Can We Make Coastal Aquaculture in New England Work?

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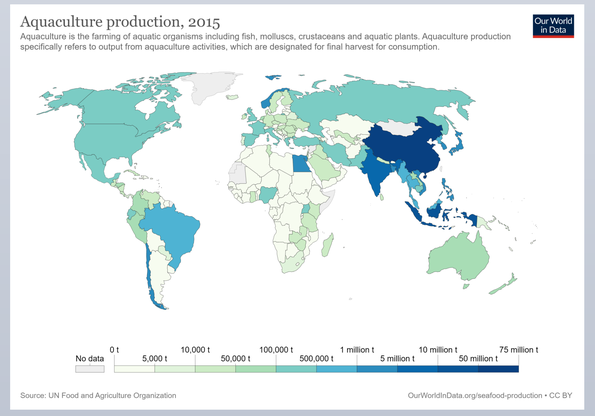
Abstract

As the demand for seafood has risen, we have used technology to keep up with demand by farming it in coastal waters. These methods have many impacts, both positive and negative. Coastal aquaculture is the breeding, rearing, and harvesting of organisms in coastal water environments. Although it mainly refers to fish and shellfish, coastal aquaculture can also involve plants and algae. One of the earliest forms of aquaculture began around 3500 BCE, when the Chinese Empire raised carp for both food and integration in rice paddies[4]. However, with the technology we use today, it can feed many more people than the Chinese Empire could. While it does provide us with a sustainable source of food, it can wreak havoc on the local environment if improperly managed. Worldwide, aquaculture production is expected to exceed 172 million metric tons by the end of 2021, and is already providing 52% of food fish production. While it is amazing that we can provide such a large amount of food compared to the space used, areas with high concentrations of farmed species can also lead to several problems, such as environmental damage from excessive feed and waste, escape of farmed species into the natural environment, or farmed species taking too much natural feed from the surrounding environment. If properly managed and organized, these damages can be mitigated, but many times, they are not. This poster will look at the pros and cons of coastal aquaculture in order to determine whether or not it is a viable and sustainable food source for New England.

What Does it Provide?

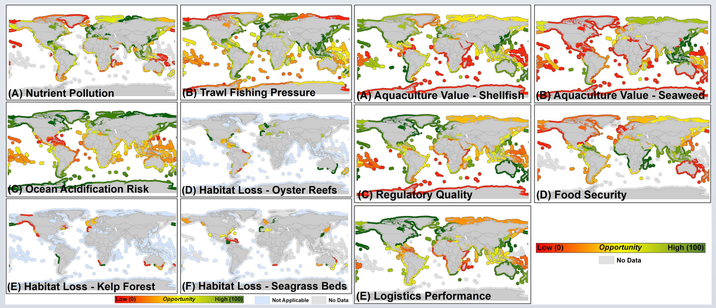
Between 1961 and 2017, seafood consumption per person in the US has increased 72%. This increase has placed increased strain on many of the fish stocks around the world. In order to alleviate the stress, many countries have turned to aquaculture. In 2015, aquaculture was able to provide 106 million tons of seafood across the world. Overall, this accounted for over half of all seafood consumption. Aquaculture is one of the fastest growing forms of food production and is currently worth $243 billion globally[14]. Sustainable aquaculture has the ability to provide large amounts of seafood while potentially placing minimal strain on the environment[13]. However, doing it properly requires strict regulation and proper management.



This map shows the total aquaculture production for each country during 2015. The United States as a whole produced almost 500,000 tons of seafood. (Ritchie, Hannah, and Max Roser)

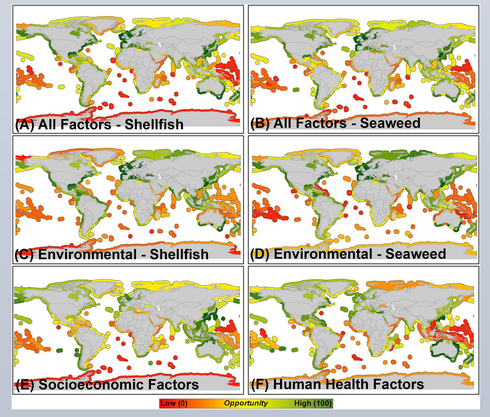
Pros

Incorporating coastal aquaculture in New England has some major benefits. For example, it will greatly reduce the stress on wild fish stocks. This will help the natural population recover from years of overfishing and would help prevent situations such as the depletion of the North Atlantic cod fishery[15]. Shellfish and seaweed aquaculture has some of the highest mitigation potential. When properly established, they can absorb large amounts of nutrient runoff from farms, which helps to mitigate coastal eutrophication. They also have the potential to provide shelter for smaller fish and crustaceans[2]. Seaweed absorbs CO2 from the water while simultaneously oxygenating it, which (locally) mitigates the effects of ocean acidification. Shellfish can promote eelgrass bed growths by naturally filtering the water, which increases the water clarity. This makes it easier for sunlight to reach the eelgrass beds, which are a naturally occurring carbon sink[1]. All of these benefits have the ability to help restore the New England coastal environment, which has been overfished and polluted for some time.



This image shows areas with environmental factors that coastal aquaculture has a higher potential of mitigating. Green areas represent higher risk areas (the areas that are most affected by these factors.) The New England coastal area is at higher risk for nutrient pollution, trawl fishing pressure, and ocean acidification. (Theuerkauf, Seth J., et al)

This image shows areas with socioeconomic factors that are beneficial to coastal aquaculture. Green areas represent the areas with the highest potential for each factor. The New England coastal area has high regulatory quality, good logistics performance, and has a high potential for shellfish aquaculture. (Theuerkauf, Seth J., et al)



This image combines all of the factors from the previous images as well as other factors into one figure. Green areas represent areas with the highest potential. This study was done in order to see what regions of the world could benefit the most from coastal aquaculture. New England was in the top 20 regions, and is consistently green in all categories. (Theuerkauf, Seth J., et al)

Cons

Despite the many positives that coastal aquaculture can contribute to the environment, several negatives can emerge if improperly managed. For example, excessive feed and waste can harm the surrounding environment. If a farmed species were to escape, it could damage the local fish populations, as many times they are genetically modified or specially bred for certain qualities that would be beneficial for farming rather than a natural environment. An excessive concentration of shellfish also has the potential to take too much plankton out of the water table. Not only is plankton a food source, but it is also a very important carbon sink in the ocean[8]. Often times, large aquaculture companies will employ the use of bioactive compounds (pesticides, antibiotics, or growth hormones) to ensure the safety of their farms. Unless they are using these in a land-based aquaculture farm, these compounds are guaranteed to leak into the environment. While careful timing and moderation can help mitigate the effects that these compounds would have, excessive use of them can have far-reaching consequences on the local environment[3]. Excessive use of antibiotics and pesticides can lead to the same problems we see on regular farms and feedlots: drug-resistant diseases and pesticide-resistant pests. Another harmful source that is not often considered is the construction and the construction materials of the aquaculture farms. The actual construction can destroy previous habitats and cause settled sediments to be suspended in the water. Some chemicals used in the construction process and materials can also poison the natural environment as well as the farmed population, which the human population would then consume[7].

Impact	Observed change in ecosystem services coastal/off-coast	Categorization of impact	Offshore prediction	Source
Visual impact and ecological footprint				
Visual impacts	Conflicts with coastal users, loss of property value	Severe	Lower	Ersan (2005)
Use of fish as feed	Pressure on wild fish stocks to produce feed for mostly carnivore aquaculture species	Severe	No change	Naylor et al. (2009)
Seed collection	Pressure on wild fish stocks	Severe	No change	Naylor et al. (2009)
Benthic impact				
Benthic flora	Loss of seagrass habitat, impact on maerl	Severe	Lower	Holmer et al. (2003), Hall-Spencer et al. (2006)
Enrichment of sediments	Accumulation of organic matter	Medium	Lower	Hargrave et al. (2008)
Sediment microbial activity	Increased sulfide production leading to poor sediment conditions	Medium	Lower	Holmer & Kristensen (1992)
Benthic fauna	Increase in productivity and diversity under oligotrophic conditions; loss of productivity and diversity under eutrophic conditions	Medium	Lower/no change/ higher	Kutti et al. (2007, 2008), Holmer & Kristensen (1992)
Wild fish and fisheries				
Wild fish (genetics)	Escapees (incl. spawn) interact with wild fish, affecting gene pools, and compete for habitat	Severe (salmon)	Lower/no change	Jerstad et al. (2008), Toledo-Guerdes et al. (2009)
Wild fish (disease)	Spreading of disease between cultured and wild fish	Medium	Lower/no change	Vike et al. (2009)
Invasion of exotic species	Introduction of species into new habitats	Medium	Lower	Williams & Smith (2007)
Wild fish (attraction)	Wild fish are attracted to cages due to food availability	Medium	Lower/no change	Dempster et al. (2002)
Fisheries	Conflicts for space, increased landings	Medium	Lower/no change	Machias et al. (2005)
Other issues				
Use of antifoulants/chemicals	Accumulation of hazardous compounds	Medium	No change/higher	Samuelsen et al. (1992)
Carbon footprint	Energy consumption and CO_2 release	Low	Higher	Bunting & Pretty (2007)
Water quality (nutrients)	Higher primary productivity under oligotrophic conditions	Low	Lower	Pitta et al. (2009)

This table is a list of some potential impacts caused by coastal aquaculture along with the observed changes and the severity of the impacts (Holmer, M. 2010)

Conclusion

Clearly, coastal aquaculture does not have a simple solution. While there are many cons associated with it, they mostly extend from poor regulations or little to no oversight. However, as the world, and its seafood consumption, keeps growing, we cannot keep relying on wild fish stocks unless we want them to go extinct. When done properly, not only would it be a major source of food, it would help mitigate climate change, prevent environmental damage, and provide a large source of revenue. Due to the current New England environmental factors, regulatory quality, and total value it can provide, I believe that we should pursue the expansion of coastal aquaculture in New England.

References

1. "The Aquaculture Opportunity." *The Nature Conservancy*, 24 Sept. 2017, www.nature.org/en-us/what-we-do/our-insights/perspectives/the-aquaculture-opportunity/.
2. Brennan, William J. "To Be Or Not to Be Involved: Aquaculture Management Options for the New England Fishery Management Council." Ocean and Coastal Law Journal, vol. 2, no. 2, 1997, p. 261-272. HeinOnline.
3. Fernandes, et al. "The Scientific Principles Underlying the Monitoring of the Environmental Impacts of Aquaculture." *Journal of Applied Ichthyology*, vol. 17, no. 4, 2001, pp. 181–193., doi:10.1046/j.1439-0426.2001.00315.x.
4. "History of Aquaculture." *Chesapeake STEM*, Chesapeake STEM, www.chesapeakestem.org/assets/History_of_Aquaculture.pdf.
5. Holmer, M. "Environmental Issues of Fish Farming in Offshore Waters: Perspectives, Concerns and Research Needs." *Aquaculture Environment Interactions*, vol. 1, no. 1, 2010, pp. 57–70., doi:10.3354/aei00007.
6. Joel K. Bourne, Jr., and Photographs by Brian Skerry. "How To Farm a Better Fish." *National Geographic*, National Geographic, www.nationalgeographic.com/foodfeatures/aquaculture/.
7. Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, 1991, *Reducing Environmental Impacts of Coastal Aquaculture*, www.fao.org/tempref/docrep/fao/006/u3100e/u3100e00.pdf.
8. Lapointe, George. NROC, 2013, *NROC White Paper: Overview of the Aquaculture Sector in New England*, www.northeastoceancouncil.org/wp-content/uploads/2013/03/Aquaculture-White-Paper.pdf.
9. Ling, Kristin, et al. 2006, *East National Technology Support Center*, www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_034916.pdf.
10. "Open Ocean Aquaculture." *EveryCRSReport.com*, Congressional Research Service, 9 Aug. 2010, www.everycrsreport.com/reports/RL32694.html.
11. Primavera, J.H. "Overcoming the Impacts of Aquaculture on the Coastal Zone." *Ocean & Coastal Management*, vol. 49, no. 9-10, 2006, pp. 531–545., doi:10.1016/j.ocecoaman.2006.06.018.
12. Rice, Michael A. 2008, *North Eastern Regional Aquaculture Center*, Rice, Michael. (2008). Environmental Effects of Shellfish Aquaculture in the Northeast. Northeastern Regional Aquaculture Center Fact Sheet Series. 105. 1-6. .
13. Ritchie, Hannah, and Max Roser. "Seafood Production." *Our World in Data*, Ourworldindata.org, 13 Sept. 2019, ourworldindata.org/seafood-production#how-is-our-seafood-produced.
14. Theuerkauf, Seth J., et al. "A Global Spatial Analysis Reveals Where Marine Aquaculture Can Benefit Nature and People." *PLOS ONE*, vol. 14, no. 10, 2019, doi:10.1371/journal.pone.0222282.
15. Thuesen, Gretchen. "Atlantic Cod: The Good, the Bad, and the Rebuilding." *Sustainable Fisheries UW*, 14 Feb. 2019, sustainablefisheries-uw.org/fishery-feature/atlantic-cod-part1/.