



FACTORY-FED FISH

HOW THE SOY INDUSTRY IS EXPANDING INTO THE SEA

About Food & Water Watch

Food & Water Watch works to ensure the food, water and fish we consume is safe, accessible and sustainable. So we can all enjoy and trust in what we eat and drink, we help people take charge of where their food comes from, keep clean, affordable, public tap water flowing freely to our homes, protect the environmental quality of oceans, force government to do its job protecting citizens, and educate about the importance of keeping shared resources under public control.

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Executive Summary

In 2010, the CEO of the American Soy Association reported that the organization has been closely monitoring progress in the development of offshore fish farming legislation and meeting with congressional staff on the topic.¹ In March 2011, it endorsed a controversial plan that would allow such fish farming or “aquaculture” in the Gulf of Mexico.² In September 2011, a press release was issued announcing a new marine fish farm project that would “revolutionize sustainable agriculture.”³ The source of the release? The Illinois Soybean Association.⁴

Why are trade associations for an agricultural commodity that is grown on land involved in policies and marketing that affect the use and stewardship of our oceans?

Seafood is one of our last wild food sources. Fish are a vital part of many people’s diets because of potential health benefits, fresh taste and the connection that fish give us to our oceans and coasts. Around half of the world’s seafood, however, now comes from farms rather than from the wild.⁵ In some of these farms, fish are grown in crowded, polluting cages and may be fattened on commercially prepared diets.⁶

Feed has been one of the aquaculture industry’s greatest challenges. Many of the species grown by the ocean finfish industry are highly valued carnivorous fish,⁷ which have typically been fed diets consisting of fishmeal and oil made from smaller, wild fish.⁸ The excessive use of wild fish to grow farmed fish can make aquaculture inefficient.⁹ Further, aquaculture has been accused of spurring the depletion of these

small fish, which is problematic not only for their own populations, but also to the other animals that rely on them for food.¹⁰

With little public scrutiny, soy has been hailed by some as a sustainable alternative to feed based on wild fish, thus supposedly solving some of the fish farming industry’s sustainability problems.¹¹

In this report, the first to address the relationship between the soy and factory fish farming industries, Food & Water Watch reveals that, while the soy industry stands to make large profits from the expansion of factory fish farming,¹² there is no guarantee that soy-based aquaculture feed can consistently produce healthy fish or promote ecological responsibility. In fact, by causing fish to produce excess waste,¹³ soy could lead to an even more polluting fish farming industry.

By supporting factory fish farming, the soy industry could not only help to expand an industry that degrades marine environments, threatens wild fish populations and damages coastal communities, it could also extend its own negative impacts. Already, industrial soy production has led to the prevalence of genetically modified crops on U.S. farmland¹⁴ and in consumer food products,¹⁵ caused massive deforestation in South America¹⁶ and displaced indigenous communities living in areas now used to grow soy.¹⁷

Rather than actually promoting sustainability in a developing industry, the involvement of soy associations in aquaculture could spur the growth of two industries that have extremely negative impacts on our land, our oceans and the communities that depend on them.

Findings

- If the soy industry succeeds in helping the aquaculture industry meet the annual production goals for marine finfish set by the federal government, and in getting a substantial portion of soybean meal included in the diets of these farmed fish, it could net an additional \$201 million each year; this doesn't include revenue it may earn from supplying soy as a feed ingredient for other types of fish farming in the United States or abroad.
- Although the soy industry claims that soy is an environmentally friendly alternative for fish feed, fish that are fed soy have been shown to produce more waste; thus, an increase in the amount of soy fed to fish in fish farms could increase the pollution load on the environment surrounding these farms.
- In open ocean fish farming, uneaten feed flows directly from the cage into the environment. Because 94 percent of the soy grown in the United States and much of the soy grown internationally is genetically modified, feeding soy to farmed fish means that genetically modified food will enter the environment and diets of other marine organisms.
- The rising use of soy in fish farming industries will mean that notorious agribusinesses like Monsanto, which has sponsored feed trials with genetically modified soy and salmon, and Cargill, which has an aquaculture feed division, will play a hand in seafood production.
- Deforestation to clear land for soy farms, which is already a problem in South America, could increase given the large quantity of soy that aquaculture would require to meet U.S. targets for finfish production.
- A growing number of researchers has noted that the potentially negative impacts of the increasing amount of soy in our diets are under-researched, and it is even less apparent what the long-term human health impacts could be of consuming soy secondarily, through fish and meat raised on soy.

Introduction

As you take your first bite of a freshly grilled fish fillet, you may be imagining the weathered boat that reeled it in or the seaside town where it was brought to shore. Perhaps you are contemplating the life it led in the seas and feeling content that you chose a healthier, fresher alternative to the mass-produced hamburger you considered ordering. But what you, along with most people, are probably not picturing is a deforested plantation in Argentina, the “dead zone” growing in the Gulf of Mexico or a U.S. soy industry executive signing off on a press release to promote factory fish farming.

Around half of the seafood consumed in the world is now produced through aquaculture, or fish farming.¹⁸ There are various types of fish farming, including production in coastal ponds, near-shore cages, or cages placed farther off the coast. Open ocean factory fish farming, also known as offshore aquaculture, is the practice of growing finfish in huge, often overcrowded cages miles off the coastline. This method of farming can be problematic for both the environment and the economy.

The waste – fecal matter, uneaten food and the chemicals or drugs used in these operations – flows directly into the ocean, where it has the potential to damage ecological equilibrium.¹⁹ Fish tend to escape from cages, and once in the wild they can interbreed with or outcompete wild fish, leading to decreased genetic viability and access to resources.²⁰ Even before escape, fish can spread diseases and parasites – which may be prevalent on some farms due to crowded conditions – to nearby wild fish.²¹ If farms damage wild populations, fishing communities and local coastal economies could be seriously threatened.

A variety of concerns also come into play with regard to feed for farmed fish. Farmed fish have generally been raised on feed that is formulated with fishmeal or oil made from small, wild fish.²² But now, both ecological and financial obstacles to this practice are arising.²³ As a result, the industry is seeking out potential alternative ingredients to feed farmed fish, and the soy industry has positioned itself as a viable

option. The American soy industry is powerful. It has been able to fund many studies on using soy for fish feed²⁴; it has built relationships in the aquaculture industry²⁵; and it has publicly supported federal policies in favor of offshore aquaculture.²⁶

Supporters of the soy-aquaculture alliance claim that using soy for fish feed could allow for a new, more environmentally friendly type of aquaculture.²⁷ Soy does not have the full array of nutrients demanded by fish, however²⁸; nor is it a natural fish food or substance in the marine environment. In fact, using soy may cause some fish farms to pollute more by producing extra waste.²⁹

Further, the negative ramifications of the soy industry on the environment and potentially on our health are reasons to resist the allure of soy as a “savior” of the aquaculture industry. The cultivation of soy is associated with agricultural runoff that is contributing to the dead zones in the Gulf of Mexico,³⁰ with deforestation in Latin America³¹ and with the displacement of many indigenous peoples from their homes and work.³²

As soy becomes increasingly ubiquitous in our diets – in processed foods and the meat from animals that have been raised on it³³ – we must ask what health impacts this high level of soy consumption may have on us. Scientists are beginning to question claims about the benefits of eating soy and to suggest that the plant-based estrogens that occur naturally in soy, many of which are endocrine disruptors, could potentially have adverse impacts.³⁴ In light of these concerns and unanswered questions, it is troubling to know that much of our fish – one of our last wild foods – could be fattened on this crop.

Why Should We Be Concerned?

People who are looking to fish for a lighter, healthier or more sustainable food option may have no idea that mega-industries from both land and sea are wielding influence on the types of seafood that we can consume.³⁵

U.S. policy and much of the research and development on aquaculture, however, is currently focused on the development of factory-style offshore fish farms and on soy as an ingredient in fish feed.³⁶ In 1999,

the U.S. Department of Commerce (DOC) released a policy calling for a quintupling of the total value of the nation’s annual aquaculture production by the year 2025 – from \$900 million a year to \$5 billion.³⁷ The policy listed DOC objectives including offsetting the seafood trade deficit, creating more jobs and bringing more high-quality seafood to U.S. consumers.³⁸

To completely offset the seafood trade deficit through open ocean aquaculture would require producing an almost unimaginable 200 million fish in offshore cages each year.³⁹ But the seafood deficit is more complicated than simply producing more fish. The United States exports 74 percent of the seafood caught or grown domestically and, in turn, imports 85 percent of the seafood available in the United States, primarily from Asian countries.⁴⁰ This problem could be better met by increasing import inspections in order to keep cheaper, lower-quality seafood out, and keeping more U.S.-produced seafood in the country.⁴¹

The likelihood that open ocean aquaculture would produce a significant number of jobs is also dubious if Kona Blue Water Farms, a prototypical open ocean farm in Hawai’i, is taken as a potential indicator of what an expanded U.S. industry might look like. Although the company once employed 49 people, it projected in 2009 that it would eventually employ only 14. The company said that staff reduction would be necessary to achieve profitability.⁴²

Further, a large-scale offshore fish farming industry could cause major environmental damage. Placing fish farms in the open ocean has been pitched as a way to minimize pollution by diluting or dispersing waste.⁴³ There is not enough information available yet to know what the long-term effects of these farms will be,⁴⁴ and research from Italy indicates that pollution from offshore farms “may affect the marine ecosystem well beyond the local scale.”⁴⁵ The ecosystems around farms could also be disrupted by chemicals and drugs used on farms, potentially leading to negative health consequences for people. One study found that the use of antimicrobials on fish farms can lead to the development of drug-resistant genes in fish pathogens – genes that could be transferred to bacteria that infect humans. This could make human illnesses more difficult to treat.⁴⁶

Despite indications that offshore fish farms are economically unfeasible, environmentally unsound and unlikely to provide major benefits to U.S. consumers or the regional economies that could most benefit from a revitalized seafood industry, the National Oceanic and Atmospheric Administration (NOAA) has hung on to it as a pet project and continued pushing for it.⁴⁷

Various environmental, consumer-interest and fishing groups, as well as many individual citizens, have raised concerns about NOAA's aquaculture policy.⁴⁸ But the agency has held on to allies in the soy industry, who are interested in new markets.

Fishy Traditions

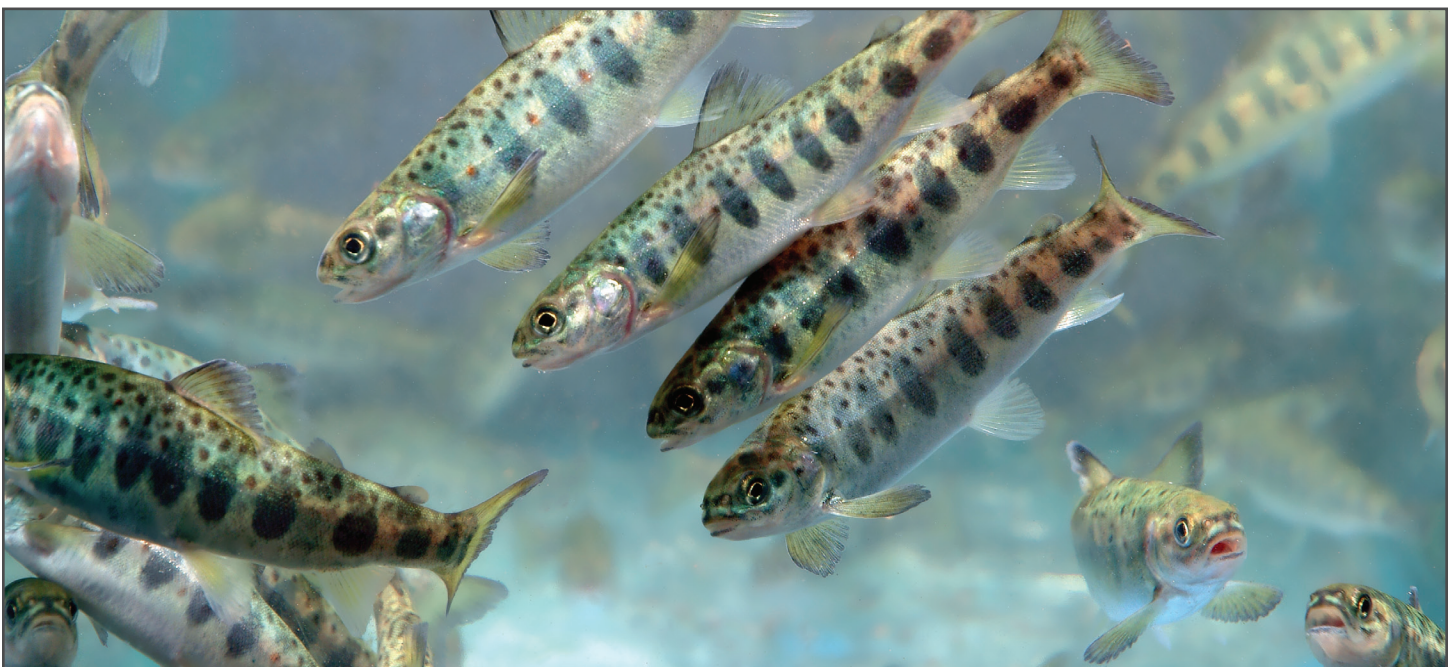
Feeding fish is one of the central challenges in the fish farming industry. To grow and produce marketable quantities for seafood, fish must be fed a sufficient diet. On farms, carnivorous finfish are typically fed commercial diets containing fishmeal and/or oil, which can be produced from smaller fish species or, in some cases, from fishermen's unwanted catch.⁴⁹

The use of fishmeal and oil in fish farming began in Europe and North America in the early 19th century as a way to utilize excess herring catch.⁵⁰ Unfortunately, what started as a creative way to utilize extra catch has now become a motivation to exploit small, forage fish populations and a burden on marine food

webs. On average, it takes one to two pounds of wild fish – processed into fishmeal or oil and included in commercial feed – to produce one pound of farmed fish (rates vary between species; for some it takes much more).⁵¹ Therefore, as aquaculture production increases, so does the demand for fishmeal and oil. Between 1995 and 2010, the aquaculture industry's use of fishmeal increased 75 percent, and its use of fish oil has risen by 62 percent.⁵²

The growing demand for fishmeal and oil does not appear to be without consequence. Some species of the small fish used to create these products are considered to be “fully exploited” or “overexploited,” which, according to the Food and Agriculture Organization of the United Nations, means that no “sustainable increases in catches from these species can be expected.”⁵³ Exploitation of these species can threaten not only their own populations, but also those of the predatory finfish,⁵⁴ marine birds and mammals that depend on them for survival.⁵⁵

In addition to these ecological problems from using increasing amounts of fishmeal and oil in the fish farming sector, financial impediments have arisen. As demand has gone up and supply has been squeezed, the price of fishmeal has risen sharply. It doubled between 1995 and 2010, and now constitutes the fish farming industry's largest production expense.⁵⁶



State of the Soy Industry

In light of the burden that factory fish farming places on the marine food web, any alternative plant-based fish feed may seem like a welcome alternative.

But before soy is accepted as the savior of the fish farming industry's sustainability, the state of the soy industry and soy production's impacts on the environment and our diet must be analyzed.

Who is lobbying for the soy industry?

The soy industry is well organized and represented in Washington, D.C. and other parts of the world.⁵⁷ The American Soybean Association (ASA) represents 32,000 soybean producers and is primarily concerned with policy development and influencing the legislative process in favor of soy growers.⁵⁸ In addition to the national association, 26 affiliated Soybean Associations represent various states or regions of the United States,⁵⁹ and the U.S. Soybean Export Council has nine international offices.⁶⁰

The ASA states in a policy resolution that it “supports expansion of the domestic aquaculture industry, including offshore aquaculture,” and “encourages federal funding for research that would optimize the use of soybean protein and oil in aquaculture feed.”⁶¹ It even has included a resolution that it “supports the recommendation of the Gulf Coast Fishery Management Council to allow offshore fish farms in the Gulf of Mexico,”⁶² referring to a controversial factory fish farming plan that was challenged in federal courts.⁶³

How much soy is genetically modified?

According to the 2007 Census of Agriculture, the number of soy farms in the United States, at 279,110, was second only to the number of corn farms.⁶⁴ In the 2008 Organic Survey, only 1,336 soybean farms were reported as certified organic.⁶⁵ The standards for certified organic food do not allow the use of genetically engineered crops.

If farms aren't producing for the organic market, there is a good chance that they are using genetically modified seeds, and that they are – whether intentionally or not – looped into the major transnational companies that control large portions of our current food system. While the seed industry once relied on universities

for most of its research and development, a few major chemical and pharmaceutical giants now dominate.⁶⁶

Between 1996 and 2007, Monsanto acquired more than a dozen smaller companies.⁶⁷ The company controlled approximately 62.5 percent of soybean seeds and seed trait licenses in the United States by 2010.⁶⁸ By 2009, because of this dominance, 93 to 94 percent of the soybeans produced in the United States are genetically modified according to Monsanto patents.⁶⁹ The increase in genetically engineered soybeans, which are resistant to Monsanto's herbicide Roundup, has led to an increase in herbicide use.⁷⁰

How much soy is in our food now?

From 1996 to 2009, the sales of foods containing soy increased from approximately \$1 billion to almost \$4.5 billion.⁷¹ Soybeans are a key ingredient in many foods that Americans eat every day, even though they may not know they are eating them. Soybeans are a key feed ingredient for cattle, hogs and chickens, and products known as “textured soy protein” and “soy protein isolate” are used in a wide variety of processed foods including hot dogs, hamburgers, baked goods, cereal, pasta and snack foods.⁷² Soybean oil is also commonly used to fry french fries at fast food restaurants.⁷³ According to various estimates, soy is found in 60 to 70 percent of our processed foods.⁷⁴



Beyond the soy that we consume directly, large amounts of soy are entering our food chain indirectly, through our consumption of meat from animals that have been raised on soy. An estimated 47 percent of the soy produced in the United States is consumed by livestock.⁷⁵

What Does Soy Have to Do With Fish Feed?

The U.S. soy industry is powerful and successful at expanding its markets. The American Soy Association testifies before and lobbies Congress,⁷⁶ and counts many successes in encouraging Congress and federal agencies to enact policies in its favor.⁷⁷

The soy industry's championing of soy diets for factory farmed fish

In 2002, the United Soybean Board and the Illinois, Indiana and Ohio State Boards funded the Soy in Aquaculture Initiative, with the goals of increasing the use of soy in fish feed and developing a program for international marketing of soy-based aquaculture feed.⁷⁸ Under this initiative, the industry has funded many research projects to investigate the inclusion of soybeans in diets for salmon, marine shrimp and marine finfish. These studies have been carried out by researchers at numerous U.S. universities, and with commercial farmers in Latin America, Asia and the Mediterranean.⁷⁹ In China alone, where the ASA began work in 1989,⁸⁰ the industry has successfully increased the volume of soy used annually in aquaculture feed from close to zero to approximately 6 million metric tons.⁸¹

Although the industry has also given some support to the inclusion of soy in the diets in more sustainable means of fish production, such as re-circulating land-based aquaculture, it has focused much effort on offshore cage-based aquaculture.⁸² In 2004, the Soy in Aquaculture Initiative began an Ocean Cage Technology Project to experiment with feeding soy to fish raised in offshore cage prototypes. For the next two years, trials were completed off the coast of Hainan, China. Although the study found that these fish, which were kept at densities of 9,600 fish per cage, performed as well on soy-based diets as on the fish meal-based control, the author concluded that growth rates were at least partially caused by the

effects of antibiotics that the fish were given after contracting a parasitic infection.⁸³

The industry appears eager to bring this type of offshore farming to the United States as well. The ASA gives support to policies that will encourage the development of a U.S. offshore aquaculture industry, and it has stated not merely that it “applauds” the release of a national aquaculture policy that includes the controversial plan for offshore aquaculture in the Gulf of Mexico, but also that it “will work toward [the policy’s] implementation.”⁸⁴

Further, both the Illinois Soybean Association (ISA) and Indiana Soybean Alliance are members of the Ocean Stewards Institute, a trade organization that advocates for the open ocean fish farming industry and provides testimony and public comments to Congress and federal agencies on policies regarding offshore aquaculture.⁸⁵ The Director of the ISA has been vocal in the organization’s support of NOAA’s aquaculture plans, stating: “We want to see aquaculture grow and flourish. Economic activity within the industry would be the best driver for economic opportunity for soybean farmers, too, and we hope to see that.”⁸⁶

The ISA has also worked closely with Kampachi Farms, formerly known as Kona Blue Water Farms, in Hawai’i. In August 2011, the ISA recognized Kampachi’s Neil Sims with an “Excellence in Market Development” award for research on soy inclusion in the diets of the company’s fish.⁸⁷ The following month, a press release listing the ISA as a source announced Kampachi’s new project to test offshore cage technologies in which fish would be fed a diet with significant portions of fishmeal and oil replaced by soy and other agricultural proteins.⁸⁸ In the past, the Kona Blue Water Farms has also listed the United Soy Board, Nebraska Soy Board and mega-agribusiness Monsanto as partners in its research.⁸⁹

The soy industry’s enthusiasm for expanding open ocean aquaculture is not surprising given the potential market it offers soybean producers. The federal government has estimated that marine finfish production could be raised to 590,000 tons annually by 2025.⁹⁰ The ISA has said that soy may be able to comprise 35 percent of fishes’ diets.⁹¹ If the federal

government's goal is reached, and each of these fish is fed on a 35 percent soy diet, the soy industry could stand to net an additional \$201 million each year by supplying feed for marine finfish farmed in the United States.⁹² This does not include additional revenue that could be made supplying soy-based feed for freshwater fish, like catfish, or "anadromous" fish like salmon and trout. Nor does it include earnings made by supplying soy-based feed to rapidly expanding aquaculture industries in other countries.⁹³

Cargill and Monsanto: Corporate interest in soy for farmed fish

It isn't only soybean trade associations that have a stake in supporting the development of open ocean fish farming. Other large corporate soy interests have a role to play, too. For instance, Monsanto supported a study on incorporating soy into fish diets by providing both genetically modified and non-genetically modified soy for the researchers to give salmon in feed trials.⁹⁴

Cargill, "the world's largest trader in agricultural commodities" and the third largest soybean-crushing firm,⁹⁵ is also extending its role in the fish feed business. Cargill created a team dedicated to aquaculture feed products in the 1990s.⁹⁶ In April 2001, Cargill acquired Agribrands International, Inc.⁹⁷ Combined, the two companies control 178 animal nutrition facilities/ factories.⁹⁸ Agribrands Purina, owned by Cargill, is now producing several lines of fish feed,⁹⁹ and in May 2004 Cargill acquired another fish feed production company, Burriss Mill.¹⁰⁰ According to the vice president of Cargill Animal Nutrition, "Aquaculture is the primary focus of Burriss Mill, and Cargill intends to increase its presence in this industry."¹⁰¹

Impacts of a Soy Diet on Fish and Their Environment

Despite the industry's best efforts, there are still serious limitations and challenges to feeding soy to farmed fish – which is not entirely surprising considering that it is not a food that fish would ever encounter naturally. Even the America Soybean Association has stated that, "despite years of research funded both by government and industry, there are still unidentified factors in plant feedstuffs that limit its use in diets for carnivorous species, including most marine species of commercial importance, as well as salmon and trout."¹⁰²

Issues of indigestibility and nutrient deficiency

Various inherent qualities of soybeans make them a less-than-ideal food source for fish. Although, as the ASA and researchers have said, there are unidentified soybean meal components limiting its use, there are also many difficulties that have been identified. A review article of studies on plant-based feeds for fish indicates that soy is not easily digestible for fish, a problem that can lead to reduced growth rates and inefficient feed use.¹⁰³

Soybeans contain lower levels of some of the nutrients that fish need, and excessive concentrations of others. They are lower than fishmeal in nine of the 10 essential amino acids, crude fat and ash.¹⁰⁴ Crude fat and ash can be made up for through supplementation, and amino acid concentrations could be increased by processing soybeans into soy protein concentrate or isolate, but these products are relatively expensive compared to fishmeal.¹⁰⁵



On the surplus side, soybeans contain high levels of carbohydrates, including two types that are indigestible for fish.¹⁰⁶ One of these types, non-starch polysaccharides (NSPs), interferes with the ability of fish to digest feed, thus making it difficult for the fish to obtain the energy they need.¹⁰⁷

Additionally, soybeans contain protease inhibitors, natural components that help make the bean more resistant to pests but that damage the enzyme balance in fish digestive tracts, also impeding their ability to digest and utilize soy.¹⁰⁸

To make things worse, when the fraction of soybeans in fish feed is too high, fish may develop an inflammation of the lower intestine called enteritis.¹⁰⁹ This inflammation may be sparked by immunological food intolerance – essentially, like some people, fish may be allergic to soy.¹¹⁰ Trout and salmon that are fed soy, for example, sometimes mimic the human allergic reaction, suffering skin lesions, alterations of the digestive tract and excessive mucus in the feces.¹¹¹

Potential impacts on the marine environment

Because certain characteristics of soy make it difficult for fish to digest, feeding fish soy and other plant-based feeds causes them to produce higher levels of excrement.¹¹² Even without unusually high waste production, waste flowing directly through fish farms into the ocean can damage the ecological equilibrium of the sea floor and cause habitat destruction or disrupt the ecology in the area.¹¹³

In addition, soybeans contain phytoestrogen, an estrogen-like chemical produced by plants. There is inadequate research on what the impacts are of introducing phytoestrogen to the marine environments around farms. Various research has confirmed the “[o]estrogenic activity” of soybeans in fish.¹¹⁴ In other words, the phytoestrogens in soybeans have been shown to produce physical effects on fish that are fed soy or injected with phytoestrogens in clinical settings.

There is insufficient evidence to understand how severe these effects can be, but one study found that when eels were fed one type of phytoestrogen present in soy, 11 times more eels became females than in the control group.¹¹⁵ There is inadequate research to know whether levels of soy feed being released

into the aquatic environment are harmful to the reproduction of native fish species in the surrounding areas. But this lack of understanding should give regulators and the open ocean aquaculture industry pause before the wholesale adoption of soy diets for farmed fish.

Déjà vu?

Fish are certainly not the first animal to be fed an unnatural diet on factory farms. Ninety-eight percent of soybean meal in the United States goes to livestock feed,¹¹⁶ and either corn, soybeans or a combination is the main ingredient of most feed mixtures for factory farmed cows, chickens and pigs.¹¹⁷ Soy and corn became cheap feed options for livestock operations after a series of policy changes culminating with the 1996 Farm Bill, which marked the end of policies designed to stabilize farm prices.¹¹⁸ Change in farm policy eliminated requirements that some land be kept fallow and resulted in large increases in the amounts of soy and corn produced, thus leading to price decreases for these crops.¹¹⁹

Rather than addressing the root cause of this problem in the 1996 Farm Bill, Congress issued emergency payments for farmers to offset their losses.¹²⁰ These subsidies have continued to encourage overproduction, and livestock producers can often buy corn and soy feed below the cost of production.¹²¹ Unfortunately, these farm animals aren't naturally suited to corn and soy diets. Cows, for instance, are ruminants – their four-part stomachs are made specifically to digest grass. When they eat other foods, their gut health may be impaired. Studies show that artificial diets increase the amount of time that *E. coli* strains live on in the manure of cows, which can be passed on to the meat itself.¹²² Increased antibiotic use to counter *E. coli* contributes to the development antibiotic-resistant bacteria strains.¹²³

Impacts on Consumers

Evidence indicates that soy-based aquaculture feeds may not be the best option for the fish that eat them or the marine environment into which they are released. But what about the people who eat the fish?

Unfortunately, there are lots of unanswered questions about both eating soy in general, and eating fish raised on soy. However, several potential health problems associated with soy consumption, as well as concerns about the nutrient profile of fish that are fed soy, indicate that we should proceed with caution.

Missing omega-3s

Consumers increasingly prefer food products that are high in omega-3 fatty acids.¹²⁴ Omega-3 fatty acids are thought to promote human health and lessen the likelihood of various diseases, including coronary heart disease.¹²⁵ There are three types of omega-3 fatty acids, which fall into two general categories. One, α -linolenic acid (ALA), is a plant-based fatty acid, and the other two, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are marine fatty acids. We get these by consuming fish, which become enriched with them by eating algae.¹²⁶ The American Heart Association recommends that adults eat fish at least twice a week in order to gain the positive benefits of EPA and DHA, which it says are more potent than ALA.¹²⁷

Unfortunately, substituting the fish oil used in feed for farmed fish with terrestrial plant oils, like soybean, reduces the concentration of these omega-3s in feed.¹²⁸ If fish farmers do not want to produce a final product low in omega-3s, they must switch their fish off of a soy diet and on to a high-fish oil diet shortly before harvest.¹²⁹ Doing so, however, means that the industry will continue to consume small, wild fish – the very problem that soy use was intended to avoid. Researchers have also explored genetically engineering soy and other plants to increase the amount of omega-3s in them.¹³⁰ This would be a troubling proposition, however, for those who turn to fish for a more natural, sustainable food product, and it may bring other unintended consequences.

General impacts of soy consumption

Perhaps more complicated is the issue of increasing soy in human diets. Although eating fish that are fed soy is a less direct way to consume soybeans than eating soy products or snacks made with soybean oil, it needs to be questioned whether some components of soy – such as the phytoestrogens – could also be passed on to human consumers through their consumption of fish.

Soy is often associated with healthy eating.¹³¹ A central component in some Asian diets, such as the Japanese cuisine, soy has been associated with the historically lower rates of cardiovascular disease, menopausal symptoms, breast cancer, diabetes and obesity in these populations than in Western populations.¹³² However, some researchers are calling this linkage into question,¹³³ or suggesting that these low rates may be caused by different factors.¹³⁴

Moreover, the soy in these diets may not be equivalent to the soy now present in the American diet due to differing levels of isoflavones – organic compounds that have been associated with some of the potentially negative impacts of soy.¹³⁵ New Zealand-based toxicologist Dr. Mike Fitzpatrick has



pointed out that the soy in traditional Asian diets is typically fermented, a process that lowers its levels of isoflavones.¹³⁶ Additionally, the strains of soybeans grown in Asia are lower in isoflavones even before fermentation than those grown in North America, which have been bred to be higher in isoflavones to make them more pest resistant.¹³⁷

The debate over soy's impacts on human health has been contentious and complicated. Although researchers have connected consumption of the phytoestrogens in soy to potential lowered risk of osteoporosis, heart disease and breast cancer, scientists Heather Patisaul and Wendy Jefferson have pointed out that phytoestrogens are also endocrine disruptors with a range of potential negative impacts that likely depend on a person's age and health status.¹³⁸ They state: "While the potentially beneficial effects of phytoestrogen consumption have been eagerly pursued, and frequently overstated, the potentially adverse effects of these compounds are likely underappreciated."¹³⁹

In addition, the jury is still out on whether the phytoestrogens in soy are helpful or harmful in protecting against breast cancer. Although many studies have been conducted in both humans and animals, the results have been conflicting.¹⁴⁰ For instance, a meta-analysis supported by the Susan G. Komen Breast Cancer Foundation found that the risk of developing breast cancer decreased as soy intake increased among Asian women, but that "soy intake was unrelated to breast cancer risk in studies conducted in Western populations."¹⁴¹

Another study that looked at the effects of soy consumption on pre-existing cancers suggested that highly processed soy, like the sort commonly consumed in the United States, may be harmful to post-menopausal women with breast cancer. The study found that mice that were fed minimally processed soy flour, like that typically consumed in Asian diets, had no tumor growth, whereas tumors in mice that were fed more processed forms of soy grew. The study concluded that the beneficial impacts of soy may be eliminated during certain types of processing, and cautioned against the common practice of natural hormone replacement therapy via

increased soy intake for menopausal women, particularly those with breast cancer.¹⁴²

There is also evidence that phytoestrogens could potentially be harmful for males. A study geared at determining the negative impacts of feeding soy formula to male human infants found that feeding soy formula to monkeys reduced the typical neonatal rise in testosterone expected at a certain age, an effect that they expected would be equal, or perhaps more marked, in human infants under the same conditions. Although researchers are not sure what the impacts of suppressing this neonatal rise in testosterone are, they write that "it would seem prudent to avoid feeding infants with SFM [soy formula milk] whenever alternatives are possible."¹⁴³ Another researcher has suggested that the isoflavones present in soy reduce sperm's mobility, thus having a great impact on male fertility.¹⁴⁴

While the potential health impacts of soy consumption are yet to be fully understood, it appears that, as Patisaul and Jefferson state, "moderation is likely key."¹⁴⁵

Environmental and Human Rights Infringements in Soy Production

Rather than provide a sustainable feed for farmed fish, soy-based feed simply shifts the burden and potential risks onto other ecosystems. Ninety-four percent of soy grown in the United States is genetically modified,¹⁴⁶ as is the majority grown in Argentina and Brazil.¹⁴⁷ Monsanto introduced genetically engineered soy in the mid 1990s. The company's Roundup Ready soy plants are designed to be resistant to Roundup, a herbicide that the company also sells, so that farmers can chemically control weeds without damaging crops.¹⁴⁸ Increased use of herbicide has been shown to lead to herbicide-resistant weeds, which can in turn lead to even heavier herbicide use in a vicious cycle. This intense chemical application raises concerns about potential environmental and human health impacts.¹⁴⁹

As the soy industry has expanded into South America, most notably in Argentina and Brazil, but also in Paraguay, Uruguay and Bolivia,¹⁵⁰ it has led to deforestation and corresponding reduction of tropical

biodiversity and soil erosion.¹⁵¹ An estimated 10,000 hectares (24,711 acres) of forest is lost in Argentina each year to expanded soy production.¹⁵² This is damaging not only to plants and animals,¹⁵³ but also to human populations. As soy farms take over, indigenous people have been pushed from their homeland.¹⁵⁴ An estimated 300,000 peasant and indigenous families have been displaced in the last decade as a result of soy expansion in Argentina, and four out of five previously existing farming jobs have been lost.

In response, groups of small farmers and peasants, such as La Via Campesina and the National Indigenous Campesino Movement of Argentina, have organized against the monoculture-based soy industry.¹⁵⁵ Even more shocking, there have been documented instances of forced labor on soy plantations in Brazil. In 2004, the government created a registry of agricultural firms found to have used slavery.¹⁵⁶ According to an October 2011 search of the government's database, six soy operations have been cited for enslaving a total of 241 workers.¹⁵⁷

If the U.S. government's estimation that the country can increase marine finfish production to 590,000 tons a year by 2025 is achieved, and an average of 35 percent of soy is included in the fish's diets, as the Illinois Soy Association says is possible,¹⁵⁸ then the industry would need to utilize an entire 456,292 tons of harvested soy a year to feed these fish. It would take approximately 172,838 hectares of land, or around 427,000 football fields, to produce this much additional soy each year.¹⁵⁹ This is over two times the size of greater New York City,¹⁶⁰ and is 1.73 times the amount of forest already lost to soybean cultivation in Argentina each year.¹⁶¹ It is unclear what land would be used to meet this growing need – will it be found through additional tropical deforestation?

Soy production in South America can also be problematic for national food security. Even the Argentine government has blamed the “soybean economy” for diverting agricultural capacity toward soy exports, which have forced the country to import crops that it used to produce domestically.¹⁶²

The environmental effects of soybean production are by no means exclusive to South America. In



Illinois, Iowa, Ohio and southwest Minnesota, underground drainage pipes are used to make the land dry enough to plant corn and soybeans. The water that these pipes collect from farms, which is mixed with nitrogen fertilizers, drains into tributaries that eventually feed into the Gulf of Mexico.¹⁶³

The nitrogen fertilizer from these pipes is possibly the largest source of nutrient pollution in the Gulf.¹⁶⁴ These pollutants feed harmful algae blooms that take oxygen out of the water, and can cause fish, shrimp, crabs and other marine life to suffocate if they cannot swim quickly enough to a more oxygen-rich area of the water. These oxygen-depleted areas are known as “dead zones,” and in 2011 the dead zone in the Gulf of Mexico equaled and likely exceeded the size of New Jersey.¹⁶⁵ If aquaculture were to create a demand for much more soy, it could potentially lead to more harmful runoff from soy farms, and more destruction of wild fish.

Other Alternatives

There are other options for working toward seafood sustainability. On the most basic level, consumers can restrict their consumption to wild seafood from well-managed fisheries or sustainable farming operations. Research, government funding and private entrepreneurial efforts can be shifted away from open ocean factory fish farming and toward other alternatives, such as land-based recirculating fish farms. Because conditions in these closed-loop systems can be carefully controlled, growth rates can be higher in

closed-containment fish farms than in others.¹⁶⁶ Plus, fish convert feed efficiently when the water they are in is at the optimum temperature,¹⁶⁷ so the ability to control temperature in recirculating systems could potentially lead to lower overall feed requirements. Instead of being fed wild fish or soy, these fish could be fed alternative ingredients such as algae.

Because algae are rich in omega-3s and oils¹⁶⁸ and are produced in marine environments, they seem likely to be a better option for fish feed than soy. Whereas soybeans contain only 18 percent oil, algae contain as much as 70 percent by weight.¹⁶⁹ They can also be efficient to grow, with some species able to double their population in only 24 hours.¹⁷⁰ Several researchers around the world, including a team at the University of Maryland, which also houses a demonstration closed-loop recirculating fish farm, have been studying possibilities for using algae as fish feed.¹⁷¹ For algae to be a good option, however, water use will need to be monitored and genetically engineered varieties avoided.

Conclusion

The soy industry's involvement in aquaculture is a tale of how far-reaching the influence of a large, powerful, well-organized agribusiness can be.

Although soy is an unexpected and unnatural food for fish to eat, the research and outreach funded by the soy industry has propelled it to the forefront of alternative feed research in the aquaculture industry. Because of the widespread concern about fish farming's reliance on small, wild fish for feed, the industry has been able to position soybeans as an answer to aquaculture's sustainability problems.

Unfortunately, however, feeding soy to fish is far from sustainable. Increasing the global demand for soy through the aquaculture industry could exacerbate the negative ramifications that already exist, including pollution to the Gulf of Mexico, deforestation in South America, displacement of indigenous peoples, and an increase in genetically modified crops. It also raises questions about the rising ubiquity of soy in the food chain and concerns about potential human health impacts.

Even if soy alleviates the feed problem in aquaculture, open ocean factory fish farming would still be plagued with the burden of potentially spreading disease to wild fish, threatening many types of marine mammals, birds and fish, and disrupting coastal fishing communities. Even worse, soy feed could increase some of the pollution impacts of ocean fish farming by increasing the amount of waste that fish produce.





Rather than a partnership for innovation, the relationship between the soy and aquaculture industries is one that could spread damage on both land and sea.

Recommendations

Consumers:

- Choose local or domestic seafood that is from sustainable, wild fisheries or from conscientious land-based farms, particularly closed, recirculating farms. See Food & Water Watch’s Smart Seafood Guide for more tips on seafood that is safe for you, your environment and the communities that bring it to you.
- Oppose federal agencies’ efforts to allow commercial fish farming operations in federal waters.

Policymakers:

- Support research and efforts to sustainably manage wild fish stocks, and explore other methods of aquaculture, such as land-based recirculating systems.
- Shift research funded by the NOAA-USDA alternative feeds initiative from soy to algae.
- Support bills to prohibit federal agencies from recklessly expanding commercial fish farming operations into federal waters.
- Shift U.S. farm policy to help stop overproduction of commodity crops like soy by restoring commonsense policies to balance crop supplies with consumption and reduce commodity price volatility.

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