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OVERVIEW OF THE STATE OF AQUACULTURE IN THE US

Report Summary

The global aquaculture production is expected to increase more than 30% over the next decade. As the seafood industry continues to play a significant role in the global livelihood, further advancing production will be necessary to meet increasing demands. Globally, the United States is a minor producer and exporter of commercial marine products, but is a major importer. In recent years the seafood industry in the United States has seen changes; now putting more emphasis on developing and expanding domestic aquaculture within the United States. Despite the Executive Order enacted by the Trump Administration in May of 2020 creating the Seafood Trade Task Force to revise policies and giving federal oversight to NOAA, there are major challenges regarding operations and costs preventing growth.

Beyond regulation challenges, other identified hurdles are: disease prevention, vaccine delivery, fish meal replacement, sustainable solutions, and public perception. Additionally maintaining the balance between wild-caught and farmed seafood is crucial to maintain ecosystem health and overall environment health. In order to sustainably increase aquaculture in the United States bringing together science and industry will be a necessity.

Aquaculture Market Opportunity

Aquaculture is the fastest growing division of global food production. The marine aquaculture segment is considered the most promising industry to ensure global seafood production; accounting for 38% of global aquaculture supply.[1] According to the Food and Agriculture organization of the United Nations, in 2018 global fish production reached an estimated 179 million tonnes, and it is predicted that the demand for fish and fish products across the globe will only increase.[2] According to Markets and Markets, the global Aquaculture market value was estimated at $30.1 billion in 2018. By 2023, the market is expected to witness a growth of CAGR of 7.2%, ultimately reaching a value of $42.6 billion.

Since 1999, there has been a 527% increase in global aquaculture production and 122% increase in total fish consumption across the world[3] due to drivers such as population growth, economic growth, and declines in wild fish availability[4]. Since 2000, the sustainability of global aquaculture production has been a debated topic. A significant market driver is the rising trend

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[1] Campbell, Lisa M., et al. “From Blue Economy to Blue Communities: Reorienting Aquaculture Expansion for Community Wellbeing.” *Marine Policy*, Pergamon, 17 Dec. 2020, www.sciencedirect.com/science/article/pii/S0308597X20310125?casa_token=w3-1rNScSsYAAAAA%3ANa2b4jyGD_iPKEhb5Vt_nWjqueNbfC2rteTRewmWhCXbxm0OYXlRvHHcGwA7QQjHeuGNbbeaUg.

[2] “The State of World Fisheries and Aquaculture 2020.” Www.fao.org, www.fao.org/state-of-fisheries-aquaculture.

[3] “The State of World Fisheries and Aquaculture 2020.”

[4] Naylor, Rosamond L., et al. “A 20-Year Retrospective Review of Global Aquaculture.” *Nature News*, Nature Publishing Group, 24 Mar. 2021, www.nature.com/articles/s41586-021-03308-6.

of smart fishing and an increase in the global seafood trade[5], as more farms are looking to increase efficiency and productivity to keep up with demand.

United States Market Opportunity

The United States is a minor producer and exporter of commercial marine products. Comparatively, the US imports about 75% of its seafood - about 50% of which is grown and produced via aquaculture.[6] According to NOAA, the US is a minor aquaculture producer but does play an important role in the global aquaculture market through supplying advanced technologies, feed, equipment, and investments to global producers[7]. Despite the limited domestic production, the United States has the largest Exclusive Economic Zone (EEZ) in the world (federally managed waters about 200 miles offshore). This area is currently underutilized for offshore farming due to the challenges of obtaining federal permits and completing the required surveys to develop the areas.

However, the seafood industry in the United States is changing, and officials are seeking to grow domestic seafood production. Back in 2020, former President Trump signed an Executive Order on "Promoting American Seafood Competitiveness and Economic Growth." The goal of the order was to increase US seafood production and expand offshore aquaculture. From the order, the Seafood Trade Task Force was developed. Additionally, the order gave the power and authority to NOAA and other organizations. These groups can reassess current commercial fishery management practices. Specifically, NOAA was granted the authority to review current aquaculture standards and develop a uniform set of standards, update aquatic animal health regulations, and redesign the permitting process. A major goal set by NOAA is to identify four offshore areas for finfish, seaweed, or integrated aquaculture production by 2025.[8] Conclusions from these strategies are aimed to increase the US aquaculture competitiveness and develop offshore opportunities.

Regional Differences and Challenges

The United States has one of the largest EEZ, allowing for viable offshore aquaculture growth. However across the country, each region has their own restrictions and challenges that are inhibiting those from entering the market and overall growth.

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[5] "Aquaculture Market." *Markets and Markets*, www.marketsandmarkets.com/Market-Reports/aquaculture-product-market-2224024.html.

[6] Fisheries, NOAA. "U.S. Aquaculture." *NOAA*, 8 July 2021, www.fisheries.noaa.gov/national/aquaculture/us-aquaculture.

[7] Fisheries, NOAA. "U.S. Aquaculture."

[8] Howell, Megan. "Ensuring the Sustainable Growth of the US Offshore Aquaculture Sector." *The Fish Site*, 25 Mar. 2021, thefishsite.com/articles/ensuring-the-sustainable-growth-of-the-us-offshore-aquaculture-sector.

According to NOAA Aquaculture Coordinators from the Northeast, Southeast, and Hawaii and Pacific Islands, one of the biggest hurdles right now is the permitting process for leases. Between surveys and working with multiple organizations to find suitable space, the permitting process can be strenuous and overall confusing. One of NOAA's main goals is to streamline the permitting process, with the hope that a new process will be manageable for new and existing farms. Additionally, identifying new sites for farms can help scale the aquaculture industry in the United States. Andrew Richard, the Aquaculture Coordinator in the Southeast, is working on a project involving identifying areas of opportunities in the Gulf region. The process involves using spatial planning to find the best sites that are deconflicted (not used for military or recreational purposes) and suitable for farm development. The end goal of this project is to provide areas of opportunity to industry for offshore growth.

The negative impact of public preconception is an additional hurdle preventing growth in the United States. Regardless of location, all NOAA coordinators cited public perception as a main challenge to overcome. There has been some growth due to people looking to incorporate more seafood into their diet and increase consumer awareness of the supply chain and where their food is coming from. However, public perception tends to focus on the negative impact rather than the benefits. For example, Tori Spence, the Aquaculture Coordinator for Hawaii and Pacific Islands, mentioned the salmon escape in the Pacific Northwest that infiltrated the native salmon supply as one situation the public tends to come back to. In the Northeast, monitoring and protecting engardered species is crucial for aquaculture growth in the area. As aquaculture interest grows, so do the concerns about putting more gear in the water and impacting the North Atlantic Right Whales. In order to fully sustain aquaculture in the United States, educating the public about the benefits of aquaculture, not just for food supply but for the environment, will be crucial.

However, public perception does change a little based on location. In locations like Hawaii, where seafood is more openly eaten and a part of the cultural diet, the public is more open to aquaculture farms. Tori Spence also mentioned the importance of implementing cultural practices back into farming. This also includes understanding and tying together what is done on land and nearshore to offshore. On the islands, there have been difficulties reviving fish ponds due to them not being very suitable for hatcheries, but one company - Ocean Era - has been able to complete the life cycle for a native fish, which is traditionally grown in fishponds, in their pens. This breakthrough has helped supply the native species back to the fish ponds. Hawaii is also the first state to have a commercial aquaculture farm in federal waters, showing that it is possible.

Programs for Aquaculture Advancement

One of the most recent aquaculture advancement projects comes from ARPA-E. The MARINER (Macroalgae Research Inspiring Novel Energy Resources) project was developed in 2017 for solutions to develop tools that will help the US become a global leader for producing marine biomass. The program is designed to scale macroalgae production for wider uses, like

feedstock, fuels, and chemicals, in addition to supporting production for human consumption. In the project, teams will design and develop technologies to develop viable, renewable biomass for energy applications - without land, freshwater, and synthetic fertilizers.[9]

Challenges Inhibiting Market Growth

COVID-19 Impact

Three months after the first confirmed case of coronavirus, the United States required all nonessential businesses to close. Agriculture and food production were deemed as essential services and were able to continue operations. However, the US aquaculture industry suffered hardships due to the loss of market channels and other disruptions in other economic sectors.[10] In the report, Effects of COVID-19 on U.S. Aquaculture Farms, researchers identified four major effects that pandemic had on the industry, "1) the disruption of traditional marketing channels and resulting losses in revenue; 2) effects on farm labor; 3) challenges with inputs, goods, and services provided by other sectors of the U.S. economy; and 4) management challenges from holding market-ready aquaculture products on farm.[11]" The US aquaculture industry was already classified as vulnerable, but the unforeseen impacts from the COVID-19 crisis are likely to impact the industry for several years.

In addition to increased fish and shellfish consumption driving demand for aquaculture growth, seaweed aquacultures present the unique opportunity to improve urbanized estuaries[12] in areas such as the northeastern United States. While the aquaculture industry in the United States is beginning to accelerate, there are a variety of areas that will require more R&D. According to an article in Forbes, the largest areas in need of innovation in order to support globally sustainable aquaculture are: 1) disease prevention, 2) vaccine delivery, 3) fish meal replacement, 4) development of sustainable solutions.[13]

Challenge 1: Disease Prevention

Environmental factors such as changing water temperatures and water quality can cause marine animals and plants to experience high levels of stress. When they become stressed, they are more susceptible to diseases. Unlike in terrestrial farming, where farmers can easily

[9] "Macroalgae Research Inspiring Novel Energy Resources." *Mariner*, arpa-e.energy.gov/technologies/programs/mariner.

[10] Senten, Jonathan van, et al. "Effects of COVID‐19 on U.S. AQUACULTURE FARMS." *Wiley Online Library*, John Wiley & Sons, Ltd, 3 Jan. 2021, onlinelibrary.wiley.com/doi/full/10.1002/aepp.13140.

[11] Senten, Jonathan van, et al.

[12] Kim, JangKyun, et al. "Opportunities, Challenges and Future Directions of OPEN-WATER Seaweed Aquaculture in the United States." *Taylor & Francis*, 11 Sept. 2019, www.tandfonline.com/doi/full/10.1080/00318884.2019.1625611.

[13] Helmstetter, Michael. "5 Innovations in Aquaculture Worth Catching on to Now." *Forbes*, Forbes Magazine, 31 May 2019, www.forbes.com/sites/michaelhelmstetter/2019/05/29/5-innovations-in-aquaculture-worth-catching-on-to-now/?sh=f8eb220431f2.

administer vaccines by hand or implement preventative measures to protect the animals; aquaculture farmers are limited by delivery and preventative choices. In the wild, fish diseases occur naturally, but are frequently undetected due to dead fish being eaten[14]. In fish farms, there is an increased risk of spreading disease from farmed populations to wild populations from water moving freely between the farms and the ocean water. According to NOAA, disease management is focused on monitoring and maintaining culture conditions for farmed fish to adapt and "resist disease through good nutrition, genetics, and low stress environments"[15] Additionally, infestations of parasites are affecting farmed supplies. One of the biggest concerns is sea lice in farmed salmon. Currently, there is a lack of solutions to manage sea lice infestations without stressing the salmon. Some of the emerging solutions include: using cleaner fish to eat the sea lice, developing physical barriers to prevent shedded sea lice from entering the pens, and developing specific fish feeds with additional supplements to boost protection from infections[16].

Challenge 2: Vaccine Delivery

In vaccine delivery, there has been some progress with innovating mechanical injection systems; however, handling the fish can induce stress. Experts foresee oral delivery of vaccines or immersion vaccines to provide the best solution for aquaculture. Aside from reducing handling and damage, oral vaccine delivery can be repeatedly used, and provide a cost-effective solutions while reducing mortality rates[17]. For oral vaccine administration, vaccines are mixed in with the feed. Many fish are most susceptible to disease in the early or juvenile stages, and require a different vaccine administration approach. For juveniles, immersion systems are best suited. During immersion, vaccine antigens are absorbed through the skin, gills or gut and processed by the immune system[18]. Despite emerging developments, there are still significant opportunities to develop aquatic vaccines.

Challenge 3: Fish Meal Replacement

With increasing demand for marine proteins and products, many aquaculture farms are working to either enter the market or increase current farm efficiency. In order to do that, they are looking to increase supply, which will require more fish feed. Most feed uses fish meal and fish oil which are made from recycled fish parts; this has led to overfishing and has created environmental and economic challenges. Feed costs are a large operational expense and in order to reduce overfishing and costs, developing alternative feed solutions will be imperative.

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[14] Fisheries, NOAA. "Aquaculture Fish Health." *NOAA*, 18 Nov. 2019, www.fisheries.noaa.gov/content/aquaculture-fish-health#:~:text=Over%20the%20last%20two%20decades,appropriate%2C%20judicious%20use%20of%20antibiotics.

[15] Fisheries, NOAA. "Aquaculture Fish Health."

[16] Helmstetter

[17] Helmstetter

[18] Bøgwald, Jarl, and Roy A Dalmo. "Review on Immersion Vaccines for Fish: An Update 2019." *Microorganisms*, U.S. National Library of Medicine, 29 Nov. 2019, pubmed.ncbi.nlm.nih.gov/31795391/.

Challenge 4: Sustainable Solutions

Sustainable solutions in three major areas: economic, environmental, and social will help the future of aquaculture by improving and increasing farm operations. A major focus of sustainable aquaculture solutions is precision fish farming (PFF), utilizing “hardware and intelligent software to improve animal health and welfare while increasing productivity, yield, and environmental sustainability”[19] A few examples are: cameras, sonar, smart feeding systems, and water probes. Monitoring methods are used to understand how growing methods and animals interact with one another; understanding the behavioral and physiological responses between methods and animals can lead to improving fish farming conditions.

[19] Carballeira Braña, Carlos Brais, et al. “Towards Environmental Sustainability in Marine Finfish Aquaculture.” *Frontiers*, Frontiers, 21 Apr. 2021, www.frontiersin.org/articles/10.3389/fmars.2021.666662/full#h6.