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Open Ocean Aquaculture

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Summary

Open ocean aquaculture, defined as the rearing of marine organisms in the U.S. Exclusive Economic Zone, is seen as a viable option for supplying consumer demand for marine products while avoiding inshore user conflicts and addressing the growing seafood trade deficit. However, major barriers to open ocean aquaculture include 1) difficulties in obtaining sufficient front-end capital investment; 2) a multi-agency permitting process; 3) technical challenges in the design and construction of facilities able to withstand the marine environment; and 4) the social and environmental impacts of open ocean aquaculture.

Open ocean aquaculture is broadly defined as the rearing of marine organisms under controlled conditions in the U.S. Exclusive Economic Zone (EEZ), the area that begins generally 3 miles from the U.S. coast at the seaward boundary of state waters and extends to two hundred miles offshore. Several terms for open ocean aquaculture are used interchangeably, including *offshore aquaculture*, *marine aquaculture*, *mariculture*, and *offshore fish farming*. Open ocean aquaculture facilities consist of large enclosures (e.g., cages, net pens) that can be free-floating, secured to a structure, or moored to the ocean bottom. Currently-operating commercial facilities use cages moored to the ocean bottom.

Proponents of open ocean aquaculture cite the growing seafood trade deficit, increasing prospects for employment, and avoiding inshore user conflicts as the main rationales for increasing open ocean production. In 2002, the United States imported 55% of its edible seafood,[1] almost half coming from Asian nations. As a result, seafood is the second largest contributor from a natural resource to the balance of trade deficit. Advocates of open ocean aquaculture operations view it as a means to promote the domestic seafood industry, which has some of the highest unemployment rates in the country. However, critics point out that the high cost of tending fish far from shore means these facilities are likely to be automated and local employment benefits may be minimal.

[1] U.S. Dept. of Commerce, National Marine Fisheries Service, *Fisheries of the United States, 2002*, Current Fishery Statistics No. 2002 (Washington, DC: Sept. 2003), p. 75.

In addition, increasing numbers of different interests such as commercial and sport fishermen, recreational boaters, and coastal landowners are competing for use of inshore coastal waters. Using offshore waters may also be controversial, since traditionally, offshore and nearshore waters have been perceived to be held "in the public trust," and open ocean aquaculture may be perceived by some as the de facto privatization of the ocean.

Currently, two commercial open ocean facilities are operating in U.S. waters — Cates International, Inc. cultivates moi (Pacific threadfin) near Hawaii[2] and SnapperFarms, Inc. cultivates cobia (ling) near Puerto Rico.[3] Kona Blue Water Farms of Hawaii has recently completed the permitting process and is in the process of obtaining financing to begin constructing deepwater pens for the culture of mahimahi.[4]

Internationally, research and commercial open ocean aquaculture facilities are in operation or under development in Norway, Japan, and Chile. Alaska commercial fishermen and state officials have expressed concern over the potential environmental and commercial impact of possible Canadian open ocean aquaculture for sablefish (blackcod), a $10.9 million Alaskan fishery.

As part of a National Marine Aquaculture Initiative, the National Sea Grant College Program has initiated research throughout the United States on open ocean aquaculture.[5] Many species are currently being studied, including halibut, haddock, and cod at the University of New Hampshire; black sea bass at the University of South Carolina; mutton snapper at Universities of Miami and North Carolina; cobia at the Universities of Virginia, South Carolina, Mississippi, and Texas; yellowtail snapper at the University of Texas; corvina at the University of California; and bay scallops at the National Oceanic and Atmospheric Administration (NOAA) Fisheries Milford Laboratory in Milford, CT, and the University of South Florida. Other research topics being investigated include hatchery culture technologies; designs for automated feeders; culture of new species; identification and control of diseases; development of cages and husbandry technology for rough water environments; identification of alternative food sources; understanding of nutrition requirements; definition of carrying capacity of offshore waters; and development of environmental monitoring technology.

Barriers to Open Ocean Aquaculture

Four major barriers to open ocean aquaculture are: difficulties in obtaining sufficient front-end capital investment; a multi-agency permitting process; technical challenges in

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[2] *Hawaii Business* at [http://www.hawaiibusiness.cc/hb32004/default.cfm?articleid=11], visited August 12, 2004.

[3] Snapperfarms at [http://www.snapperfarm.com/], visited July 16, 2004.

[4] Kona Blue Water Farms at [http://www.blackpearlsinc.com/3_4.shtml], visited Aug. 5, 2004.

[5] Helsley, Charles E., "Open Ocean Aquaculture – a Venue for Cooperative Research Between the United States and Japan," In: Nakamura, Y., et al. (eds.), *Ecology of Aquaculture Species and Enhancement of Stocks*, Proceedings of the Thirtieth U.S. – Japan Meeting on Aquaculture (Sarasota, FL: Mote Marine Laboratory), UJNR Technical Report No. 30, p. 1-6.

the design and construction of facilities able to withstand the marine environment; and the social and environmental impacts of open ocean aquaculture.

Funding. New technology and high capital costs make securing funds for new open ocean facilities difficult. In addition to capital costs, the location of the aquaculture facilities away from shore will carry high variable costs such as fuel, transport, feed, and equipment. NOAA anticipates submitting a draft "National Offshore Aquaculture Act" to the Office of Management and Budget that would provide for long-term (10-, 20-, or 30-year) leasing of ocean tracts to insure a longer-term business and assist entrepreneurs in securing financing.[6]

Permitting. The multi-agency permitting process leads to uncertainty for the open ocean aquaculture industry, making it difficult to plan and finance operations. Current permitting requires approval by five federal agencies that have oversight responsibility. The U.S. Environmental Protection Agency is responsible for granting water pollution exemptions under the Ocean Dumping Act (33 U.S.C. §§1411 et seq.). The Army Corps of Engineers has jurisdiction, because of navigation concerns, over permanent or temporary "devices" used to explore, develop, or produce resources on or around the seabed in federally controlled waters (33 C.F.R. Part 322). NOAA Fisheries authorizes open ocean aquaculture operations through an exempted fishing permit, under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§1801 et seq.). NOAA Fisheries also has review responsibilities under the Marine Mammal Protection Act (16 U.S.C. §§1361 et seq.) and the Endangered Species Act (16 U.S.C. §§1531 et seq.). The Coast Guard regulates vessel traffic and dictates safety measures (light and signal) for aquaculture structures to ensure safe vehicle passage under the Rivers and Harbors Act of 1899 (33 U.S.C. §407). The Fish and Wildlife Service has review and commenting responsibilities for any project that may harm threatened species under the Fish and Wildlife Coordination Act (16 U.S.C. §§661 et seq.), the Endangered Species Act, the Marine Mammal Protection Act, and the Migratory Bird Treaty Act (16 U.S.C. §§703 et seq.). The review required under each of these five agencies' responsibilities can delay or result in denial of a permit. A draft "National Offshore Aquaculture Act," under development by NOAA for submission to the Office of Management and Budget for review, would establish a "one-stop" permitting system for open ocean aquaculture operators. Under the proposed measure, open ocean aquaculture facilities would be regulated under fishery management plans by exempting the farm-raised fish from some of the requirements normally imposed on conventional commercial fishing. This legislation would implement a U.S. Commission on Ocean Policy recommendation that a multi-agency aquaculture program be managed through a new Office of Sustainable Marine Aquaculture.[7]

Technical Challenges. Open ocean aquaculture facilities, moored miles off the coast in a high-energy environment, experience numerous environmental conditions, including exposure to wind and wave action from all directions, short and steep wave

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[6] See "Aquaculture for the Future" at [http://www.pnwer.org/meetings/Summer2004/Presentations/Chaves.pdf], visited Aug. 18, 2004.

[7] The U.S. Commission on Ocean Policy's preliminary report, *Preliminary Report of the U.S. Commission on Ocean Policy*, was available at [http://oceancommission.gov/documents/prelimreport/welcome.html] on Apr. 27, 2004.

patterns, strong currents, seasonal anoxic (oxygen-lacking) conditions at depth, and unpredictable ocean conditions that can prevent operators from being able to access their cages for days to weeks. Some of the systems developed to overcome these obstacles include using cages that are anchored deep enough below the surface to avoid wind and wave action, that can be towed out of unfavorable conditions, or that are rigid to allow the waves to flow through them, instead of against them.[8] Universities and commercial researchers are in the process of developing automated buoys that can monitor and feed the fish for weeks and completely automated floating cages that would travel with the currents.

Impacts. Some suggest that open ocean finfish aquaculture systems may encounter fewer of the environmental issues experienced in near-shore aquaculture systems. However, some critics of open ocean aquaculture cite a number of concerns, such as the escape of fish, water pollution from feed and waste, and the spread of water-borne disease from cultured to wild fish.[9] Environmental groups hope that the regulations will become more stringent, since existing regulations are not necessarily designed to address issues specifically relating to open ocean aquaculture. NOAA Fisheries and the Gulf of Mexico Regional Fishery Management Council reportedly are pursuing independent efforts to provide better regulatory oversight and direction to deter poorly conceived projects.[10]

Open ocean aquaculture pens are open to the surrounding environment, allowing fish feces and uneaten food to fall into the surrounding water, possibly degrading water quality. However, current research indicates that currents keep water around fish cages well circulated, dissipating waste products quickly, resulting in minimal impact of open ocean aquaculture facilities on water quality.[11] Critics, however, question whether the experience with small-scale experimental facilities is relevant to future commercial operations, which will likely need to be much larger to be profitable. A possible solution suggested by environmental groups is to combine finfish operations with the culture of seaweeds or bivalves to consume the excess nutrients.

Most fish currently approved for open ocean aquaculture are carnivorous and consume large amounts of fishmeal and fish oil, which is obtained from wild fish stocks. As a result, three or more pounds of wild fish are required to produce one pound of farmed fish, causing some to question whether aquaculture production could exacerbate pressures on ocean fish stocks, rather than relieving pressure.[12] While this concern could be addressed by raising more herbivorous fish, open ocean aquaculture facilities will need

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[8] Ocean Spar cages at [http://www.oceanspar.com], visited Aug. 12, 2004.

[9] Open Ocean Aquaculture, Institute for Agriculture and Trade Policy at [http://www.iatp.org/fish/library/uploadedFiles/Open_Ocean_Aquaculture.pdf], visited Aug. 4, 2004.

[10] "Agency Sinks Proposal for Gulf Fish Farm," *St. Petersburg Times* (Dec. 30, 2003) at [http://www.sptimes.com/2003/12/30/Southpinellas/Agency_sinks_proposal.shtml], visited Aug. 4, 2004.

[11] The University of New Hampshire's CINEMar/Open Ocean Aquaculture Annual Progress Report for the period 1/01/03 to 12/31/03 at [http://ooa.unh.edu/environmental/index.html], visited Aug. 4, 2004.

[12] Naylor, Rosamond L., et al., "Effect of aquaculture on world fish supplies," *Nature*, v. 405 (June 29, 2000): 1017-1024.

to initially grow and process high-value carnivorous fish species to offset large investment costs. Alternatives to wild fish-derived fishmeal are under investigation, such as soy-based fishmeal and the culture of smaller herbivorous fish as a fishmeal source.

Another concern involves the spread of fish-borne disease and genetic anomalies that could possibly occur if wild fish are exposed to or interbreed with hatchery-raised fish. This issue would arise if genetically modified or non-native fish could escape from aquaculture facilities and breed with wild fish.[13] Critics claim that cultured fish are bred to grow faster and larger than native fish; they can out-compete native fish in the short term but often do not have the genetic heritage to survive in the wild for the long term. This is especially a concern in states such as California, where genetically modified fish are banned within state waters but might be grown offshore in federal waters.

Since facilities will be offshore and underwater, possible harm or disturbance to marine mammals and other wildlife are a concern. To address these concerns, current cage designs avoid the use of small diameter or loose lines to prevent the entanglement of sea turtles and marine mammals in net pens and associated gear. Since net pens would be under tension, the possibility that a turtle flipper or whale fluke would get tangled in lines or nets is likely minimal.

Federal Action

At its November 2003 meeting, the Gulf of Mexico Regional Fishery Management Council adopted an open ocean aquaculture policy for the Gulf of Mexico EEZ.[14] The Council developed this policy to encourage environmentally responsible open ocean aquaculture, opposing the use of non-native species unless no detrimental impacts on native species can be demonstrated and recommending that only FDA-approved therapeutic and chemical treatments be used as part of best management practices. This policy also contains provisions on the location, design, and operation of facilities to prevent adverse impacts on the environment and minimize conflicts with other stakeholders. Recently the Gulf of Mexico Regional Council completed public hearings to review management options for open ocean aquaculture under the Magnuson-Stevens Act and may adopt a fishery management plan amendment on this subject as early as fall 2005.[15] However, some worry that management under the Magnuson-Stevens Act may add another layer of bureaucracy, especially if the other seven regional fishery management councils follow suit and develop their own, possibly contradictory, open ocean aquaculture management policies.

In addition to NOAA Fisheries and the Gulf of Mexico Regional Council initiatives, the Rigs to Reefs Act of 2003 (H.R. 2654) has been introduced to authorize the use of

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[13] Goldburg, Rebecca J., Matthew S. Elliott, and Rosamond L. Naylor, *Marine Aquaculture in the United States: Environmental Impacts and Policy Options*, Pew Oceans Commission (Arlington, VA: July 2001), p. 6-9. See [http://www.pewoceans.org/reports/137PEWAquacultureF.pdf], visited Aug. 17, 2004.

[14] The Gulf of Mexico Council's open ocean aquaculture policy is available at [http://www.gulfcouncil.org/downloads/mariculture_policy_GMFMC.pdf], visited Aug. 4, 2004.

[15] 69 *Federal Register* 7185-7186, Feb. 13, 2004.

decommissioned offshore oil and gas platforms for the culture of marine organisms. This bill would exempt oil and gas companies from having to remove offshore production platforms within a year of lease termination and award them tax credits for allowing their platforms to be used for open ocean aquaculture, artificial reefs, or scientific study. Proponents of the bill see major economic potential in establishing aquaculture operations at decommissioned oil and gas platforms, although opponents fear that the oil and gas industry could use the provisions of this bill to avoid the substantial costs of removing offshore production platforms.

Limited federal funding has been provided for open ocean aquaculture. Under NOAA's Ocean and Atmospheric Research budget, $1.7 million was appropriated in FY1998, followed by an additional $2.4 million each in FY1999, FY2000, and FY2001, for the open ocean aquaculture demonstration project at the University of New Hampshire.[16] Additional funding for open ocean aquaculture research is provided through NOAA's National Sea Grant College Program, but the portion devoted specifically to open ocean aquaculture cannot be determined.

Chronology

09/26/1980 – The National Aquaculture Act of 1980 (P.L. 96-362, 16 U.S.C. §§2801 et seq.) establishes a national policy of encouraging development of aquaculture in the United States.[17]

09/00/1995 – Open ocean aquaculture recognized by the federal Office for Technology Assessment as a potentially viable way to raise fish.[18]

00/00/1997 – The University of New Hampshire begins its Open Ocean Aquaculture Demonstration Project, funded through Sea Grant.

00/00/2001 – Cates International, Inc. opens the first commercial open ocean aquaculture facility.

04/20/2004 – The U.S. Commission on Ocean Policy recommends that open ocean aquaculture by streamlined and permitting be located within NOAA.

00/00/2004 – NOAA anticipates submitting a draft "National Offshore Aquaculture Act" to the Office of Management and Budget for review.

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[16] The University of New Hampshire's open ocean aquaculture project overview at [http://ooa.unh.edu/overview.html], visited Aug. 5, 2004.

[17] National Aquaculture Act of 1980 at [http://www.nmfs.noaa.gov/sfa/sfweb/aqua_act.htm], visited Aug. 5, 2004

[18] Office of Technology Assessment, *Current Status of Federal Involvement in U.S. Aquaculture*, at [http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk1/1995/9554/9554.PDF], visited Aug. 6, 2004.