The Dangers of Industrial Ocean Fish Farming

Friends of the Earth

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"Fish schooling in aquarium tunnel", 2010

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Photo: Fish harvest. Credit: Shutterstock

I. Introduction

The seafood business is booming. It comprises over 16% of the protein we eat worldwide, the majority of which is farmed.[1] In the last 30 years, global fish farm production increased from 5 million to 63 million tons.[2] Aquaculture recently surpassed global beef production,[3] and by 2030, it is projected that over 60% of the world's seafood will be farmed.[4]

Many people opt for seafood over terrestrially-raised meat because they want better nutrition, a more humane option, and a smaller environmental impact. However, not all seafood is created equal. Much of our available seafood has been mass-raised and harvested in industrial ocean farms, pumped with agricultural drugs and pesticides, and provided feed comprised of overfished species, GMOs, and filler ingredients such as corn. In other words, the salmon on your plate could very well be unhealthy, inhumane, and unsustainable.

Thankfully not all seafood production methods are bad, and you can continue to feel good about the fish you eat. There are many sustainable ways to produce seafood, including land-based recirculating farms, ocean-based farms utilizing entire water columns, and even some wild-caught fisheries.

We want you to know your seafood's story. Read our report to find out all you need to know to make a healthy, informed choice that is good for you and for the environment.

II. What is Industrial Ocean Fish Farming?

Simply put, aquaculture is the farming of underwater organisms, like mollusks, crustaceans, and fish. There are many forms and methods of aquaculture that occur around the world in ponds, rivers, oceans, estuaries, and even land-based facilities.

Aquaculture is no stranger in the United States. Although aquaculture production initially had the purpose of enhancing sportfishing opportunities, farmers started raising catfish in ponds and harvesting shellfish from enhanced open-water beds in the early 1900s.[5]

However, a new form of aquaculture has recently surged in popularity and is beginning to take over our oceans. Industrial ocean fish farming – sometimes referred to as open ocean or marine aquaculture – is the mass breeding, rearing, and harvesting of finfish in areas of the ocean in underwater nets, pods and cages. This farming technique is extremely risky and fraught with environmental and socio-economic havoc. These CAFOs of the sea impose significant harm on public health, the environment, and the people, industries, and economies which rely on the ocean and its many resources.

Industrial ocean fish farming techniques:

Industrial ocean fish farms are inherently unsustainable and cause extreme harm in countless ways. As with the mass production characteristic of most corporate-controlled industries, costs and expenses are cut to the absolute minimum with an eye toward maximum profitability. Unfortunately, the only beneficiary of this business model is the corporation, and the victims include the farmed fish, the ocean ecosystem and its inhabitants, the economy, and consumers.

These facilities are essentially underwater factory farms, but with even less pollution controls. They are used to farm massive populations of finfish in net pens, pods, and cages that provide no real barrier between the farm and the ocean. This allows for free exchange between the net pens and the open water, including direct deposits of untreated fish waste, diseases and parasites, excess feed, agricultural drug residues, chemicals and anti-foulants from the farm's infrastructure, and oftentimes spills and escapes of farmed fish – all dumped right into the surrounding environment. This open exchange also attracts predators and other wildlife to congregate around the farms, which then get entangled in nets, harassed by acoustic deterrents, and hunted.

Typically, the farmed fish and enclosures are fully submerged so that workers must dive to access them directly, with numerous platforms and walkways above the surface for workers to access the remainder of the infrastructure – much like an oil rig. There are oftentimes no barriers between the elements and the farm, such that workers are directly impacted by severe ocean conditions, including strong wind and wave activity from all directions, short and steep wave patterns, and strong currents.

The farms are usually anchored to the ocean floor, held up by buoys and other flotation mechanisms, and connected by walkways, tubing, ropes, or other surface-level infrastructure. However, this model is fallible and structures can easily float away from their positions and nets can become disconnected due to tides, winds, and other elements. Over time, this shifting stresses the mooring and weakens the infrastructure, which creates a heightened risk of damage to the farm and often leads to releasing additional debris, trapping and harming wildlife, and spilling farmed fish into the ocean.

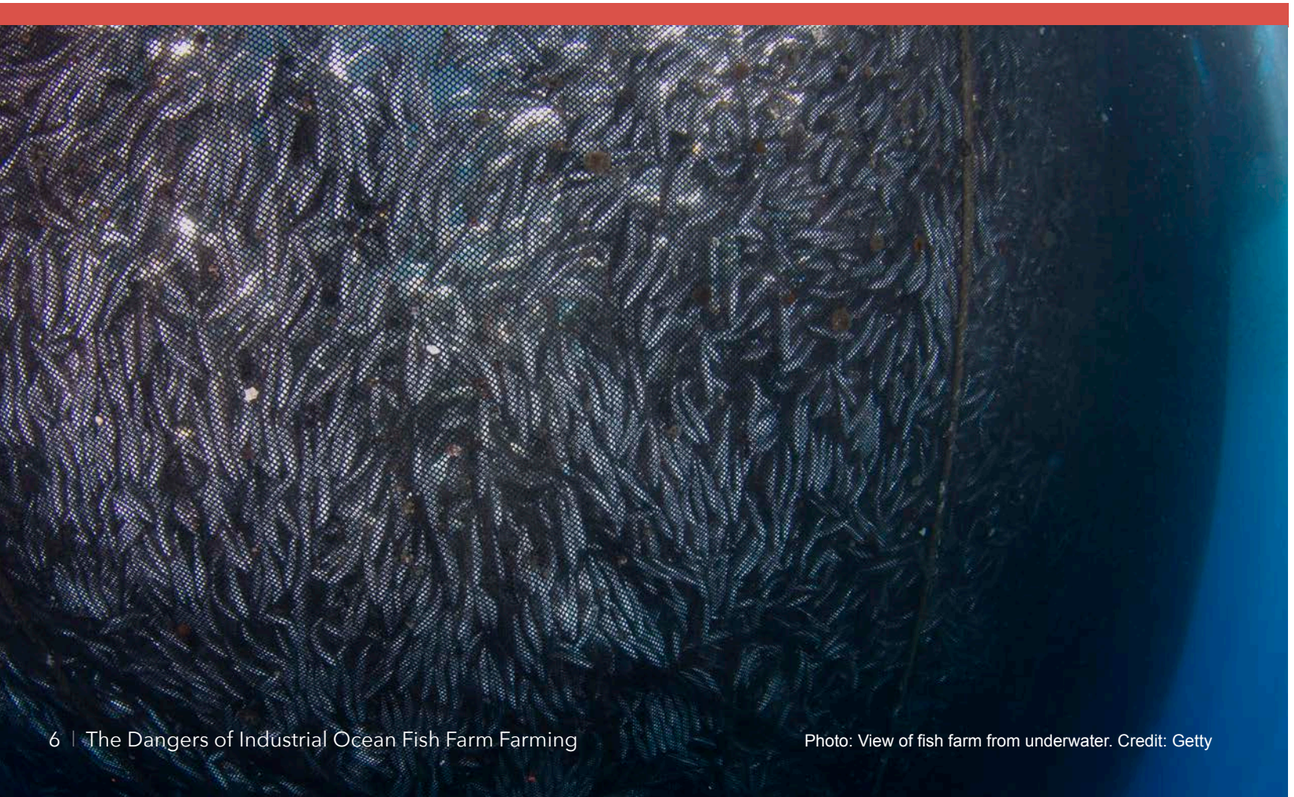

Photo: View of fish farm from underwater. Credit: Getty

III. Industrial Finfish Farming Burdens the Environment and Society.

Industrial ocean fish farming is extremely problematic for public health, the economy, and the environment. Continuing to allow mega-corporations to factory farm seafood in our public waterways will only continue to benefit corporations and force us to bear its burdens.

Underwater factory farms significantly harm the ocean ecosystem. From the release of untreated fish waste and excess nutrients to the overuse of antibiotics and endangerment of marine life, industrial ocean fish farms are nothing but bad news for our oceans. The ocean ecosystem is interconnected such that any impact to one species has a rippling effect on a number of other species. To that end, the significant impact that industrial ocean fish farms has on even the smallest fish no doubt takes a toll on the nearly extinct orca whale.[6]

Pests, disease, and agricultural drugs: It is no secret that a massive population of animals in a closed space will breed pests and disease. Farmed fish in net pens are hosts to a variety of pests and diseases, including sea lice, infectious salmon anemia, and Piscine Reovirus, just to name a few. Rather than solve the root of the problem – that is, by sustainably farming animals in more humane conditions – mega-farms simply add to the problem by using pesticides and a pharmacopeia of agricultural drugs in an attempt to control pests and disease.

A number of industrial ocean fish farms have embraced pesticides to ward off sea lice and other parasites. Not only do these dangerous chemicals kill off sea lice, but also everything living nearby the farm. It was recently uncovered that the Scottish government likely colluded with the pharmaceutical company Merck to cover-up the "widespread damage to wildlife" from a sea lice pesticide.[7] The fish farm chemical, known as emamectin and marketed as Slice, was found to have contaminated at least 45 Scotland lochs, causing "substantial, wide-scale reductions" in crabs, lobsters and other crustaceans.[8] Yet Scottish fish farms continue their widespread use of the drug and allegedly collude with the government to prevent heightened regulations for the fatal substance.

"It is no secret that a massive population of animals in a closed space will breed pests and disease. Farmed fish in net pens are hosts to a variety of pests and diseases, including sea lice, infectious salmon anemia, and Piscine Reovirus, just to name a few.

Industrially farmed fish contains an alarming amount of other toxins that have horrific health risks when consumed. A 2004 study comparing two metric tons of farmed and wild salmon purchased from stores around the world showed that farmed fish contained consistently and significantly higher concentrations of PCBs (which can cause a slew of side effects ranging from cancer to reproductive problems), dioxins (highly toxic chemicals causing cancer, developmental and reproductive issues), and the widely banned insecticides toxaphene and dieldrin (which generate deleterious reproductive effects).[9] A recent test of farmed salmon from U.S. stores support this finding: on average, the farmed salmon tested by the Environmental Working Group contained 16 times more dioxin-like PCBs than amounts detected in wild salmon, four times the levels detected in beef, and 3.4 times the levels found in other seafood.[10]

Bacteria found in the environment develop antimicrobial resistance through contact with already resistant bacteria, antibiotics, and disinfectant agents released by human activity. People and livestock are then exposed to this resistance through food, water, and air.[11] The World Health Organization recently published a study that found an increased presence of antimicrobial resistance in farmed fish due to heavy use of antibiotics.[12] The WHO has classified antimicrobial resistance as one of the major threats for the human population of the twenty-first century,[13] and the United Nations recently reported the same concerns.[14] Industrial ocean fish farming is significantly contributing to this public health crisis. In Chile alone, more antibiotics are used by industrial ocean fish farms than any other player in the meat industry.[15]

Photo: Tilapia pens in Laguna de Bay are choked by an algal bloom they helped create. Credit: National Geographic Creative via Alamy Stock Photo

Industrially farmed animals are sometimes given antibiotics to treat and prevent disease, but often misused for growth acceleration. For farmed fish, antibiotics not only leave residues in your seafood, but they also leach into the ocean, contaminating nearby water and marine life. In fact, up to 75% of antibiotics used by the industrial ocean fish farming industry are directly absorbed into the surrounding environment.[16]

Massive farmed fish spills: Industrial ocean fish farm containments are inherently fallible due to their use of materials that allow free-exchange with the ocean and being sited in locations with harsh marine conditions. One of the most likely events to occur when a net pen ruptures is the escape of farmed fish in massive numbers. Each single enclosure within a multi-unit farm can carry hundreds of thousands of farmed fish.[17]

Even the smallest rupture can allow for these fish to begin escaping, and oftentimes extreme weather conditions that caused the rupture prevent workers from accessing the facility to mitigate harm and make repairs. Therefore, farmed fish continue to escape into the surrounding environment until the pen is repaired, or what is more likely, until it is empty.

When a farmed fish escapes, it immediately increases competition for the limited space and resources that native marine life – including wild fish and other species – need to feed, live, and reproduce. Studies show that farmed fish typically outgrow and outcompete their wild counterparts.[18] Because many farms raise non-native fish, like Atlantic salmon farms in the Pacific Northwest, an escape carries with it the risk of spreading non-native diseases and pests. Farmed fish, which are genetically bred to grow bigger and faster, pose threats of genetic degradation and reproduction issues to wild species in the event of cross-breeding.[19] There is also the risk that escaped, farmed salmon will prey on juvenile salmon and smaller, forage fish, further stressing and decreasing populations of wild stocks.

The release of non-native species is considered a biological pollutant, threatening the environment much like the release of chemicals, toxins, and other contaminants.[20] Therefore, the release of these invasive fish species into public water may be a violation of state and federal environmental and clean water laws.[21]

The industry claims that an escaped farmed fish in the wild would behave much like an escaped land-based farm animal, or "dairy cows getting lost in the Serengeti."[22]

These farmed animals have been described by the industry as sluggish and unable to compete in the wild. These claims are wholly incorrect. Months after their August 2017 escape from a Washington State facility, farmed salmon are being found alive and well hundreds of miles from the farm.[23] In fact, a three-year study conducted on Vancouver Island in 2014 estimated that over half of 41 rivers surveyed had escaped Atlantic salmon adults and juveniles, showing successful reproduction of farmed fish in the wild.[24]

The industry's comparison of fugitive farmed fish to dairy cows simply misses the mark. The terrain surrounding a land-based farm is much more diverse than that which surrounds a net pen operation – with far more fences and barriers between the farm and surrounding land. For starters, the farmed dairy cow would likely have to cross roads, jump fences, and find a field or other land for feeding. No doubt, these hurdles would impact any creature's energy level and ability to compete successfully. However, with a farmed fish, the escape of a net pen places it directly into the primary competition area, among other marine life. Without having to force additional energy to seek out faraway and difficult-to-reach feeding and spawning areas, a farmed fish could evenly compete with its wild counterparts. Indeed, an analysis of the stomach contents of both wild, native and escaped, farmed salmon species indicated that farmed salmon species adapt well to "wild" life in the ocean.[25] And research in another study strongly suggests that farmed Atlantic salmon are "naturally reproducing" and "may be capable of colonizing and persisting" in the wild.[26]

On August 19, 2017, over 263,000 farmed Atlantic salmon escaped from an industrial net pen facility in Puget Sound.[27] This facility was discovered to have had structural defects months prior to the spill, which were left neglected by owner Cooke Aquaculture until the entire facility ruptured.[28] Cooke first attempted to outrageously blame the rupture on a recent solar eclipse, but later reneged when news broke of its reckless maintenance practices.[29] A state investigation also revealed that Cooke misrepresented critical details about the spill - from the seriousness and cause of the spill, to the number of fish released to Puget Sound.[30] Further, despite Cooke's claims that the farmed fish will not survive in the wild, as of publishing this report, many of the farmed fish are still thriving and swimming free – some have even been documented as far north as Vancouver Island and the west end of the Strait of Juan de Fuca and as far south as Tacoma, at least as far as 100 miles from the farm.[31] Some wild-caught fishers in Washington are actually reporting catches of more farmed, Atlantic

salmon on their trips than the fish they actually seek.[32] Pollution, discharge and eutrophication: Industrial ocean fish farms are sited in public waterways and take advantage of being able to directly release into the ocean an alarming amount of chemicals, untreated fish waste, pathogens, and excess nutrients, which directly harms our oceans.

Studies show that an industrial ocean fish farm operation of 200,000 salmon will release nitrogen equivalent to the untreated sewage of nearly 20,000 people, phosphorus equivalent to nearly 27,000 people, and fecal matter equivalent to nearly 63,000 people.[33] In 2000, a study of the Scottish net pen industry found that its salmon farms produced excess nitrogen and phosphorous equivalent to the untreated sewage of 3.2 and 9.4 million people, respectively.[34] The industry has undoubtedly grown substantially in the past 17 years, thus increasing these numbers for Scotland and the surrounding ocean environment.

When excess nutrients like these are added to water, a process called eutrophication occurs. This is the process where water becomes too enriched, causing environmental degradation and effects such as low dissolved oxygen levels, murky water, death of seagrasses and corals, fish kills, low- or no-oxygen "dead zones," and harmful algal blooms.[35] The EPA has acknowledged that industrial ocean fish farms (which it calls "concentrated aquatic animal production") contributes to eutrophication of waterways, and that many states with fish farms have reported impairment to their waterways and low water quality due to excess nutrient overloading.[36]

The infrastructure of industrial ocean fish farms also contains a combination of various chemicals and heavy metals to prevent corrosion and other damage from abrasive ocean conditions. These antifoulant substances often leech off the farm over time, contaminating the water and the farmed fish.[37] For example, net pen facilities often incorporate copper into their structures for its anti-foulant properties. Copper is extremely toxic to marine life, causing mortality and other adverse effects on survival, growth, and reproduction, and has been known to alter brain function, enzyme activity, blood chemistry, and metabolism.[38] Alarming amounts of accumulated copper have been detected in sediment near net pen farms, and continues to harm marine life years after the net pens have been removed from the area.[39] Zinc is also popular in the net pen industry for its anti-foulant properties, and is highly toxic to marine life.[40] These heavy metals also leech into the farmed fish and can cause extreme harm when consumed by humans, causing metal poisoning, gastrointestinal disorders, tremors, ataxia, paralysis, vomiting and convulsion, depression, and pneumonia.[41]

Unlike their terrestrial counterparts, underwater fish farms do not utilize any type of waste treatment or ventilation to mitigate waste, pollution, and discharge. Rather, they rely on water flow and currents to flush pollution away from the farm – so it's simply "out of sight, out of mind" for these corporations. But this method of waste management only pushes the burden onto the ocean ecosystem, impacting the ocean floor, the water column, and marine life. Moreover, this method of waste "management" is ineffective, as circulation and water flow is often reduced by various circumstances, including net fouling, mesh size of the nets, shape, changes, and contours of the seafloor, configuration of the pens, and varied density in the layers of the water columns.[42]

Greenhouse gas emissions and ocean acidification: Although it seems as if the current federal administration wants to erase all mentions of climate change entirely, this doesn't change the fact that climate change is real, and that human activity – especially industrially farmed animals – is a lead cause of rising global temperatures. Specifically for industrial ocean fish farming, studies have shown that this method of seafood production is nearly twice as greenhouse gas-intensive as wild, capture fishing,[43] and industrially farmed salmon is more environmentally harmful than all other seafood products.[44]

Industrial ocean fish farming "practices constitute a largely undefined source of greenhouse gas emissions," and its contribution to ocean acidification through greenhouse gas emissions is significant.[45] The net pen industry utilizes the following carbon sources: "direct use of fossil fuels in production activities; indirect fossil fuel use, expressed as embodied energy; conversion of natural ecosystems or agricultural land; [and] stock respiration and waste decomposition."[46] However, the raising, farming, and feed production portions of this supply chain are by far the dominant contributors of emissions.[47]

Nicknamed "the evil twin of global warming," ocean acidification is becoming a widespread threat in the U.S., and the industrialization of our oceans is to blame.[48] Billions of tons of the greenhouse gas carbon dioxide (CO2) are released from anthropogenic, or man-made, activities, and about half of this is absorbed by our oceans.[49] Industrial salmon farms contribute the highest carbon dioxide emissions out of the entire seafood sector (including capture fisheries).[50] And as the presence of industrially farmed seafood grows, so too

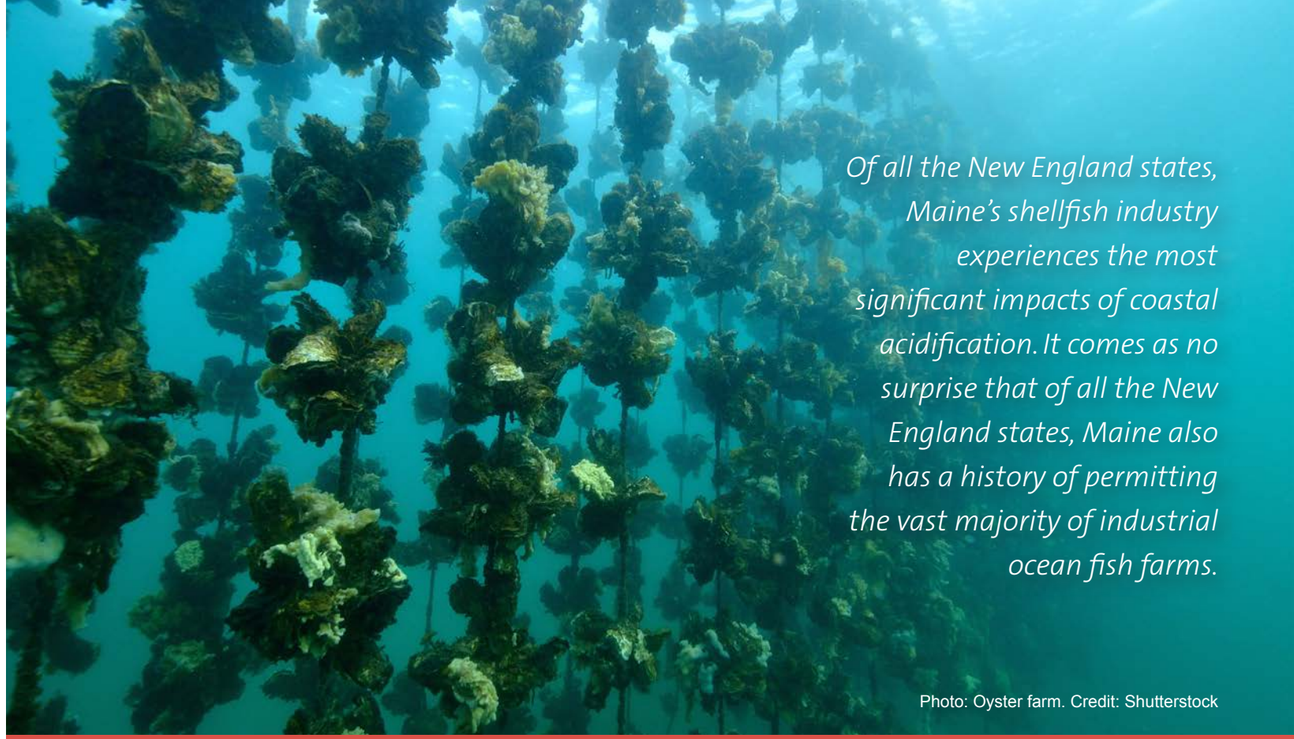

Photo: Oyster farm. Credit: Shutterstock

will its emissions of harmful CO2 and other greenhouse gases. Like all living things, the ocean ecosystem and its marine life require a specific pH balance to thrive. When the ocean water absorbs CO2, certain chemical reactions change the biological makeup of the water and reduce the pH value – thus making it more acidic.[51]

Ocean acidification is a threat on multiple fronts, because it impacts a number of biologically important minerals and nutrients. For instance, the reduced pH changes the concentration and saturation states of calcium carbonate minerals, which are essential for building the skeletons and shells of numerous marine organisms[52] and coral formation.[53] NOAA has reported that ocean acidification directly alters smell-driven behaviors of salmon populations, which – when functioning properly – help fish avoid dangerous waters.[54]

This creates a vicious circle, as ocean acidification has been shown to negatively impact the aquaculture industry – especially for shellfish farmers. Oyster farmers face significant problems for larval production and midstage growth of their species as a result of ocean acidification.[55] In the mid-2000s, it was reported that oyster larvae were dying *en masse* at some production facilities, with mortality totaling 100 percent at some locations.[56] Mussel farmers are also seeing negative impacts on final shell growth and thickness and severe development and hatching problems due to changes in pH of the surrounding water.[57] In 2011, one study estimated that the total global cost of ocean acidification for the shellfish industry could exceed $ 100 billion (USD).[58] And as industrial ocean fish farming continues to acidify the ocean, this number can only be expected to grow.

Of all the New England states, Maine's shellfish industry experiences the most significant impacts of coastal acidification.[59] It comes as no surprise that of all the New England states, Maine also has a history of permitting the vast majority of industrial ocean fish farms. [60]

Underwater factory farms are inhumane. From the farmed fish to the surrounding marine life, industrial ocean fish farming imposes a feedlot-style environment that takes a widespread toll on animals due to water quality issues, escapes, disease and parasites, predator control, and feed sourcing.

Net pen operations cause chronic stress and health problems for farmed fish populations. As with most, if not all, industrial farming operations, animal welfare is one of the lowest priorities and profits are the highest. To that end, factory farms house massive populations of animals without regard for well-being, and industrial finfish farms are no different.

Net pens expose farmed fish to **degraded water quality,** which is one of the most important factors affecting fish health. Finfish are highly sensitive to pollution and water quality issues due to the large surface area of their gills.[61] Water quality in intensive settings like a net pen operation can be degraded by a number of factors, including fish respiration, waste, and excess feed – which are exacerbated by intense stocking densities – and direct exposure to anti-foulant chemicals and heavy metals that secrete toxins directly into the water from the net pen infrastructure.[62] Exposure to poor water quality over time can cause fish to experience health problems and infection risk, high mortality rates, and chronic stress, which causes reduced growth and reproductive performance, and increase susceptibility to disease and parasites.[63]

There are a **handful of diseases** that farmed fish – typically farmed salmon – suffer, including infectious salmon anemia, Piscine Reovirus, and Heart and Skeletal Muscle Inflammation.

Infectious salmon anemia (ISA), formerly known as hemorrhagic kidney syndrome, is a highly contagious, fatal virus that can have a cumulative mortality rate exceeding 90% of infected populations.[64] Although this disease primarily infects farmed Atlantic salmon, other species can carry and it has been documented to cause illness in other species as well, including coho salmon and rainbow trout.[65] Fish suffering from ISA exhibit lethargy, anemia, leukopenia, ascites, exophthalmia, internal bleeding, and increased mortality rates. Of great concern is the ability of ISA to rapidly mutate and increase its virulence – which means that the disease can adapt and emerge as an even more severe and harmful virus that can impact a wider range of species, including native, wild fish stocks.[66]

Pscine Reovirus (PRV) is a highly infectious pathogen widely found in farmed Atlantic salmon, but can also impact and transfer to a range of other fish species. Although much about PRV remains unknown, it is widely suspected as the cause of Heart and Skeletal Muscle Inflammation (HSMI) in finfish, which causes fish to become lethargic and more vulnerable to predators.[67] HSMI causes lesions and severe damage to the heart and skeletal muscles, and has nearly a 100% morbidity rate in farmed salmon populations.[68] PRV also causes erythrocyte inclusion, a disorder of the red blood cells, and is documented to have decreased the success rate of at least one species of wild salmon attempting to return to upstream.[69] A recent study confirmed that wild salmon exposed to industrial ocean fish farms are significantly more likely to contract PRV than those species without contact.[70] The lead author of the study confirmed that industrial ocean fish farms must be removed "from key salmon migration routes, or we risk the complete loss of wild salmon" in those areas.[71] Industrial ocean fish farms are also an ideal breeding ground for sea lice, allowing the parasite to thrive and grow exponentially before being released from the farm back into the ocean. In fact, salmon farms are the most significant source of sea lice epizotics (exceptionally heavy and fatal infestations) on juvenile wild salmon in Europe and North America.[72] Sea lice infest and reduce survival of juvenile salmon populations – the smaller the fish, the greater the damage. And because juvenile salmon occupy the outer-most, higher-risk areas in a school, their increased mortality increases the risk of predation for the entire school.[73] Sea lice can also carry and spread dangerous viruses from one fish to another.

Sea lice are documented as the most pathogenic parasite in salmon farming, and in 2016 cost the global industry about $1 billion (USD) annually.[74] This cost has impacted the wholesale cost of salmon, which increased as much as 50% in 2016.[75] The industry's primary solution to sea lice is the use of pesticides. Not only do these chemicals kill the sea lice, but they also kill off other vital marine life in the area. And studies show that sea lice are beginning to exhibit drug resistance to these pesticides.[76]

Farmed salmon are three times more likely than their wild relatives to **suffer deformities** that cause deafness. These farmed salmon are given growth accelerators, and such a rapid change in size causes a deformity in the ear that is irreversible and worsens with age.[77] Sadly, this deformity affects more than 95% of fully-grown hatchery-produced fish. All of these issues —the lack of hearing abilities, deformities, and growth accelerators — raise significant concerns for the welfare of farmed fish, who are unable to express their natural behaviors and live a life that is free from disease.

Wildlife is attracted to net pens. Industrial ocean fish farms inherently attract predators and other wildlife. Whether these animals hope to feed on plump, farmed fish contained in open nets, or forage on excess feed and nutrients that surround the farm, one thing is clear: these facilities are a floating attractive nuisance for marine life, with a deadly bite.

In March 2017, a Hawaiian monk seal was found dead, tangled in the nets of a Hawaii fish farm that is owned by Blue Ocean Mariculture and partially funded by the National Oceanic and Atmospheric Administration (NOAA). The highly endangered monk seal – there are only 1,400 left in the wild – wandered into the nets, likely looking for fish to eat. NOAA officials announced that the farm recently attracted and trapped a shark around that same time.[78] In 2016, industrial ocean fish farms in B.C. contributed to the entanglement of three humpback whales in the span of just a few weeks, two of which resulted in deaths.[79]

So many predators are attracted to net pen operations globally that workers have crassly taken to shooting and killing animals on sight – even species that are listed as endangered in the U.S. – preferring "cheap bullets" to more humane ways of deterrence and stock protection, such as improved anti-predator nets.[80] For the first half of 2017, Scotland's industrial ocean fish farms contributed to 50% more seal killings than the same period for 2016 – most being shot on sight by workers.[81] British Columbia follows suit: since 1990, B.C. fish farms shot and killed more than 7,000 marine mammals: almost 6,000 harbor seals, 1,200 California sea lions and 363 endangered Steller sea lions.[82]

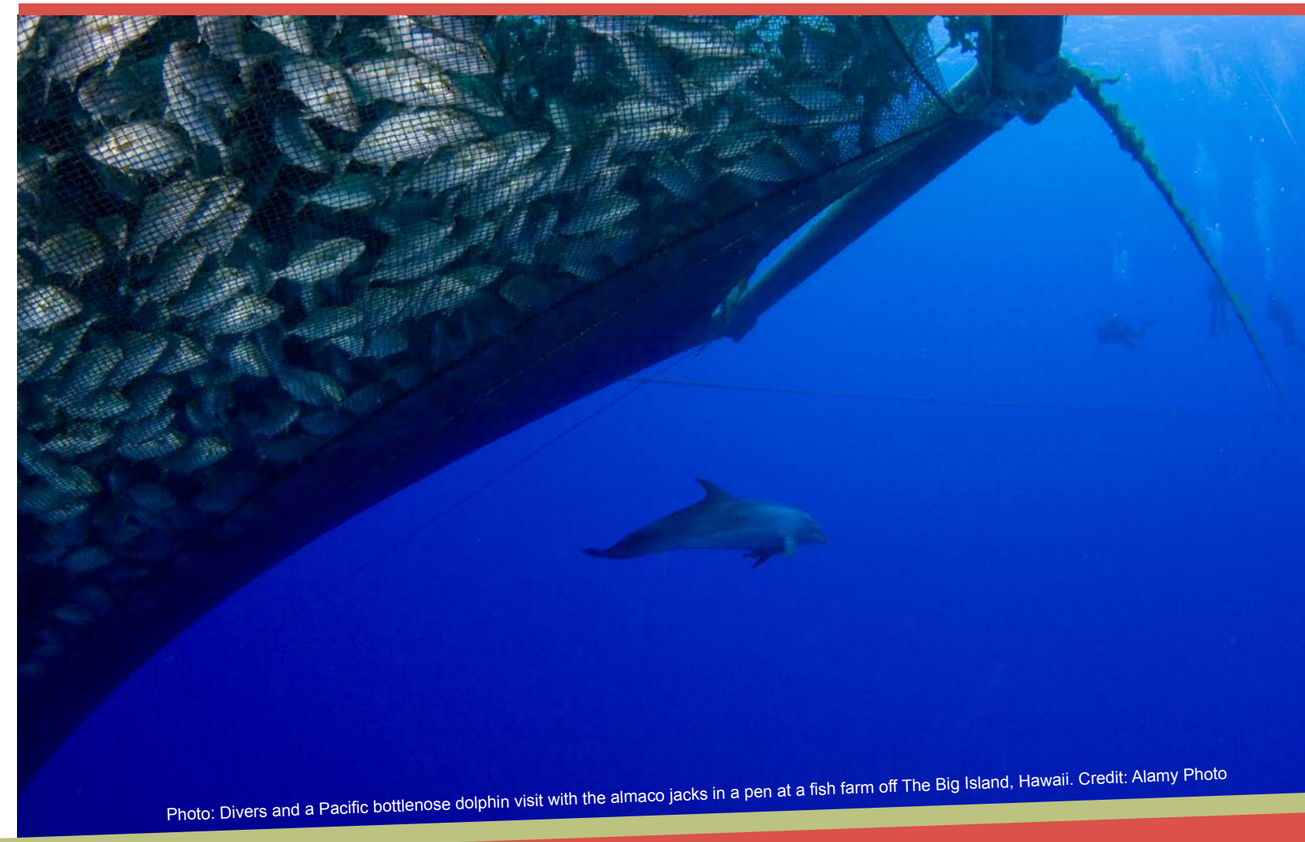

Photo: Divers and a Pacific bottlenose dolphin visit with the almaco jacks in a pen at a fish farm off The Big Island, Hawaii. Credit: Alamy Photo

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Photo: Close-up of large group of fish in fish farm.Credit: Getty images.

Photo: Aerial view of Cooke Aquaculture's Cypress Island facility before salmon spill (left) and after (right).Credit: Beau Garreau.

These floating feedlots are tremendously wasteful. From the diets of farmed fish to the number of farmed fish deaths due to pests and disease, industrial ocean fish farming contributes to a significant amount of waste annually.

The diet for the most popular farmed fish results in a net protein loss: The most popular and widely farmed finfish, Atlantic salmon, is carnivorous. The diet for this species results in a "protein in, protein out" deficiency. In other words, it takes significantly more protein to feed a farmed Atlantic salmon than is produced at harvest. A recent study reported that it requires four or more pounds of wild fish to produce one pound of farmed salmon or other carnivorous fish.[83] Because the majority of this protein is derived from fish meal and fish oil, it is easy to see how this diet has led to overfishing problems.

The higher demand for fish feed from industrial ocean fish farms has caused a surge in value for fish feed – especially in light of the more limited availability of forage fish species. In today's capitalist society, it comes as no surprise that a slew of corporations have jumped into the market. Past reports projected that the fish feed industry will be worth over $70 billion in the next couple of years.[84] However, that figure has recently been blown out of the water – the fish feed industry is worth over $100 billion today.[85]

Industrial ocean fish farms use wasteful, unsustainable, and unhealthy fish feed. To maximize profits, the net pen industry contributes heavily to harmful forage-fish sourcing practices and widespread use of GMO ingredients and other unhealthy additives for its fish feed.

Industrial ocean fish farms are wiping out forage fish species. To meet the protein needs of their stocks, industrial ocean fish farms rely on fish meal and oil from smaller, lower-trophic level ocean fish such as anchovy, herring, and krill – also known as forage fish. In fact, 30 million tons of these fish are caught and processed annually to feed farmed fish. Within a decade, it is projected that the global aquaculture industry will use two-thirds of world fish meal production, and there may already be a serious fish oil shortage.[86]

This shortage has caused many manufacturers to substitute genetically engineered ingredients as filler, such as corn, soy, and algae, which means more environmental degradation and a less nutritious fish for consumers.

Factory fish farms toss millions of fish each year. In addition to "routine" losses due to fish spills, diseases, parasites, and other issues plague the stocks of industrial ocean fish farms, often causing significant death tolls. The Scottish net pen industry admitted to throwing away over 10 million fish in 2016 – nearly a quarter of its entire stock, and more than double the figure from previous years.[87] A single incident at a fish farm in Tasmania – caused by human error – resulted in the mass death of 30,000 juvenile farmed fish.[88] These seafood corporations can simply write off these deaths as "business losses," thus benefitting from the mortalities and having no incentive to improve their poor farming practices.

Underwater factory farms are taking a significant toll on society and the economy. Mega-corporations are taking over our oceans and seafood production, which puts truly sustainable fishing communities and producers out of business. This industry has made clear that it's willing to place profits over sustainability – forcing society to shoulder the burdens. Corporations are taking control of our oceans and seafood production. In 2015, it was reported that only a handful of corporations control nearly 20% of the global marine catch (9-13 million tons) and 40% of the largest and most valuable fish stocks, including farmed salmon and fish feed production.[89] The ten largest seafood companies in the world raked in over a third of total seafood revenues, and the top 25 companies accounted for nearly half of all revenue.[90] This equates to an alarming amount of power, and allows corporations to dominate business structures, production methods, and management policies within the industry – and takes away from the amount of decision-making power you have over what you eat. This power also provides corporations disproportionate influence over the dynamics of the ocean ecosystem and seafood production globally.

Cooke Aquaculture – the fifth largest salmon farmer in the world, and the single largest salmon farmer outside of Norway – has its sights set on controlling America's coastline by purchasing its competition.[91] In 2016, Cooke was listed as the largest growing seafood corporation in the world.[92] Cooke is the principle industrial ocean fish farming corporation in our domestic waterways, with eight Atlantic salmon facilities in Washington State, several facilities scattered throughout Maine's waterways, and many more in the works. It seems as if Cooke may also be planning to gain control over additional stages of the seafood farming process; the corporation recently purchased Omega Protein Corporation, which was a leading provider of fish feed.[93]

Cooke Aquaculture's poor maintenance of a facility in Washington State caused a catastrophic spill of more than 263,000 non-native Atlantic salmon into Puget Sound and Pacific waters.[94] Cooke eventually apologized for the event after first trying to blame it on a recent solar eclipse.[95] However, despite the spill and public outcry, the corporation soon thereafter moved millions more Atlantic salmon fry and eggs into other Washington State facilities (one of which was found to have structural flaws and neglected maintenance).[96]

What is more, a state investigation recently uncovered that Cooke significantly misled the public about the spill – "from the seriousness and cause of the initial trouble

at the farm in July, to the number of fish released to Puget Sound."[97] Rather than Cooke's figure of approximately 160,000 escaped fish, the actual number is at least 263,000.[98] And of this number, at least 206,000 of the non-native fish are still unaccounted for (which is more than double what Cooke represented).[99] In response to this misconduct, Washington State officials have canceled Cooke's lease for the Cypress Island facility and fined the company $332,000.[100] Cooke has also recently been reprimanded by state officials for repeatedly violating pollution laws by power washing its equipment in public waterways at another facility,[101] and the state is being sued by Cooke for attempting to completely shutter a second operation for breaking multiple lease terms, including polluting Styrofoam debris and using missing or damaged infrastructure.[102] One thing is clear: Should the status quo continue, another catastrophic fish spill is just waiting to happen.

Governments rely on corporate-controlled industrial ocena fish farms to mitigate their own environmental harm. Governing bodies leave a number of environmental protection and mitigation efforts to the corporation's responsibility and "best management practices."[103] But because corporations are profit driven, and often sacrifice sustainability to save money, they largely choose cost-effective measures over environmentally-sound options. Further, because these floating factory farms have a disproportionate amount of control over the industry, these decisions and business practices become the standard for industry participants hoping to compete.

Industrial ocean fish farms are harming local commercial, tribal, and recreational fisheries, coastal communities, and related economies.

Industrial seafood farms damage small, family-owned fisheries, associated seafood industries, and workers. These underwater factory farms produce the highest amount of fish at the lowest cost possible, which places downward pressure on fish prices across the board. This reduces the price that most consumers are willing to pay all seafood products, which directly harms the sustainable and wild-caught seafood industry. Further, industrial seafood farms threaten the integrity of wild fish populations that are key to the wild-caught fishing industry's success, and the coastal communities they support.

Tribal nations are also experiencing strife from industrial ocean fish farms. The waning native salmon populations cause direct harm to our tribal nations, who hold the native species as sacrosanct as part of their spiritual and cultural identities.[104] Tribal communities located near these factory farms are directly impacted. Their fishers have been put out of work, fish processing and canning plants are being shuttered, and their local economies are suffering.[105]

Marine waters that are tainted by industrial fish farms are also unavailable for commercial and recreational fishing, ship traffic, renewable energy infrastructure, and tourism-related activities. These competing activities, especially tourism, generate significantly more revenue for coastal communities than industrial fish farms. Moreover, these farms are typically owned by mega-corporations that are willing to endanger the ocean and its inhabitants in order to turn a profit.

Working at an industrial ocean fish farm is one of the world's most dangerous jobs. The Bureau of Labor Statistics recently listed aquaculture as the most dangerous job in the United States.[106] Industrial ocean fish farming facilities are exposed to severe marine conditions, including strong wind and wave activity from all directions, short and steep wave patterns, strong currents, seasonal anoxic (oxygen-lacking) conditions that can prevent operators from being able to access their cages, ranging in days to weeks.[107] When operators do access the facilities, they could easily be caught in any of the above conditions, without ready access to first aid or other treatment. Moreover, safeguards put into place at these facilities are often woefully insufficient to properly prevent injury.

One worker at a Cooke Aquaculture facility in Maine recently lost multiple fingers while on the job, due to Cooke's alleged negligence, failure to provide adequate safety equipment to employees, and failure to provide proper training.[108] In 2013, an employee working on a Mediterranean net pen farm was bitten by a shark, which was attracted to the fish and excess feed in the net pens.[109] Finally, in November 2017, a Nepalese net pen worker went missing from the fish farm after a thunderstorm damaged the facility.[110] These are just a few examples of the workplace accidents that can – and do – occur at industrial ocean fish farms.

Photo: Nha Trang, Vietnam. June 23,2013. Workers are feeding barramundi fish in cage culture in the Van Phong bay in Vietnam. Credit: Getty images.

Industrial ocean fish farming facilities are exposed to severe marine conditions, including strong wind and wave activity from all directions, short and steep wave patterns, strong currents, seasonal anoxic (oxygen-lacking) conditions that can prevent operators from being able to access their cages, ranging in days to weeks.

IV. Industrial Ocean Fish Farming in the United States

Photo: Coastal net pens off the coast of Maine. Credit: Flickr.com/NOAA

Industrial ocean fish farming is occurring in nearly every coastal country of the world. The countries producing the most industrially farmed finfish include China, Indonesia, Norway, and Chile.[111] The U.S. has made clear that it wants to compete with these countries, and unfortunately, it has chosen to industrialize our oceans in the process. Industrial ocean fish farms are already operating in domestic waters.

Industrial ocean fish farms are sited in the U.S. in both the Atlantic and Pacific oceans, and although the approved federal permitting system for these industrial farms in the Gulf of Mexico is currently the subject of litigation, a large-scale facility is preparing to commence operations there. More underwater factory farms like these are likely on the way as NOAA pushes for net pens in federal waters and states continue to permit facilities closer to the shoreline.

Commercial net pen facilities are currently farming Atlantic salmon in Maine and Washington State (where they are not a native species), and yellowtail in Hawaii. As mentioned above, Cooke Aquaculture owns and operates the vast majority of industrial ocean fish farms in the United States. Cooke already operates a number of Atlantic salmon facilities that dominate waters in Washington State and Maine, and is actively looking to expand.[112] In Hawaii, finfish are farmed in net pen facilities by two principle corporations: Blue Ocean Mariculture and Kampachi Farms (which is expanding to the Gulf of Mexico, as detailed below).[113]

A number of other companies are also attempting to startup in domestic waters. A net pen venture led by Seaworld is eying California's waters near the Port of San Diego.[114] Manna Fish Farms is actively working toward operating an enormous, multi-unit pod facility for striped bass off the coast of New York.[115] To aid more startups like these, NOAA has deemed aquaculture in federally-controlled waters as a high priority for the agency and is currently allocating a significant amount of its resources toward developing domestic aquaculture production in all regions of the U.S.[116] NOAA recently provided national Sea Grant funding to Hawaii company Kampachi Farms to expand its operations to the Southeastern Gulf of Mexico, which will carry out an on-site aquaculture study while it seeks a permit for commercial operations.[117] NOAA also recently announced the availability of more federal Sea Grant funding, as well as a new pilot project, that will fund aquaculture operations in coastal waters of the Atlantic, Pacific, Gulf of Mexico, and even the Great Lakes.[118]

NOAA is unlawfully regulating aquaculture without proper authority. NOAA is improperly classifying aquaculture as "fishing" under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), 16 U.S.C. § 1801 et seq. NOAA's definition of fishing includes "the catching, taking, or harvesting or fish," but none of these activities involves the culturing, growing, and rearing of fish in pens in open waters for eventual harvest. Simply because fish are removed from the industrial farm's nets at time of harvest does not mean the activity is the same as fishing. Indeed, these activities are farming – just as a chicken or pig is raised for human consumption on a land-based farm. In fact, these industrial ocean fish farms are very similar to CAFOs on land, which the federal government defines as "an animal feeding operation where more than 1,000 'animal units' … are confined at the facility…"[119]

The conservation and management goals of the Magnuson-Stevens Act cannot be met when it is also used to craft a program for industrial ocean fish farming. NOAA is forcing a square peg into a round hole, and is reaching far beyond its authority in attempting to use Magnuson to control these activities. If the agency wants to manage industrial ocean fish farming, specific legislation should be created to do so. In past years it was clear there was no collective Congressional mindset to approve legislation creating a permitting system for these farming activities. As it stands, NOAA is currently sanctioning inappropriate industrial activity in our federal waters.

NOAA should stop regulating industrial ocean fish farming as a fishing activity under the Magnuson-Stevens Act. This takes away limited agency resources that should support and regulate fishing communities, fisheries, and wild fish stocks. Congress should take steps to explicitly remove fish farming from the definition of "fishing" under Magnuson-Stevens so that it's unequivocally clear to NOAA that Magnuson-Stevens is not meant for regulation of fish farming activities. New legislation is needed that clearly delineates to NOAA what fish farming is and how it should be regulated.

NOAA is prioritizing underwater factory farms at the expense of truly sustainable fisheries. Currently, NOAA is prioritizing the expansion of domestic marine aquaculture, and is already in the practice of devoting much of its meager aquaculture budget to fostering industrial fish farming practices. NOAA reports that marine aquaculture "enhances coastal resiliency, creates jobs, improves food security and human nutrition and is a valuable tool to help rebuild some protected species and habitats." However, as detailed above, it is clear that mainstream industrial ocean fish farming is the problem – not the solution.

NOAA's current aquaculture permitting and regulatory scheme for the Gulf of Mexico allows industrial ocean fish farms to harm the ocean and its wildlife through unsustainable and irresponsible business models, such as using net pens that allow for ample fish escapes and the free discharge of pollutants in the form of excess feed, antibiotics, fecal matter, chemicals, and parasites. NOAA should instead be working toward developing an aquaculture program that prevents these serious environmental ramifications, and impose hefty sanctions for violations.

NOAA also provides funding assistance that could be used to aid sustainable farmers and fishing communities; however, industrial seafood farms have taken advantage of these programs to fund their unsustainable practices – including research grants for marine aquaculture technology and financial assistance for fish escapes and deaths that are shrouded as "losses." Rather than subsidizing industrial seafood farming, which takes precious resources away from sustainable farmers and fishing communities, NOAA should be focusing on developing sustainable seafood production alternatives, and leveling the playing field so that these sustainable producers can compete with industrial fish farms that corner the seafood market.

Moreover, NOAA has made a practice of cherry-picking its science so that industrial ocean fish farming is portrayed in a far better light than is really the case. NOAA has described net pens and cages as "dependable," reported that farmed species will "thrive in the open ocean environment," noted that these industrial ocean farms will produce "safe and healthy seafood," and characterized the industrial fish feed industry as "ecologically and socio-economically sustainable."[120] But as we have provided above, none of these is true.

V. Solutions to Industrial Ocean Fish Farming are Available and Obtainable

Seafood can be produced sustainably. Whether farmed or wild-caught, there are a number of sustainable options for seafood production that that can continue to meet demands while producing little to no pollution, restoring the ocean ecosystem, protecting wild fish populations, and sustaining local fishing communities. Many of these alternatives are already in use, but simply cannot compete with large-scale, industrial ocean fish farms.

There are agro-ecological solutions by farming fish in tanks on land. Land-based recirculating aquaculture systems are closed-loop facilities that continuously filter and recycle water, which requires a small amount of water and releases little to no pollution. Other benefits include biosecurity, as facilities can operate without the addition of antibiotics or chemicals, and space and production efficiency. They can also be operated in tandem with aquaponics – the practice of growing plants using nutrient-rich water. Plants grown in aquaponics systems include algae, seaweeds, basil, okra, lettuce, watermelon, mint, chives, tomatoes, cantaloupe, cucumber, flowers, squash, bok choy, collard greens, sorrel, and arugula, among many others.

Today there are a growing number of successful, recirculating inland fish farm systems. Indeed, according to a recent markets report on land-based fish farming, the technology has progressed more quickly than expected so that operating a full-scale recirculating farm has "never looked better" for start-up costs, production yield, and profitability.[121]

Recirculating Farms Coalition fosters the development of healthy, natural, and community-based ways to grow fresh food. They use closed-loop, land-based farms that can grow plants (hydroponics), fish (aquaculture), or plants and fish (aquaponics). Their approach to farming creates green jobs and food security in every community in the United States by focusing on placing localized farms in communities and urban areas, which decreases fuel for transporting food, and provides consumers with fresher, more affordable food. The Coalition's recirculating farm systems re-use their water, recycle their waste, utilize renewable energy, and run on very little to no additives, including zero antibiotics or other drugs or chemicals. Recirculating Farms Coalition also provides on its website (http://www.recirculatingfarms.org/links/) free online materials of open-source, do-it-yourself plans and resources, including classes, so you can find everything you need to join the movement.

In response to the surge of industrial ocean fish farms in British Columbia's waterways, the Namgis First Nation began farming Atlantic salmon in land-based systems to prove that it can be done without environmental harm. Their facility is called Kuterra – a combination of the Namgis People's word for salmon (kutala) and land (terra) – and it keeps wild salmon and the waters they live in separate from farming, to grow good quality, healthy farmed fish. Like its fish harvests, the facility itself is thriving: Kuterra produced 3,000 metric tons of fish this year and is expected to break even after less than two years of operations. In case others want to start their own operations, Kuterra is open-sourced and has all of its plans and industry specs posted on its website (www.kuterrra.com) so others can access exactly what they need to get started.

When done well, capture fisheries can continue to produce seafood humanely without harming the ocean or its inhabitants. Wild-caught fisheries have been in operation for centuries, and if managed responsibly, can continue to produce healthy, sustainable seafood options for consumers. Sustainable wild fishing can be achieved with slight modifications to fishing gear and procedures that increase selectivity for target fish species and reduce bycatch for other species. With these equipment and technique variations, fishing communities can operate in ways that allow wildlife to thrive, while still sustaining their industry and livelihood.

A number of organizations have developed resources for consumers to consult in purchasing wild-caught seafood. These consumer guides research and evaluate environmental impacts of certain fishing activities to determine which species should be avoided. The Monterey Bay Aquarium (MBA) regularly updates its Seafood Watch program to provide free guidance to consumers, and even has regionally specific pocket guides.[122] MBA analyzes a number of environmental impacts from wild-caught fishing to make its recommendations, including overfishing, illegal fishing, bycatch, habitat damage, and government oversight programs. Visit www.seafoodwatch.org to find out which seafood has a lesser impact on the environment.

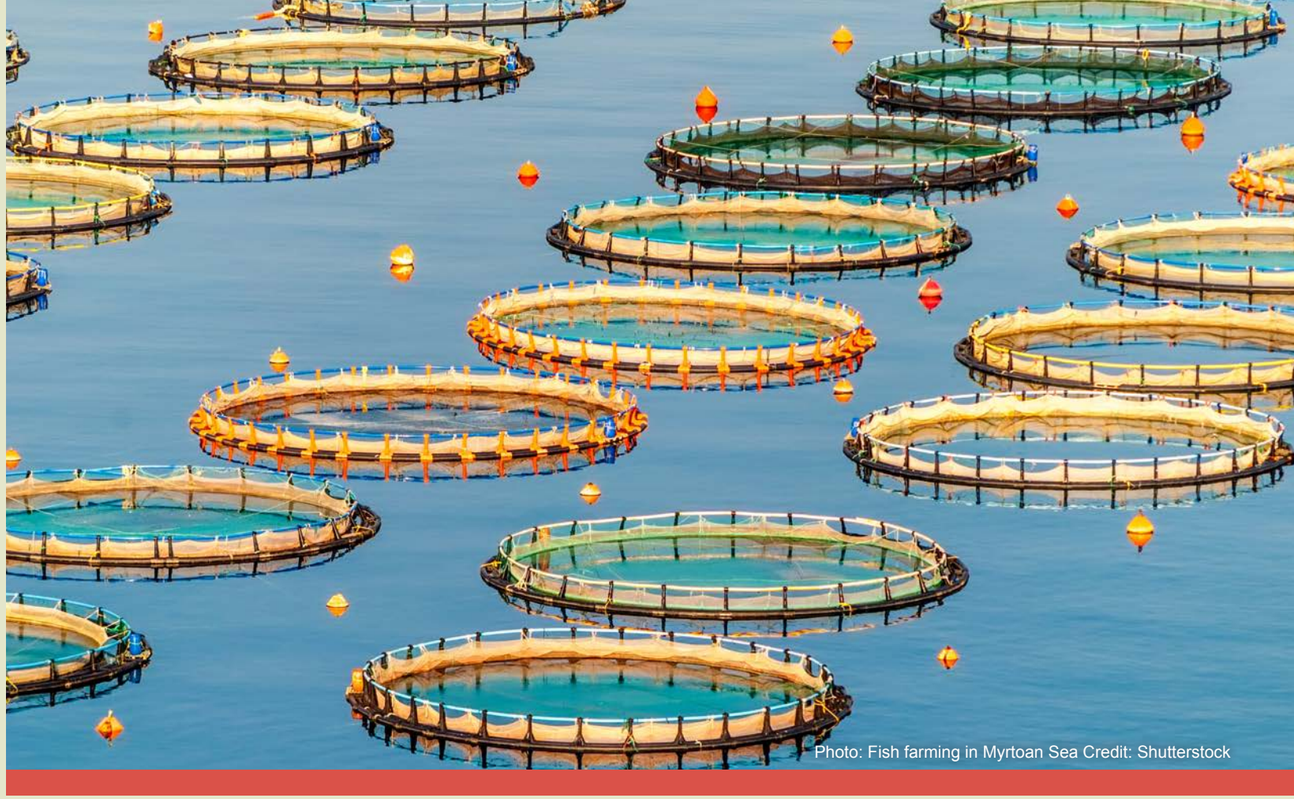

Photo: Fish farming in Myrtoan Sea Credit: Shutterstock

Greenpeace also provides free seafood guides for consumers on global and regional levels. The organization's Red List guides provide scientifically compiled lists of marine species that, for a variety of reasons, should not be made commercially available. Greenpeace looks at various issues, including low stock populations, disruption of the marine food chain, and irresponsible fishing or farming practices that contribute to the destruction of our ocean ecosystem.[123] Greenpeace also provides direct links to reputable fish guides from a number of organizations, including the Marine Conservation Society, Forest & Bird, the Australian Marine Conservation Society, and Seafood Choices Alliance.[124]

Advancements in fishing techniques and equipment can also lead to an even more sustainable wild-caught fishing industry. A number of organizations and industry participants are devoted to preventing harm to the ocean from wild-caught fishing while fostering the development of the industry.

Ecosystem-based management of capture fisheries has gained traction in many sectors, and has proven effective in working closely with fishing communities to achieve truly sustainable seafood production and better conditions for workers. The World Wildlife Fund provides an integrated, 12-step approach that involves maintaining the natural and unique structure, function, and productivity of each ocean ecosystem in which fisheries operate, and applies science-based models to eliminate harmful fishing techniques such as bottom-trawling, reduce bycatch, and allow wild fish populations to thrive.[125] National Geographic Society also works to end "fish factories" and educate the public on ways to make wild-caught fishing more sustainable through technology and fisheries management.[117] Some of these sustainable fishing practices include selective, seasonal fishing that allows fish stocks to replenish naturally; strictly avoiding protected areas such as coral reefs; and techniques that avoid waste and bycatch, such as hook-and-line, spearfishing, and cast net methods.[126]

Advancements in fishing gear and technologies can also help wild-caught fishing be more sustainable. For example, the Burns brothers, longtime fishermen and cattle farmers, have developed a new fishing vessel that is not only environmentally friendly, but also more humane for fish and safer for workers.[127] Blue North is designed to catch Pacific cod using the bottom longline method, which has been rated the greenest, "best choice" catch method.[128]

Certain ocean-based systems may also sustainably farm seafood. 3-Dimensional ocean farms operate in the ocean, but utilize an entire water column to grow vertical lines of kelp and seaweed interspersed with hanging nets of scallops and mussels, with oyster cages and clams below that. These farms have the potential to be sustainable models, as kelp can absorb five times more carbon than land-based plants, and both the kelp and oysters process nitrogen as they grow. When these farms are designed well and operated sustainably, they can restore rather than deplete our oceans while growing food and fertilizer.

Greenwave is a farmer and fisher-run organization based in the U.S. that works with seafood producers to develop and implement 3D, column-based aquaculture models.[129] Greenwave is dedicated to building a truly blue-green economy that creates jobs, mitigates climate change, and grows healthy food for local communities. Their 3D farming models require zero inputs, sequester carbon, and rebuild reef ecosystems, all while producing high yields with a very small footprint. They're also open source and widely obtainable: anyone with around 20 acres, a boat, and $20,000 can be up and running within a year.[130]

Carnivorous, farmed finfish can be fed sustainably. Feed for farmed fish presents serious problems regardless of where or how fish are being farmed. The industry surge has led to a significantly higher demand for feed, and as a result, forage fish species are being overfished to the brink of extinction to source fish meal and fish oil - the primary ingredients in feed.

With an eye toward higher profits, many fish farmers have begun substituting fish meal and oil with cheaper ingredients, such as GMOs and unhealthy fillers like corn. Not only does this result in a less healthy and happy fish, but it also provides consumers with less nutritious seafood.

Thankfully, when used in conjunction with a sustainable fish farming model such as land-based, recirculating systems, there are solutions to nutritiously feeding farmed fish that will not contribute to wiping out forage fish and devastating the ocean ecosystem. Many of these methods involve using insects and non-GMO plants and single-cell organisms like yeast, bacteria, and algae. A number of companies are successfully bringing in millions of dollars for producing sustainable, alternative fish feed production from black soldier fly larvae and other insects.[134] Researchers are also reporting that sustainably harvested jellyfish – which have bloomed into overpopulation as a result of global warming – can be used for nutritious, alternative fish feed.[135]

Studies have proven that at least eight species of carnivorous fish can thrive on these alternative sources of feed: white sea bass, walleye, rainbow trout, cobia, arctic char, yellowtail, Atlantic salmon and coho salmon.[136]

There are market-based solutions that will support sustainable seafood. One of the most successful ways to get the seafood industry to shift toward more sustainable production is by increasing the demand for sustainable seafood options.

Seafood suppliers, such as grocery stores, markets, and restaurants, should adopt sustainable seafood sourcing policies that are dedicated to purchasing and supplying seafood only from fish farms and capture-fisheries with truly sustainable methods (like recirculating, land-based farms, 3D ocean farms, and environmentally-friendly capture fishers).

Consumers can increase demand for sustainable seafood by omitting industrially farmed fish from their diets. Eating smaller or herbivorous fish (such as tilapia, catfish, carp, and trout) and opting for seafood that is produced sustainably, whether farmed or wild-caught, are some ways to contribute to positive, market-based change.

Recommendations and Next Steps:

- Congress should explicitly remove fish farming from the definition of fishing in the Magnuson-Stevens Fishery Conservation and Management Act, and pass new legislation that clearly delineates to NOAA what fish farming is and how it should be regulated.
- NOAA should stop regulating industrial ocean fish farming as a fishing activity, and develop an aquaculture program that supports truly sustainable fish farming practices, prevents environmental harm from fish farming, and imposes hefty sanctions for violations.
- Governing officials should undertake each of the policy recommendations made by the Center for a Livable Future in *Ecosystem and Public Health Risks from Nearshore and Offshore Finfish Aquaculture* (2017), including increased testing, reporting, and monitoring requirements and development of separate aquaculture regulatory and promotion programs within federal and state governments.[137]
- A moratorium should be imposed on new marine finfish farms at the state and federal level until the above recommendations are fully implemented.
- Prior to purchasing seafood, cosumers and suppliers should consult sustainable seafood guides for recommendations on choices that pose less environmental impacts.

  Check out www.seafoodwatch.org to get started.

Photo: Sea fish farm. Cages for fish farming dorado and seabass. Credit: Shutterstock

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