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on Media, Politics and Public Policy

Farmed versus wild salmon: Research review



(Wenceslas Hollar, c. 1600s. University of Toronto Library)

By [David Trilling](#)

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Evidenced by the rapidly growing salmon-farm industry, salmon is one of the world's most popular fish. The volume of farmed Atlantic salmon increased almost 1,000 percent between 1990 and 2015, according to United Nations [statistics](#); 75 percent of all the salmon we eat is farm-raised. Wild-caught salmon, meanwhile, has become a luxury; it's harder to find and generally more expensive.

Aquaculture is often hailed as a solution to feeding our growing planet. A 2017 study in [Nature Ecology & Evolution](#) estimates that fish farms could produce 15 billion tons of fish per year, over 100 times more seafood than humans currently eat. In the case of [Atlantic salmon](#) — the most popular farmed variety — these farms consist of large cages anchored offshore, primarily in Norway, Chile, Canada and Scotland. The sea cages are susceptible to parasites like sea lice and other predators, which pisciculturists often fight with pesticides and other chemicals.

A growing body of research —



accompanied by an explosion of media reports with the Harvard Kennedy School's Shorenstein Center and the Carnegie-Knight Initiative. Journalist's Resource is an open-access site that curates scholarly studies and reports.

environment. This brief overview will

identify trends in academic research



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There are many types of fish in the [Salmonidae](#) family: pink salmon, chinook, sockeye salmon, trout. Here we'll focus largely on the farmed Atlantic salmon and wild-caught salmon, which include several subspecies. All provide [important nutrients](#), such as vitamin B12, vitamin D and protein. Their omega-3 fatty acids (popularly known as "[good fats](#)") "reduce the risk of cardiovascular disease in adults and promote healthy vision and brain development in infants," [according](#) to the Washington state Department of Health.

But a [2016 paper](#) in *Nature* found that over the previous 10 years, the omega-3s in farmed salmon had fallen about 50 percent because farms were switching from feeding their salmon fishmeal (ground up bits of fish) and substituting plant-based sources such as soybeans. What's more, farmed Atlantic salmon has [three times](#) more saturated fat (the bad kind of fat) than wild Pacific salmon, according to the U.S. Department of Agriculture. (Most wild salmon sold in the United States is from the Pacific.)

Contaminants

Salmon are carnivores. They have a taste for shrimp and little sea creatures called plankton and other fish. But farmers cannot afford to give them such a rich diet. Instead, salmon farmers feed their stocks pellets made of [soybeans](#), corn, ground-up other fish ([fishmeal](#)) and, sometimes, [antibiotics](#) to fight disease.

Of course, the oceans are far from pristine and all fish have some contaminants. Researchers have found [mercury](#) in wild salmon, though whether the amount is higher in farmed or wild salmon remains unclear. Little bits of [plastic debris](#) are also a [growing concern](#), both in wild and farm-raised fish. (These plastics often contain [endocrine disruptors](#), which mimic sex hormones and confuse our bodies.) Here are a few other concerns:

Dioxins

In the mid-2000s, several prominent studies raised concerns about [dioxins](#) and other persistent environmental pollutants (POPs) in farmed salmon. Dioxins, [says](#) the World Health Organization, "can cause reproductive and developmental problems, damage the immune system, interfere with hormones and also cause cancer" in humans. Though they can occur naturally, dioxins are mainly industrial byproducts that accumulate in the food chain. Pointing to dioxins, a [2004 study](#) in *Science*

warned that “consumption of farmed Atlantic salmon may pose risks that detract from the beneficial effects of fish consumption,” singling out salmon farmed in Scotland and the Faroe Islands. Salmon farmed in Washington state and Chile, the paper said, had lower toxin levels. Later papers produced [similar](#) results.

But the industry may be changing. A [2015 study](#) found that the level of some contaminants, including dioxins, fell in salmon farmed in Norway between 1999 and 2011. More recently, a [2017 study](#) found higher dioxin levels in wild Atlantic salmon than in Norwegian-farmed Atlantic salmon.

PCBs

[Several studies](#) have also raised concerns about polychlorinated biphenyls, or PCBs, in both farmed and wild salmon. PCBs are “oily, synthetic chemicals that were used in electrical equipment and as additives to paint, plastics, and other products” until the 1970s, [according to](#) Harvard Medical School, which notes that they may cause cancer. PCBs are found in high levels in smaller fish, such as anchovies and herring, that are then fed to salmon. A [2016 study](#) found that changes to feed composition in Norwegian fish farms have resulted in falling PCB levels there.

“Red dye”

Salmon flesh is naturally red, at least in the wild, because salmon feed on krill and shrimp that contain a compound called astaxanthin (it also turns flamingos “pink”), which helps prevent cancer and aging. But farmed salmon generally don’t receive a natural source of astaxanthin in their diets. Their flesh is, instead, congenitally grey. Enter: the marketing department. Consumers like their salmon pink. So farmers feed their fish a synthesized astaxanthin — sometimes made from [corn](#) and sometimes from [petrochemicals](#) — to “pigment” the salmon. There are few studies on the long-term effect of synthetic astaxanthin.

Antibiotics

The use of antibiotics in agriculture for decades has provided ample evidence of resistance spreading from food into humans. A similar trend appears to be happening with farmed fish, too: “The recent growth of aquaculture is contributing to the development of the same resistance mechanisms also seen in agricultural production,” said a [2015 meta-analysis](#) published by the American Association of Pharmaceutical Scientists.

But outrage may have had some effect on the use of antibiotics in aquaculture, suggests this [2013 study](#) of farmed salmon production in British Columbia.

A newer concern, detailed in a [September 2017 paper](#) in *Environmental Science and Technology*, is how antibiotic-resistant genes are making their way from fishmeal into salmon farms and into ocean-borne bacteria that threatens humans.

Sea lice

Bite into a salmon fillet and the last thing you want to crunch is a pea-sized parasite. But sea lice have become an expensive problem for fish farmers in recent years, costing the Norwegian salmon industry alone almost half a billion dollars in 2011, according to a [2017 study](#).

One solution is pesticides. Emamectin benzoate is often used to treat sea lice, though the Scottish [government](#) has fought with a [local trade group](#) over its safety, with authorities [calling](#) for a sharp reduction in usage. Its effect, moreover, may be waning, [suggests](#) one study.

Pisciculturists also use pyrethroids. A [2017 study](#) in *Food and Chemical Toxicology* found pyrethroids in 100 percent of farmed salmon samples and, though at much lower levels, 50 percent of wild salmon samples. The authors note that the chemical was not found at high enough levels to pose a threat to humans, but remind readers that pyrethroids can have toxic effects in mammals.

Researchers are looking at [alternative](#) treatments. Some are developing lasers to target the lice; others are looking at farming salmon alongside mussels and scallops, which may eat larval sea lice.

Ecosystems and contaminating wild fish

Thousands of Atlantic salmon [escaped](#) a farm off Washington state in August 2017, introducing a non-native species into a delicate ecosystem and highlighting concerns about the [transfer](#) of parasites and diseases into the wild, where they cannot be treated. The *Proceedings of the National Academy of Sciences* has published [several studies](#) on how aquaculture may impact wild fish populations' natural defense mechanisms. A [forthcoming paper](#) in *Ecological Economics* assesses the economic impact of sea lice transmission from fish farms to wild salmon stocks in the Canadian Pacific.

What's next? Genetically modified salmon

In 2015 the Food and Drug Administration (FDA), a federal regulator, [approved](#) the sale for consumption of genetically modified salmon. The AquaAdvantage salmon, designed by Massachusetts-based [AquaBounty](#), grows twice as fast as Atlantic salmon, the company says, in land-locked tanks. But a debate over labeling has [delayed](#) sales in the U.S., with critics, including Alaska Senator Lisa Murkowski, [deriding](#) the AquaAdvantage salmon as "frankenfish." (Alaska is home to the [world's largest](#) wild salmon industry, which has been hurt by increased salmon farming.)

Other resources:

The United Nations [Food and Agriculture Organization](#) (FAO), the [U.S. Department of Agriculture](#) (USDA), the [Fish and Wildlife Service](#) at the Department of Interior, The National Oceanic and Atmospheric Administration's [National Marine Fisheries Service](#), [Canadian Ministry of Fisheries and Oceans](#).

Citations:



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