as to why thousands of fish were vomiting —not a pretty sight, whether from humans or fish.

Upon arrival at the *balsa jaulas*, a light brown foam could be seen stuck to the nets and floating around the parameter of each pen. Rainbow trout being raised here had been vomiting for days, while another site only several kilometers away with the same species and food source were unaffected. The feed representatives and Jarpa developed possible scenarios throughout the inspection process and

[4] One of the primary complaints about salmon farms from Doug Tompkins (Pumalín Park) is the illegal killing of sea lions by some companies. One company in particular, Fiordo Blanco, has several cultivation centers in the fiords next to Pumalín. Tompkins has found shot sea lions washed up on shore and an illegal dump of salmon farm waste on his land. Several years ago, lawsuits pressed by Tompkins against Fiordo Blanco put him in the middle of another public debate and pitted yet another sector of Chilean society — salmon farming — against him and his project. Conflicts with Fiordo Blanco have lessened in recent years after a change in ownership. A Canadian company, Heritage Salmon, now owns Fiordo Blanco.

Environmentalists and Salmon Farmers Join Forces

It's not often that environmentalists and aquaculture industrialists find themselves in the same camp. However, in southern Chile they've come together to battle a common opponent — the proposed Alumysa project. Toronto-based Noranda, Inc. has submitted an environmental-impact assessment (EIA) to the Chilean government to construct an aluminum smelter and three hydroelectric power plants near the small communities of Puerto Chacabuco (pop. 1,175) and Puerto Aisen (pop. 12,762) in Chile's 11th region. Called the largest investment proposal in Chilean history at $2.75 billion, Noranda's plant would produce 440 tons of ingots per year for export. Alumina ore would be imported from Australia, Brazil and Jamaica for processing in southern Chile before export to Asia. The principal threat seen by salmon farmers and environmentalists is the projected 600,000 to 800,000 tons of solid and toxic industrial waste accumulated each year.

Many salmon companies have cultivation centers in the fjord leading to Puerto Chacabuco. The increased possibility of contaminated water from the proposed plant and/or oil spills from barge traffic has prompted the salmon industry to fight against the project. Several company executives have warned that they may relocate salmon farms if the aluminum smelter is approved because their fish would be near or in polluted waters. The 24-volume EIA submitted by Noranda in September, 2001 received thousands of comments during the public-review period. In late December, when the comment period closed, Noranda's contractor, CH2Mhill, began preparing responses to the barrage of comments. In August 2002, they hope to present a revised proposal to the Chilean Environmental Commission for final approval or rejection.

after dissecting a fish from the pen. The trout's stomach and digestive tract were clean, no food had been digested for at least a week "Could it be bad fish food? Or maybe all the fish are ill? Or is the water polluted in this area?" wondered Jarpa. No one had a definitive answer or seemed overly concerned, which I thought strange, considering the fact that tens of thousands of dollars in fish product were slowly starving to death.

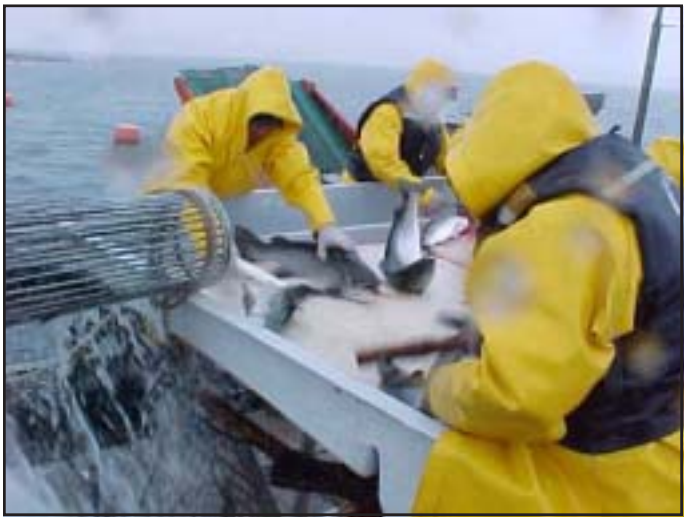
The Harvest

Imagine the somewhat dull process of monitoring and feeding salmon for two years. They don't do much except swim in circles and eat. Then harvest day comes, and everything changes. To experience this moment, I joined Fjord Seafood Salt Water Production Manager Jorge Uribe to observe the harvest process in the bays off the inland coast of Chiloé Island. Uribe's objective on this visit was to try a new technique for loading salmon into the transfer bins. I was particularly interested in seeing how salmon are taken out of the water.

Excitement built up as nets were cast into *balsa jaulas*, trapping several hundred salmon in one corner. Where the fish were trapped, a large funnel with a tube was connected to a platform above. Aided by a gas-powered compressor, water was pushed down under the nets, creating a vacuum and pulling fish through the funnel and tube. On the platform above, next to a two-square-meter tray, were workers wearing raingear and rubber boots. Those nearest the pen and the adjacent tube had clubs in their hands and those further down the line had hooks, impatiently awaiting salmon to arrive. In a fury, salmon and water came spraying onto the tray from the tube connected to the pen. Thud, thud, thud was all I heard over the drone of compressors. Salmon were being clubbed in the head and gills were cut open to bleed the freshly killed fish.

A five-kilo slippery salmon flapping around can be difficult to hold, and a mis-hit could damage the fish or even the harvester's hand. Hitting salmon precisely on the head is crucial to a quick death and eventual product value. Bruises and gapping, the pock marks, gaps and holes in salmon flesh, are caused by stressed salmon that weren't harvested in the most efficient manner. From the clubbing tray, salmon are sent down a chute to a docked barge, where double-walled plastic bins, half-filled with ice, await. Uribe was instructing workers on the barge to fill the bins with layers of ice, fish, salt and sea water. In the past, filling bins was like making a "salmon soup," but Uribe wanted more of a "salmon layer cake." He was hoping this method would result in even temperatures throughout the bin.

Previously, temperatures had ranged from -1 degree Celsius at the top to +4 degrees Celsius at the bottom of each bin. During a 20-hour transport to the processing plant, salmon not kept at cooler temperatures can lose value. This can add up to a significant loss at the market, where the difference between high-grade and low-grade salmon is 40 cents per kilo. Each bin held 100 fish and weighed, on average, 450 kilos fully loaded. With 65 bins aboard the barge, any reduction in gapping would add to profits. Uribe's experiment worked; temperatures in the bin ranged from +0.8 degrees Celsius to -0.5 degrees Celsius top to bottom. This



After approximately two years of growth Atlantic salmon are harvested at sea and sent to processing plants.

A prime example of gapping. Holes and gaps in salmon filets reduce the end-market value. This filet is destined for a low grade, a result of stress in the harvesting process.

reduced the gapping rate from the average of 2.5 percent to 0.5 percent — an increased value of several hundred dollars for this shipment and thousands of dollars spread throughout annual production.

This is just one small effort to increase product value. On a larger scale, some companies are significantly improving harvesting techniques by transporting salmon live to the processing plant. This is being done with a new fleet of "well boats" by just a handful of companies. Salmon are taken live from pens and put into the boat's "well" and transported directly to processing centers accessible by water.

At the processing plant, salmon are unloaded by the bin-full and sent through an elaborate conveyor-belt assembly line. If the fish is destined to become a filet, it is headed, gutted, cleaned, descaled, cut, weighed and graded. Depending on various factors, such as gapping and color, salmon are graded from best to worst classes: premium, grade 1, industrial A and industrial B. Salmon filets are further classified by specific cuts, ranging from "Trim A" to "Trim E." Trim A has the most fat and Trim E the least fat with skin removed.

At the end of the conveyor line, salmon filets and steaks are placed in plastic bags and passed through freezer vaults set at — 35 degrees Celsius. If the product is to be sold as "fresh" it remains for 25 minutes. Products to be sold frozen stay three to four hours. After the freezer stage, fresh salmon are packed in insulated boxes with frozen gel packs before being loaded into climate-controlled (1 degree Celsius) refrigerated trucks. Fjord Seafood packages salmon under various trade names including Morey, Windward, Salmoamerica and Omega. Due to a recent collapse in salmon prices, current focus is on developing value-added products, pre-cut into steaks or special packing with spices and side dishes to make a complete meal.

After salmon are processed for human use, up to 40 percent of the body weight is waste. What is done with these fish heads, tails, pin bones, scales, internal organs and blood? Waste for some industries is the source material for others. Solids are collected by companies such as *Pacifica Star* and *Salmonoil* for processing into feed for poultry and pets. Fish oil is also produced and used in making margarine, paints, shortening and pet food, among other items. At the Fjord Seafood plant in Puerto Montt liquids are sent to a tertiary treatment plant on site. However, this is not true of all processing plants. Some are just beginning to hook up water treatment systems, while others still return liquid waste to the sea.

An emerging market, albeit a fishy one, is a salmon byproduct that uses skins for clothing. One day a friend read me an article headline saying that salmon leather will revolutionize the clothing industry. "Yeah, *right*," I said sarcastically, "You won't be seeing *that* on some Italian fashion runway." I ate my words when she read: "Chilean fashion designer Claudia Escobar will be presenting her clothing line, 'Lights of Chile,' in Milan, Italy during the

The salmon processing line at Fjord Seafood's Puerto Montt plant. Between 12,000 and 13,000 salmon are processed each day and sent to the principal markets of Japan and the United States.

Fish Nutrition

In Chile, salmon preparation ranges from fried, to baked, to grilled ,with a variety of accompanying creamy sauces. Unfortunately, despite an ungodly amount of available fresh salmon, demand for sushi is not sufficient to support a sushi bar in diversity-starved Puerto Montt. That said, the nutritional value of a four-ounce *cooked* salmon filet has 180 calories, 21 grams of protein, 10 grams of fat (1.5 g. saturated), and 60 grams of cholesterol. Salmon are considered an efficient protein provider because, on average, they convert 1.2 kilos of feed to one kilo of body weight. Poultry requires 2.5 and hogs three times more feed to gain one kilo of weight. Although, all of this is dependent on the feed for each animal. Currently, industrial salmon, chicken and hog farms use high-protein fish meal as a principal feed ingredient. However, the efficiency of making fish meal is questionable because the process requires three to five kilos of fish (sardines, anchovies, etc.) to produce just one kilo of feed.

upcoming fashion week." It turns out Escobar has been working on this clothing line for the past five years and has designed salmon-leather pants, jackets, shoes, purses and bathing suits. Hmmm, no comment.

The Power of Salmon

Salmon farming continues to strengthen regional and national economies. In a country where the nationwide unemployment rate is 7.9 percent.[5] The rate in Chile's salmon-producing regions (X and XI) is only 4.9 percent. A little less than 25,000 people are directly employed in the salmon industry, with another 10,000 indirectly employed, providing support services. Driving back to Puerto Montt one day from Chiloé Island with Fjord Seafood's Miguel Jarpa, I had a new appreciation for the industry's economic impact. "Over there is a business that makes and repairs nets; this company here produces ice that is used in harvesting salmon; in that building they fabricate boats used by salmon farms," Jarpa continued on, pointing out refrigerated-container suppliers and transportation providers — and the list went on and on.

Almost 40 percent of Chile's gross domestic product come from exports. According to the Economy Ministry, farmed salmon and seafood ranks fourth among national exports. This ranking sets salmon, with 5.3 percent of the export market, behind mining with almost half of all exports ($6.9 billion in 1999; copper was 85 percent of this sector), wood products ($1.9 billion in 1999) and fresh produce (9.3 percent, mostly grapes and apples) and ahead of Chile's popular wine-export market (3.2 percent). In 2001, salmon accounted for 78 percent of all exports from the 10th region, which includes Puerto Montt. Overall, Chilean exports increased from $15 billion in 1996 to $18 billion in 2000. Of all countries importing Chilean goods, the United States has the largest share at 17.3 percent, followed by Japan (13.8 percent) and England (5.8 percent).

Slicing and dicing export statistics can be confusing, and analyzing the world salmon market is no different.[6] Nevertheless, the most important thing to understand is that the price of salmon has dropped like a lead sinker. The principal culprit is overproduction, by none other than Chile. However, it's not completely Chile's fault. In 1999, Chilean salmon producers, of which four of the top seven are foreign -owned, reaped great profits from high prices and poured this money into further production. The result was a jump in production of 50 percent from year 2000 to 2001, up to 300,304 metric tons. This bulge in the market, cut prices from a high in July 2000 of $6.50 per kilo (Atlantic salmon 4-5 kilo size) to a current low of $3.50 per kilo. Other producers, such as Norway, Scotland, Canada and the United States (Alaskan seasonal wild catch and Maine farmed salmon) also suffered from the influx of Chilean salmon. Chilean salmon farmers are now killing off eggs and alevins to stabilize the market. Fjord Seafood alone has destroyed millions of alevins as they maintain production targets of 32,000 metric tons in 2002, the same as the previous year.

On the consumer end, buyers are frolicking in salmon. According to the Chilean Association of Salmon and Trout Producers, in 2001 Japan imported 52 percent of the Chilean salmon harvest. The United States imported 29 percent, followed by the European Community at seven percent and Latin America with six percent. The Japanese market mainly imports Coho and Rainbow trout because of their texture and richer color for use in sushi and other dishes. On the other hand, buyers in the United States have taken a liking to Atlantic salmon, importing over 80 thousand tons, compared to only several thousand tons of Coho and trout. In the United States, overall consumption of fish has tripled in the last four years. Chilean salmon farmers are obviously hoping this number will continue to grow.

Who's Dumping What

Due to an overproduction of salmon and a large U.S. market willing to buy relatively cheap filets, accusations of dumping have been dogging Chilean exports. Some years ago was the first time I heard the term "dumping" in reference to trade. It was at a dinner party and a friend was talking about a company dumping ball bearings. Only hearing part of the conversation and with my environmental background, I was appalled and perplexed about why someone would dump ball bearings into the ocean. Luckily, I didn't open my mouth, but listened a little closer to

[5]Chilean National Institute of Statistics, December 2001.

[6]The primary salmon producing countries are Norway (39%), Chile (32%), UK (10%), Canada (7%) and U.S.A. (2%). Of worldwide production (1,821 thousand tons), cultivated salmon account for 61 percent and the rest are wild salmon, mostly from Alaska and Japan.

learn that "dumping" is a term for imports sold in another country at less than fair value, thus injuring a domestic industry.

"U.S. anti-dumping laws are basically a form of corporate welfare, in that consumers are subsidizing producers," said CEO Thomas Kehler. He has unwillingly grown accustomed to anti-dumping petitions by his competitors in the U.S. When he owned his fresh-cut flower business in Colombia, the industry was investigated by the U.S. Department of Commerce (DOC). The DOC, through its International Trade Commission, conducts investigations under the authority of the 1930 Tariff Act. Many foreign companies view anti-dumping efforts as an anti-free trade mechanism to protect U.S. producers from "unfair" competition.

Upon receiving a petition from salmon companies in Maine, New Hampshire and the state of Washington, the DOC investigated five Chilean salmon companies in 1997. Of these, three had a "zero rating" (indicating they were not selling their product for less than the cost of producing), but two were determined to be dumping fresh Atlantic salmon in the U.S. market. Even though some companies were not investigated and others were deemed not to be dumping, DOC commissioners set a 4.57 percent anti-dumping tariff on *all* salmon producers. Each company must deposit 4.57 percent of its gross sales with the U.S. Treasury Customs Service, the agency in charge of collecting tariffs.

DOC anti-dumping investigations include a preliminary phase and subsequent "period of reviews." During the second Period of Review, several Chilean salmon companies requested specific reviews seeking to set their own rate — hopefully lower or down to zero. For an example of how this works, Fiordo Blanco, a company recently purchased by Canadian-based Heritage Salmon (with salmon farms in Maine) under corporate ownership of George Weston Ltd., opted for a review and received a new rate of 1.46 percent. They still deposit 4.57 percent of sales annually with the Customs Service, but now the difference in rates (3.11 percent) is returned to them. It's a time-consuming, complicated accounting exercise and for that reason Kehler told me, "My dumping department [eight people] is the largest office in the administrative division."

Duties collected from anti-dumping tariffs by the U.S. Customs Service *used to* remain with the Treasury Department. *Used to* are the operative words. The crafty Democratic Senator Robert Byrd of West Virginia added a rider in October 2000 to the Agriculture Appropriations Bill that this money be distributed to the "injured" domestic complaints. The rider, known officially as the "Continued Dumping and Subsidy Offset Act of 2000" or simply "The Byrd Amendment," was passed by Congress with no debate and signed by then-President Clinton on October 28, 2000. Originally introduced by Ohio's Republican Senator Mike DeWine, this proposal never gained much support due to questions about legality under World Trade Organization and NAFTA trade rules. Now, foreign companies charged with dumping are, in essence, paying their competitors in the United States.

Ironically, the world's greatest free-market promoter — the United States — is the world's leading user of anti-dumping duties. According to a July 2001 report by the Cato Institute, "As of April 2001, the United States had anti-dumping or countervailing duties on some 265 items from 40 different countries, making it easily the world's largest user... The next closest user—the European Union and its 15 countries—had 154 duties in place." The legality of the Byrd Amendment has prompted nine countries (Australia, Brazil, Chile, EC, India, Indonesia, Japan, Korea and Thailand) to file a complaint with the World Trade Organization (WTO). This is the largest joint complaint in WTO history against the United States. Due to WTO pressures, some analysts believe Congress will revisit this issue and may repeal the Act in late 2002.

Payments from the U.S. Customs Service to businesses that filed anti-dumping complaints amounted to $206 million in fiscal year 2001 (in a model of "efficiency," the administrative cost of the program went over-budget, costing $200 million). A lion's share of the checks were collected by the steel industry; two manufacturers in particular, Torrington Company and Timken Company (from Senator DeWine's Ohio) accounted for 32 percent of the total payout. Examples of other items slapped with anti-dumping tariffs include pressure-sensitive tape from Italy, paper clips from China, pasta from Italy and, of course, fresh Atlantic salmon from Chile. Tariffs collected from fresh Atlantic salmon duties totaled $863,011 in fiscal year 2001. And who received this money? Only one company — Heritage Salmon of Maine — with a parent company in Canada that now owns Fiordo Blanco in Chile. A wicked web we've woven.[7]

Salmon Farming — Here to Stay?

We live in a market society, maybe not a *free* market society, but nonetheless one driven by demand and supply. Some salmon-farming critics, such as Doug Tompkins, say that the industry will collapse and it's only a question of time. Reasons for these predictions stem from the notion that salmon farms are negatively

[7]Alaskan salmon fisherman have gotten into the anti-dumping battle lately, enlisting their Republican Congressman Don Young, to initiate investigations against the Chilean salmon industry. Congressman Young Chairs the House Transportation and Infrastructure Committee. He recently led a Congressional delegation on a site visit to Puerto Montt, Chile to analyze maritime security within the port of this city. Not viewed as a friend of the Chilean salmon industry, Young's visit prompted both the regional governor and city mayor to be conspicuously absent from the high-profile tour. They had other "obligations" on Chiloé Island. The Mayor was quoted in the local newspaper as saying, "I don't want to be near 'Mr. Dumping' when he comes."

impacting the very waters they depend on and the production of fish meal is ecologically unsustainable. Both propositions — and other downfall scenarios — are possible. However, as long as the business is profitable and Japanese and Americans continue to demand salmon, market-driven solutions will be found.

In the case of reduced water quality, cultivation centers will become land-based with water-purifying recirculation and treatment systems. If the seas are fished out of mackerel, sardines and anchovies, other "discarded" fish will be sought out or soybeans and similar protein-rich legumes will be substituted. Tens of millions of dollars have been invested in southern Chile by the salmon-farming industry, and it will adapt and continue to be competitive. Since there doesn't seem to be any downturn in salmon consumption, I would say that salmon is here to stay in southern Chile.

Given that, I have a few suggestions for the industry in Chile if they seek to polish their image. Knowledge and technology is being developed to genetically modify salmon, among other species. Some Chilean salmon farmers would like to introduce genetically modified (GM) salmon into their salmon stocks. Besides being blessed with fortitude to withstand diseases, these GM salmon grow to commercially harvestable sizes in 14 months, whereas the current cycle is 24 months. Still, it would be a mistake to follow this path.

The salmon industry in Chile has already proved it can produce more than the market can handle. Why continue to flood the market? Moreover, the most important reason to not go down this path is that consumers are becoming more concerned about GM foods and are specifically requesting GM-free products. Chile would risk losing a great part of its share of the world salmon market with only a whiff of suspicion that it was selling genetically modified fish.

On a more tangible, cosmetic scale, the industry needs to clean up its aesthetic image. Beaches on Chiloé Island and along the mainland near Puerto Montt are filled with trash. Styrofoam, rope, cans, bottles, empty fuel containers, and nets litter the beaches. Whether this accumulation is caused by salmon farms, commercial fishing vessels or local communities, something needs to be done about it. As an act of good will, salmon farming companies should promote an "adopt a beach" program and patrol local littorals periodically to clean up trash.

On Chiloé Island, half way between Castro and Chonchi, a scenic-view pullout along the highway offers spectacular views of pastoral settings on smaller islands that dot Chiloé's eastern shore. Unfortunately, photographs of the bucolic setting are difficult to capture without including those ubiquitous *balsas jualas* in the frame. This is repeated in dozens and dozens of viewpoints in southern Chile. If salmon-farm permitting officials worked with the tourism industry to place cultivation centers out of sight, a great many complaints by tourists would be avoided.

Final Impressions

Touring salmon farms, hatcheries and processing plants, I was continually surprised that this fish — that has fed societies for centuries — has fueled a multi-million dollar industry. Less than 20 years ago this sector of the economy did not exist in Chile, until a few entrepreneurs took a risk to see what they could sea. For me, everywhere I looked on my salmon tour, I saw costs adding up — personnel, boats, trucks, housing, food, air transport, electricity bills, etc. — but someone else, the entrepreneur, saw a totally different scene: profit$.

A crucial link to continue these profits is to protect water resources and especially water quality — neither are limitless. Several researchers are focusing their studies on water resources, particularly the interaction between water quality in southern Chilean lakes and the composition of surrounding forests. Professor Soto of the University Austral has begun a study to understand this relationship. Her initial findings indicate that forests remaining intact serve as a filter for fresh-water runoff. These native forests, dominated by evergreen broad-leaf *Nothofagus* species, have the property, in respect to water quality, of having the distinct ability to retain nitrogen.

Water quality, a key factor for Chilean salmon farming success to date, is dependent upon its surrounding watershed. This economic value of water quality serves as an incentive to preserve native forests and a reason to avoid clear-cutting that replaces the forest with livestock and/or a monoculture of non-native trees. In the end, what could Professor Soto's research mean? That the Chilean salmon-farming industry may eventually become one of the most ardent protectors of native forests. It may be a strange thought, but something to digest. Just imagine a future Chilean billboard exclaiming in large, dark green letters, "**EAT SALMON! SAVE THE FOREST!**" One can only hope. After all, I am a *Forest* and Society Fellow. ❑

"I´m taking this one home for dinner!" The author at the Fjord Seafood processing plant in Chonchi, Chiloé holding a frozen and sealed salmon filet.

INSTITUTE OF CURRENT WORLD AFFAIRS

Fellows and Their Activities

Wendy Call (May 2000 - 2002) • **MEXICO**
A "Healthy Societies" Fellow, Wendy is spending two years in Mexico's Isthmus of Tehuantepec, immersed in contradictory trends: an attempt to industrialize and "develop" land along a proposed Caribbean-to-Pacific containerized railway, and the desire of indigenous peoples to preserve their way of life and some of Mexico's last remaining old-growth forests. With a B.A. in Biology from Oberlin, Wendy has worked as a communications coordinator for Grassroots International and national campaign director for Infact, a corporate accountability organization.

Martha Farmelo (April 2001- 2003) • **ARGENTINA**
A Georgetown graduate (major: psychology; minor, Spanish) with a Master's in Public Affairs from the Woodrow Wilson School at Princeton, Martha is the Institute's Suzanne Ecke McColl Fellow studying gender issues in Argentina. Married to an Argentine economist and mother of a small son, she will be focusing on both genders, which is immensely important in a land of Italo/Latino machismo. Martha has been involved with Latin America all her professional life, having worked with Catholic Relief Services and the Inter-American Development Bank in Costa Rica, with Human Rights Watch in Ecuador and the Inter-American Foundation in El Salvador, Uruguay and at the UN World Conference on Women in Beijing.

Curt Gabrielson (December 2000 - 2002) • **EAST TIMOR**
With a Missouri farm background and an MIT degree in physics, Curt is spending two years in East Timor, watching the new nation create an education system of its own out of the ashes of the Indonesian system. Since finishing MIT in 1993, Curt has focused on delivering inexpensive and culturally relevant hands-on science education to minority and low-income students. Based at the Teacher Institute of the Exploratorium in San Francisco, he has worked with youth and teachers in Beijing, Tibet, and the Mexican agricultural town of Watsonville, California.

Peter Keller (March 2000 - 2002) • **CHILE**
Public affairs officer at Redwood National Park and a park planner at Yosemite National Park before his fellowship, Peter holds a B.S. in Recreation Resource Management from the University of Montana and a Masters in Environmental Law from the Vermont Law School. As a John Miller Musser Memorial Forest & Society Fellow, he is spending two years in Chile and Argentina comparing the operations of parks and forest reserves controlled by the Chilean and Argentine governments to those controlled by private persons and non-governmental organizations.

Leena Khan (April 2001-2003) • **PAKISTAN**
A U.S. lawyer previously focused on immigration law, Leena is looking at the wide-ranging strategies adopted by the women's movement inPakistan, starting from the earliest days in the nationalist struggle for independence, to present. She is exploring the myths and realities of women living under Muslim laws in Pakistan through women's experiences of identity, religion, law and customs, and the implications on activism. Born in Pakistan and immersed in Persian and Urdu literature by her grandfather, she was raised in the States and holds a B.A. from North Carolina State University and a J.D. from the University of San Diego.

Andrew D. Rice (May 2002 - 2004) • **UGANDA**
A former staff writer for the New York Observer and a reporter for the Philadelphia Inquirer and the Washington Bureau of Newsday, Andrew will be spending two years in Uganda, watching, waiting and reporting the possibility that the much-anticipated "African Renaissance" might begin with the administration of President Yoweri Musevene. Andrew won a B.A. in Government from Georgetown (minor: Theology) in 1997 after having spent a semester at Charles University in Prague, where he served as an intern for Velvet magazine and later traveled, experienced and wrote about the conflict in the Balkans.

James G. Workman (January 2002 - 2004) • **Southern Africa**
A policy strategist on national restoration initiatives for Interior Secretary Bruce Babbitt from 1998 to 2000, Jamie is an ICWA Donors' Fellow looking at southern African nations (South Africa, Botswana, Mozambique, Zambia and, maybe, Zimbabwe) through their utilization and conservation of fresh-water supplies. A Yale graduate (History; 1990) who spent his junior year at Oxford, Jamie won a journalism fellowship at the Poynter Institute for Media Studies and wrote for the New Republic and Washington Business Journal before his six years with Babbitt. Since then he has served as a Senior Advisor for the World Commission on Dams in Cape Town, South Africa.

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