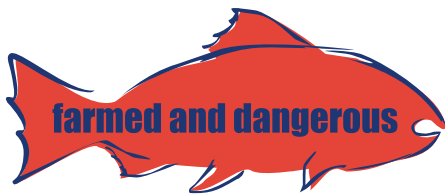


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what seafood
lovers
should know
about the
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What Seafood Lovers Should Know About The Salmon They Are Eating

Executive Summary

Salmon is the emerging seafood of choice across the U.S., with only two other seafoods - canned tuna and shrimp – purchased more often by consumers.¹

Residents of Washington, Oregon and California are among the biggest consumers of salmon in the U.S.², and Los Angeles, San Francisco and Seattle are the major destinations for farmed salmon.³

What consumers don't know, however, is that most of the salmon they buy comes from the marine equivalent of industrial-scale pig farms.⁴ Farmed salmon production is rapidly increasing, particularly in British Columbia, Canada. B.C. producers export 80% of their product, most of it to the U.S.⁵ In fact, 25% of the volume of farmed salmon imported to the U.S. comes from British Columbia.⁶ The Canadian government says that there could be a fivefold increase in farmed salmon production in that country in the next decade.⁷

Many U.S. consumers believe that eating farmed salmon is better for the environment than eating wild salmon.⁸ However, a closer look at the impacts of fish farms on the environment and potential impacts to human health indicates that most salmon is farmed and potentially dangerous.

Consider this:

- Farmed salmon are fed antibiotics. This increases the buildup of antibiotic-resistant bacteria, an emerging health threat the world over.
- Farmed salmon are treated with chemical additives to give them the color that consumers desire.
- Farmed salmon can spread disease and parasites to wild salmon and other marine species.
- Farmed salmon are higher in unhealthy fats and lower in beneficial Omega-3 fatty acids than are wild salmon.
- Farmed salmon have higher concentrations of dangerous contaminants such as polychlorinated biphenyls (PCBs) than do wild salmon.
- Salmon farms are a significant source of pollution released into the marine environment.
- Farm-raised salmon frequently escape into the wild. This so-called "biological pollution" poses threats to wild runs of salmon.
- Farmed salmon impact marine ecosystems around the world.

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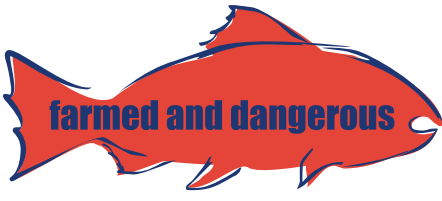
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- Farmed salmon do not take any pressure off wild fish and they pose a threat to existing coastal economies.

When these nine points are considered, consumers may wish to consider halting purchases of farmed salmon until it is safe for the ocean and safe for people.

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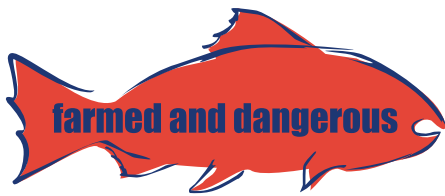
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Introduction

Americans are eating greater amounts of fish and in particular salmon. Between 1995 and 1999, per capita consumption of salmon increased a total of 42%.⁹

In large measure, this increase is fuelled by a belief that eating salmon is a healthy alternative to other sources of protein such as red meat. But there are other reasons. More salmon is available now than ever before. It is well marketed, and much of it sells at lower prices than was the case five or more years ago. For these and other reasons, salmon is now the third most popular seafood of choice in America, exceeded only by canned tuna and shrimp.¹⁰

The reason that there is so much salmon available is because it is now mass produced on farms in addition to, and in some cases in place of, the traditional wild salmon fisheries. At present, 62% of the salmon that is consumed worldwide is farmed.¹¹ Norway, the United Kingdom, Chile and Canada are the 4 largest producers of farmed salmon in the world.¹²

In terms of value, Canada has 47% of the US import market for farmed salmon. Because of its geographical proximity, Canada holds a distinct advantage over its competitors in selling fresh, whole or dressed farmed Atlantic salmon to the United States. Canada has 89% of the US fresh whole farmed Atlantic salmon market and 24% of the imported fresh filleted Atlantic salmon market.¹³

Salmon consumption is particularly strong in Washington, Oregon and California where 63% of consumers purchase salmon.¹⁴ British Columbia in particular is *the* source of Canadian production and a major supplier of farmed salmon to the U.S. western seaboard, mostly Seattle, Los Angeles, and San Francisco.¹⁵ Two thirds of Canadian farmed salmon production comes from its westernmost province, and 80% of it is exported, mostly to the U.S.¹⁶ In 2000 BC exported \$257 million worth of salmon to the U.S. This represented 96% of the total value exported.¹⁷ In terms of volume, British Columbia provides 25% of the salmon imported to the U.S.¹⁸

By far, the farmed salmon species of choice around the world is Atlantic salmon. In British Columbia, more than 35,600 metric tons of Atlantic salmon was produced at fish farms in 2000, compared to 6,370 metric tons of Chinook salmon and 1,390 metric tons of Coho salmon.¹⁹ Canadian agricultural officials believe there could be more than a fivefold increase in this production in the coming decade.

According to public opinion research, most American consumers are largely unaware about where the salmon they eat comes from. In fact, 55% of those surveyed do not know if salmon is wild or farm-raised, and there is a tendency for West Coast consumers to believe that the salmon they eat comes from the wild.²⁰

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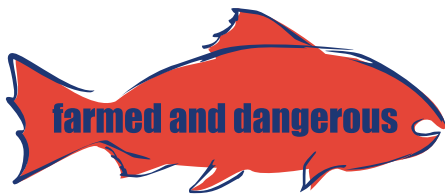
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Not unlike so-called factory farms that produce massive quantities of chicken, beef or pork, salmon farms and the fish raised on them pose numerous risks. This report highlights some of the more significant risks posed to the environment and human health from farmed salmon.

What is Salmon Farming?

Salmon farming, also known as salmon aquaculture, is the industrial mass production of salmon. Farmed salmon are raised in floating net cages located directly in the ocean. Net cages vary in size and shape, but a recent application for a new farm in British Columbia described their farms as having 14 pens. Each pen will be 90 feet by 90 feet and 48 feet deep. They plan to stock 50,000 fish per pen.²¹ This would provide each fish with a space of 2 feet x 2 feet x 2 feet (approx. 8 cubic feet). The 14 pens will cover an area equivalent to three football fields.

Antibiotics

Salmon raised on farms spend all of their lives confined to pens where they swim, feed and excrete in the same water as thousands of other fish. Despite a moratorium on new farms in British Columbia, production increased by 40% in one year.²² Farming companies were able to increase production by putting more fish into the net pens, increasing further the risk of disease and required use of antibiotics. Antibiotics that are not consumed by farmed salmon are dispersed into the marine environment through the porous net pens.

There has been a sharp rise in antibiotic resistant bacteria in North America and elsewhere in the world due to the overuse of prescription drugs. The unintended consequence of fighting disease and infection with antibiotics is a host of new organisms that are more resistant to the drugs we throw at them.²³ Giving those drugs to the fish and animals we later eat simply encourages so-called "super bugs" to get a little stronger and nastier.

In February 2002, the Northwest Science and Environmental Policy Center in Sandpoint, Idaho released a study written by Charles Benbrook, a pesticide policy expert and former Executive Director of the National Academy of Sciences' Board on Agriculture. The report unearthed evidence of widespread and poorly regulated use of antibiotics on fish farms.

In the late 1990s, Benbrook reported, U.S. fish farms produced nearly 800 million pounds of farm-raised catfish, trout, salmon and other fish and shellfish species. Big as this number is, it is the proverbial drop in the ice bucket. Seventy per cent of the seafood consumed by Americans comes from out of the country where rules and regulations applying to drug use in fish are even more lax than in America.²⁴

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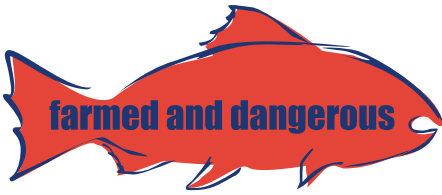
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Benbrook estimates that U.S. farm fish were fed a low of 204,400 pounds of drugs and a high of 434,400 pounds, and that because of "pervasive data gaps" he believes his figures are on the conservative end of the spectrum.

Artificial Color

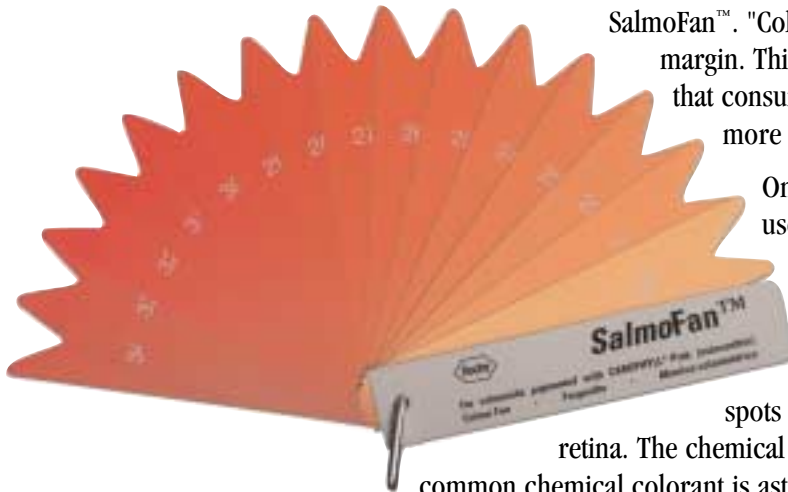
Most consumers are unaware that the robust color of the salmon they buy comes from chemical additives. That's because most salmon eaten today is not caught in the wild, but originates from farm pens, where fish are fed pellets that contain chemical colorants that are designed to give the flesh of farmed fish a look similar to the pink and red of wild salmon. If chemicals weren't used, the flesh of most farmed salmon would be gray.

On its web site, food distributor Sysco Corp. notes that chemical coloration of farmed salmon is a fine art.²⁵ People in the business of marketing the chemical colorants fed to farmed salmon have developed a color fan called SalmoFan™. The fan is similar to what you look at when you go to a paint store to select a new wall color.²⁶

In consumer tests, fish farmers and food retailers have learned that the deeper colored a salmon's flesh the more it is "associated with higher quality, better tasting salmon."²⁷

Sysco Corp. reports, "In one study, consumers from the East and West Coasts of the U.S. were shown salmon fillets matching the hues on the

SalmoFan™. "Color 33 was preferred by a 2:1 margin. This market research indicated that consumers may be willing to pay more for deeply colored salmon."



One of the chemicals commonly used to color farmed salmon was once used in a sun-tanning pill that has been withdrawn from use because of concerns that it can cause temporary blind spots and possibly damage the

retina. The chemical is canthaxanthin. Another common chemical colorant is astaxanthin.

Wild salmon develop their trademark pink to red flesh naturally by feeding on prey such as krill (tiny shrimp-like crustaceans). This food source also contains beneficial antioxidants which are good for the health of salmon and salmon consumers.

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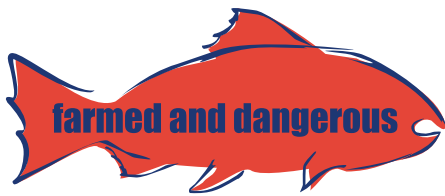
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Disease and Parasites

Farmed salmon are raised in pens or net cages placed in open bodies of water. All that separates them from wild fish swimming in the surrounding ocean are walls of net. This presents a serious problem because disease outbreaks on fish farms, where fish may be spaced only 15 inches apart, are a frequent occurrence.

According to Britain's publicly funded National Institute for Medical Research, the sharp rise in fish farming over the past 30 years "has been accompanied by the emergence of several serious infectious diseases of fish." The big concern is that disease outbreaks on farms spread to large, natural populations of fish. Farmed fish, the NIMR reports, "may act as almost limitless reservoirs and sources of infection" to wild populations.²⁸

An example of this type of disease is Infectious Hematopoietic Necrosis Virus (IHNV), a deadly disease that occurs at low levels in the wild, particularly on sockeye salmon. However in 2001 and 2002, 18 fish farms in BC reported cases of IHNV. The pathogens from this disease can be spread into the environment through a variety of routes including mucous, feces and decaying dead fish. Therefore farms that are experiencing an IHNV outbreak quickly become marine reservoirs for the disease and there is a very real danger of wild fish migrating past the infected farms being exposed to the virus at levels they would otherwise not encounter in nature.²⁹

In America, salmon farms are routinely the sites of devastating disease outbreaks. Charles Benbrook, a pesticide policy expert and former Executive Director of the National Academy of Sciences' Board on Agriculture, notes that "the larger and more industrialized the operation, the more likely [it is] to experience disease problems."³⁰

Packed in high densities, farmed salmon are also vulnerable to rapid and widespread parasitic infestations.

Sea lice infestations on salmon farms in British Columbia have been linked to outbreaks in wild salmon populations and the total collapse of eight runs of pink salmon.³¹ The tiny lice are particularly dangerous to young salmon. They feed on their bodies causing the fish to lose their scales. This triggers acute infections that can result in death. The only way to treat farm outbreaks is through the use of pesticides, which then work their way into the environment.³²

According to a 1997 study by the United Nations' Food and Agricultural Organization, one pesticide used to fight sea lice infestations is Ivermectin. Residues of this chemical have turned up in farmed salmon in the United Kingdom. The FAO went on to report that an issue of potentially greater concern is "the lack of availability of quantitative data on contemporary chemical use in the aquaculture (fish farming) industry."³³

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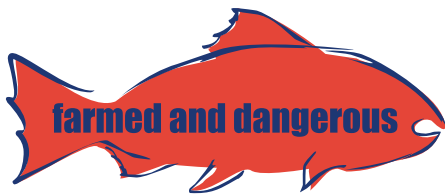
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Nutrition

When it comes to nutritional value, farmed salmon have higher fat content and are lower in the beneficial essential fatty acids such as omega-3 than wild salmon.

The U.S. Food and Drug Administration has compiled nutritional information on a number of different salmon species both farmed and wild.³⁴ In all cases farmed Atlantic salmon were found to be higher in total fat content than a range of wild salmon including: Atlantic, coho, chinook, chum, pink and sockeye.

In addition to having higher fat content, farmed salmon were also found to have another nutritional drawback. Unlike many of their wild counterparts, farmed salmon were lower in beneficial or essential fatty acids. Our bodies do not produce such fats, so we must get them from what we eat.

There are two types of essential fatty acids. They are omega-3 and omega-6. Both are important, although nutritionists and medical researchers agree that foods with a higher ratio of omega-3 fatty acids to omega-6 fatty acids are best.

Omega-3 fatty acids help to keep our cholesterol levels down, and to prevent high blood pressure, heart disease and rheumatoid arthritis. Too many omega-6 fatty acids, on the other hand, can increase these health risks.

The USDA's findings show that farmed Atlantic salmon and farmed coho salmon have consistently poorer omega-3 to omega-6 fatty acid ratios than do wild coho, chinook, chum and pink salmon.

Contamination

Big fish, such as salmon, eat little fish. And in a world where more and more toxic pollutants are working their way into the marine environment, this inevitably leads to contaminants concentrating in bigger fish.

Scientists call this bioaccumulation. It's their way of saying how things accumulate in greater concentrations in bigger species. The higher up the food chain, the greater the accumulation.

In the wild, salmon must eat lots of contaminated smaller fish before toxic pollutants begin showing up in significant concentrations in their bodies and become a health issue for consumers.

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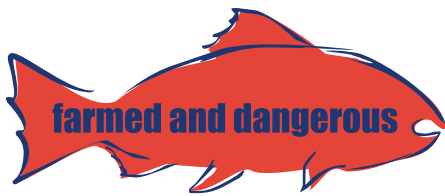
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But farmed salmon are different. They don't eat live fish. Instead they eat pellets made of fishmeal coated with fish oil. As far back as 1977, scientists found significant levels of polychlorinated biphenyls (PCBs) and DDE (a DDT derivative) in commercial fish feeds.³⁵

In a 2002 limited pilot study, Dr. Michael Easton reported how chemical analysis revealed that samples of farmed salmon had "consistently higher levels" of a range of toxic contaminants than did the samples of their wild counterparts.³⁶

"A portion of these contaminants are in the class of persistent organic pollutants (POPs) which have infiltrated the food chains and have bioaccumulated up each chain to reach substantial levels in the top predators associated with each of these chains," Easton reported in the journal *Chemosphere* (issue 46, 2002). "Many of these top predators are mammals, with humans being the ultimate predator."³⁷

This is a matter of serious concern because, according to Easton, eating contaminated fish is known to be a "major conduit of contaminants into the human body."

When Dr. Easton compared farm salmon to wild salmon he found that the farmed salmon had 10 times the level of polychlorinated biphenyls or PCBs in their fatty tissue than did wild salmon. PCBs are now banned from use in the United States, but were at one time commonly used as a coolant in electrical capacitors and transformers. They have been linked to acne, fatigue, nausea and liver disorders in humans.³⁸

Further study of farmed salmon showed that they also had much higher levels of other contaminants such as polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenylethers (PBDEs) and organochlorine pesticides (OPs) than did wild salmon.

The likely cause of this contamination is farmed salmon feed that is produced from small fish that may come from just about anywhere.

"The use of fish oil and fish meal in feed serves not only to produce high energy feeds with good growth performance qualities, but also to act as a pipeline for contaminants into the human food chain," Easton reported.

Given these results, the *Chemosphere* article concluded that there is a "safety concern for individuals who on a regular weekly basis consume farmed salmon produced from contaminated feed."³⁹

A recent analysis of pesticide contamination in food done by the British government found that all farmed salmon samples tested by scientists contained pesticides. In this study, 100 different examples of fruit, vegetables, meat and other foodstuffs were tested for pesticide residues. Farmed salmon was the only food in which every sample contained three pesticides: DDT, dieldrin and hexachlorobenzene. Almost all salmon sold in Britain comes from salmon farms.⁴⁰

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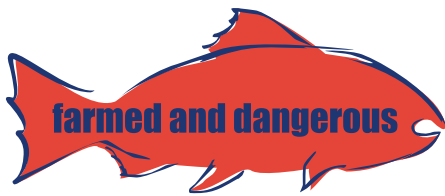
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Pollution

Salmon farms consist of pens in open waters. As a result, farmed fish share the same environment as wild fish, separated from their wild counterparts only by nets.

This is a cause for great concern because salmon farms generate enormous amounts of waste that are directly deposited on the ocean floor and pollute marine waters that wild fish and other marine organisms depend on.

Fish farm pollution generally falls into two broad categories: organic and chemical, the latter of which is described in other sections of this report dealing with antibiotic and pesticide use on fish farms.

The main organic pollutants on fish farms are fish excrement and uneaten fish feed. The feed consists of pellets made from small fish species. Up to half the dry feed fed farmed salmon ends up in feces that accumulates on the seabed.⁴¹

On each square meter below a salmon farm, up to 114.6 pounds of waste can accumulate each year. The waste increases loads of nutrients such as nitrogen and phosphorous which smothers life on the ocean floor and sets up other reactions damaging to marine life including oxygen depletion.

The 33 million pounds of farmed salmon produced in the U.S. in the mid 1990s generated an estimated 1.81 million pounds of nitrogen and 158,700 pounds of phosphorous.⁴² In British Columbia, which produces more farmed salmon than the US, 6.01 million pounds of nitrogen and a further 524,768 pounds of phosphorous was produced.⁴³ It would take the untreated sewage of a city of 628,000 residents to produce the same volume of nitrogen and a city of 216,000 people to produce the same amount of phosphorous.

Escapes

Salmon farms are also a major source of what some scientists call "biological pollution." This pollution takes the form of farmed fish escaping from their pens and intermingling with wild fish. Large numbers of farmed salmon (mostly Atlantic farmed salmon) frequently escape their pens and swim into the Pacific Ocean. Some but not all of them are subsequently caught by fishermen from Alaska, Washington and British Columbia.⁴⁴

Just how frequent and large are salmon farm escapes? Dr. John Volpe, a fisheries biologist at the University of Alberta, studied and reported on the issue for the David Suzuki Foundation in Vancouver Canada. He concluded that while escapes are a frequent occurrence, it is impossible to arrive at an accurate count. At best, published numbers of escapes are "underestimates" that should be "treated with skepticism."⁴⁵

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That salmon farm escapes are a persistent problem is not in question, however. Volpe noted a study chronicling escapes at a salmon farming operation in Puget Sound. Over a lengthy test period escapes averaged 22 percent. "These losses occurred even though daily dives found no tears in the nets," Volpe said.⁴⁶

Nearly all farmed salmon are Atlantic salmon, a non-native, exotic species in Pacific waters. Research by Dr. Volpe demonstrated that Atlantic salmon were capable of spawning in Pacific waters. This was later confirmed by the discovery of Atlantic salmon spawning, and their progeny surviving, in the Tsitika River in British Columbia.⁴⁷ This raises concerns about the colonization of alien Atlantic salmon on the Pacific Coast, with the accompanying risk of this species out competing indigenous salmon for food and habitat, putting yet more pressure on wild Pacific salmon.

As salmon farming operations expand, the possibility of more Atlantic salmon spawning in Pacific waters increases.

Global Environmental Impacts

Raising salmon is like raising any other carnivorous animal produced, you must feed them lots and lots of protein. And in the case of farmed salmon that protein comes from the world's overexploited oceans. For each pound of farmed salmon around three pounds of wild fish feed is needed.⁴⁸

More than one tenth of all the fish caught in the ocean become fish meal and fish oil for salmon farms.⁴⁹ The percentage of wild fish fed to farmed fish will only increase over time as more salmon farming operations open.

A multi-disciplinary team of scientists led by Stanford University economist Rosamond Naylor concluded, in the Winter 2001 edition of *Issues in Ecology*, that present trends spell future trouble:

...it is clear that the growing aquaculture industry cannot continue to rely on finite stocks of wild-caught fish, many of which are already classified as fully exploited, overexploited, or depleted. Taking ever-increasing amounts of small fish from the oceans to expand the total supply of commercially valuable [farmed] fish would clearly be disastrous for marine ecosystems and, in the long term, for the aquaculture industry itself.⁵⁰

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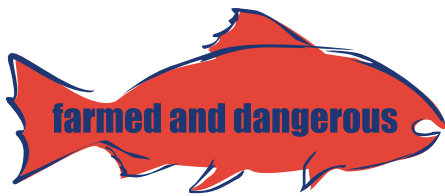
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Economic Impacts

Ironically, consuming farmed salmon does not take pressure off wild salmon species. Nor does salmon farming come without economic impacts. In both cases it can be argued that the opposite occurs.

In the late 1980s, about 10 million metric tons of a variety of farmed fish were produced worldwide. A decade later production had nearly tripled, yet the harvesting of wild fish remained unchanged.⁵¹

Considering the impacts listed above, the threat of fish farms to wild salmon puts the existing commercial salmon fishery, and other fisheries, at risk. Commercial fishing provides 15,000 jobs to the coastal residents of British Columbia and fish farms are a potential threat to traditional local economies.⁵²

Identifying Farmed Salmon

The salmon being consumed by Americans is probably farmed and potentially dangerous. Pollution, escapes, antibiotics, artificial colors, poor nutritional value, disease and parasites, are just some of the ways that fish farms are impacting the health of our ocean and, potentially, human health.

In order for consumers and chefs to avoid farmed salmon, they have to know when they are purchasing it. Unfortunately, it is not mandatory to label salmon as farmed or wild so it is easy to be misled.

However it is important to note that there is no commercial fishery for Atlantic salmon in North America. Therefore, all Atlantic salmon sold here, either fresh or frozen, is farmed.

Words like *fresh* lead many consumers to believe that the product they buy comes straight from the ocean. In fact, much of the fresh fish available in supermarkets comes from farms and carries with it all the baggage noted above. The best way to determine if salmon is farmed or wild is to ask.

Until such time as the salmon farming industry demonstrates that it no longer poses serious threats to human health and the environment, consumers should simply say no to farmed salmon.

The alternative to farmed salmon is sustainable seafood such as wild salmon or wild Pacific halibut.

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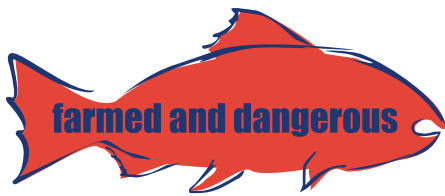
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Conclusion

The publisher of this report, the Coastal Alliance for Aquaculture Reform (CAAR), believes that fish farming can be done in a sustainable manner but that there is a long way to go before this happens. Until then, consumers and chefs are encouraged to not purchase or eat farmed salmon until it is safe for the ocean and safe for people.

According to CAAR, it will be safe when the fish farming industry:

- uses technology that eliminates the risks of disease transfer and fish escapes
- guarantees waste is not released into the ocean
- develops fish feed that doesn't deplete global fish stocks
- ensures that wildlife is not harmed as a result of fish farming
- labels their fish farmed so that consumers can make informed choices
- prohibits the use of genetically modified fish
- eliminates the use of antibiotics in fish farming
- ensures contaminants in farmed fish do not exceed safe levels
- stops locating fish farms in areas opposed by aboriginal groups or other local communities

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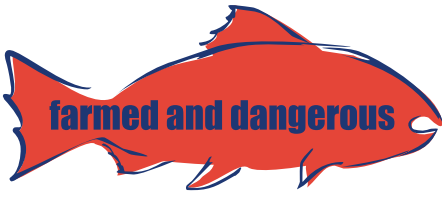
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Coastal Alliance For Aquaculture Reform

The Coastal Alliance for Aquaculture Reform (CAAR) is a coalition of First Nations, fishermen, and conservation groups working to protect wild salmon, coastal ecosystems, coastal communities and human health from destructive fish farming practices. Members of CAAR include BC Aboriginal Fisheries Commission, David Suzuki Foundation, Friends of Clayoquot Sound, Georgia Strait Alliance, Living Oceans Society, Musgamagw Tsawataineuk Tribal Council, Raincoast Conservation Society, Raincoast Research, T. Buck Suzuki Environmental Foundation, Watershed Watch Salmon Society.

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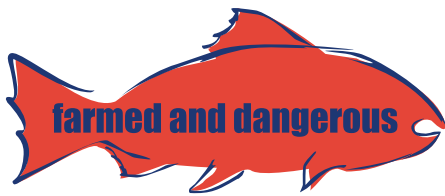
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Notes

- ¹ See Rural Enterprise and Alternative Agricultural Development Initiative web page at <http://www.siu.edu/~readi/aqua/factsheets/unitedstates.pdf>.
- ² National Fisheries Institute – April 2001
- ³ See Agriculture and Agri-food Canada's web site <http://ats.agr.ca/seafood/salmon-e.htm>.
- ⁴ See the BC Salmon Farmers Association web site at <http://www.salmonfarmers.org/industry/global.html>
- ⁵ See the BC Salmon Farmers Association web site at <http://www.salmonfarmers.org/industry/2000.html>.
- ⁶ Ibid.
- ⁷ See Agriculture and Agri-food Canada's web site <http://ats.agr.ca/seafood/salmon-e.htm>.
- ⁸ National survey of 1000 US adults conducted for SeaWeb January 28030 2000.
- ⁹ See Agriculture and Agri-food Canada's web site <http://ats.agr.ca/seafood/salmon-e.htm>.
- ¹⁰ See Rural Enterprise and Alternative Agricultural Development Initiative web page at <http://www.siu.edu/~readi/aqua/factsheets/unitedstates.pdf>.
- ¹¹ See the BC Salmon Farmers Association web site at <http://www.salmonfarmers.org/industry/global.html>
- ¹² Ibid.
- ¹³ Net Results, Northern Aquaculture Statistics 2001- The Year in Review, Price Waterhouse Coopers
- ¹⁴ National Fisheries Institute – April 2001
- ¹⁵ See Agriculture and Agri-food Canada's web site <http://ats.agr.ca/seafood/salmon-e.htm>.
- ¹⁶ See the BC Salmon Farmers Association web site at www.salmonfarmers.org/industry/2000.html.
- ¹⁷ Ibid.
- ¹⁸ See the BC Salmon Farmers Association web site at <http://www.salmonfarmers.org/industry/2000.html>.
- ¹⁹ See Agriculture and Agri-food Canada's web site <http://ats.agr.ca/seafood/salmon-e.htm>
- ²⁰ Howard M. Johnson & Associates, 2001.
- ²¹ Marine Harvest Canada's Commercial FinFish Aquaculture Management Plan for the Church House Farm Site, June 22, 2001.
- ²² Net Results, Northern Aquaculture Statistics 2001- The Year in Review, Price Waterhouse Coopers
- ²³ See the Canadian Bacterial Disease network web page at <http://www.nce.gc.ca/pubs/reports/9697/antieng.htm>
- ²⁴ Benbrook, Charles. Antibiotic Drug Use in U.S. Aquaculture. The Northwest Science and Environmental Policy Center. Feb. 2002.
- ²⁵ According to research published by Howard M. Johnson & Associates in 2001, Sysco is the top "broadline distributor" of salmon in the U.S. with just over 25 per cent of the market.
- ²⁶ See http://www.rittersysco.com/salmon_color.htm for more information on the Salmofan.
- ²⁷ Ibid.
- ²⁸ For more on the National Institute for Medical Research's writing on Infectious Salmon Anaemia see <http://www.nimr.mrc.ac.uk/MillHillEssays/1999/isa.htm>.
- ²⁹ Werring, John 2002. Implications of Holding Diseased Fish in Open Net-Pen Fish Farms and the Potential Impacts on Wild Susceptible Fish Species and Adjacent, Disease-Free Fish Farms, With Particular Reference to Infectious Hematopoietic Necrosis (IHN) Outbreaks at Marine Fish Farms in British Columbia. Unpublished report.

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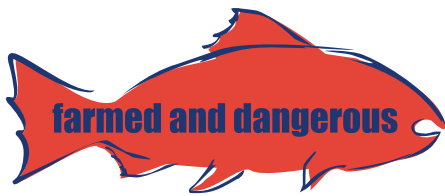
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- ³⁰ Benbrook, Charles. Antibiotic Drug Use in U.S. Aquaculture. The Northwest Science and Environmental Policy Center. Feb. 2002.
- ³¹ See Raincoast research web page at <http://www.raincoastresearch.org/current-events.htm>
- ³² For more on sea lice see <http://www.watershed-watch.org/ww/publications/SeaLice/SealicePR.html>.
- ³³ For more information on the 1997 FAO report, Towards safe and effective use of chemicals in coastal aquaculture, see <http://www.fao.org/docrep/meeting/003/w6435e.htm>.
- ³⁴ For more information on the US Food and Drug Administration's work on this topic visit its web site at http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl?salmon
- ³⁵ Gruger, E.H. Jr. et al., 1977. Introduction of hepatic aryl hydrocarbon hydroxylase in salmon exposed to petroleum dissolved in seawater and to petroleum and polychlorinated biphenyls, separate and together, in food. Bull. Environ. Contam. Toxicol. 17, 512-520. As quoted in M.D.L. Easton et al. Preliminary examination of contaminant loadings in farmed salmon, wild salmon and commercial salmon feed. Chemosphere 46 (2002) 1053-1074.
- ³⁶ M.D.L. Easton et al. Preliminary examination of contaminant loadings in farmed salmon, wild salmon and commercial salmon feed. Chemosphere 46 (2002) 1053-1074. The reports authors included M.D.L. Easton, with International EcoGen Inc. in North Vancouver, British Columbia, D. Lusznik, with Axy's Analytical Services in Sidney, British Columbia, and E. Von. der Geest, with Frontier GeoSciences Ltd. in Seattle, Washington.
- ³⁷ Ibid.
- ³⁸ As reported in Ecotoxicology and Environmental Safety 38, 71-84 (1997) and posted on the web site: <http://www.acsh.org/publications/reports/pcupdate.html>.
- ³⁹ M.D.L. Easton, op. cit.
- ⁴⁰ As reported in the Sunday Herald October 25 2002, see <http://www.sundayherald.com/28565> for more information.
- ⁴¹ EVS Environmental Consultants. Impacts of Freshwater and Marine Aquaculture on the Environment: Knowledge Gaps. Prepared for Fisheries and Oceans Canada. June 2000.
- ⁴² Ibid.
- ⁴³ Ibid.
- ⁴⁴ Naylor, R. et al. Effects of Aquaculture on World Fish Supplies. Issues in Ecology No. 8 (Winter 2001).
- ⁴⁵ Volpe, John. Super un-Natural: Atlantic Salmon in BC Waters. A report for the David Suzuki Foundation. 2001.
- ⁴⁶ Moring, J.R. Documentation of unaccounted-for losses of chinook salmon from saltwater cages. The Progressive Fish Culturist. 51 173-176. 1989. As quoted in Volpe, op. cit.
- ⁴⁷ Volpe, John. Super un-Natural: Atlantic Salmon in BC Waters. A report for the David Suzuki Foundation. 2001.
- ⁴⁸ Naylor, R. et al. Effects of Aquaculture on World Fish Supplies. Issues in Ecology No. 8 (Winter 2001).
- ⁴⁹ Ibid.
- ⁵⁰ Ibid.
- ⁵¹ Ibid.
- ⁵² See Fisheries and Oceans Canada web page for more information <http://www.pac.dfo-mpo.gc.ca/ops/fm/Commercial/index.htm>.

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