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Open Ocean Aquaculture

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Summary

Open ocean aquaculture, defined as the rearing of marine organisms under controlled conditions in exposed, high-energy ocean environments beyond significant coastal influence, is one possible option for meeting increasing consumer demand for marine products and offering new and alternative employment opportunities. Proponents see such development as avoiding inshore user conflicts, reducing environment effects, benefitting coastal communities, and potentially addressing the growing seafood trade deficit. Opponents point to a host of other concerns.

Major challenges to open ocean aquaculture development include (1) choosing appropriate species and culture techniques; (2) obtaining sufficient start-up capital investment; (3) remaining competitive in an international market; (4) negotiating a complicated legal and regulatory environment; (5) designing and constructing facilities able to withstand the open ocean marine environment; (6) evaluating social and economic impacts; (7) addressing potential environmental impacts; and (8) developing shoreside infrastructure. New and developmental technology, the risk and uncertainty associated with exposed open ocean locations, lack of operational experience, and high capital start-up costs make estimating profitability and securing financing difficult for new open ocean aquaculture ventures. In addition, significant questions remain about whether an appropriate mechanism exists for any federal agency to provide an open ocean aquaculture lease applicant with the necessary property rights to begin construction and operation. Any U.S. open ocean aquaculture enterprise will also face issues of how to compete in a global marketplace with nations whose aquaculture production costs are likely much lower.

The National Oceanic and Atmospheric Administration drafted a "National Offshore Aquaculture Act" that would implement some of the recommendations of the U.S. Commission on Ocean Policy; this legislation was introduced in the 109th Congress as S. 1195. Under the Magnuson-Stevens Fishery Conservation and Management Act, several regional fishery management councils have adopted fishery management plan amendments to address open ocean aquaculture development.

This report will be updated as circumstances warrant.

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Open Ocean Aquaculture

Open ocean aquaculture is broadly defined as the rearing of marine organisms under controlled conditions in exposed, high-energy ocean environments beyond significant coastal influence. These activities are located at a considerable distance from shore and are open to the natural ocean elements from all sides. When such operations are located beyond coastal state jurisdiction, within the U.S. Exclusive Economic Zone (EEZ), they are regulated primarily by federal agencies.[1] Thus far, only a few aquaculture research facilities have operated in the U.S. EEZ;[2] all commercial aquaculture facilities have been sited in nearshore waters under state or territorial jurisdiction.

Several terms for open ocean aquaculture are used interchangeably, including *offshore aquaculture* and *offshore fish farming*.[3] Open ocean aquaculture facilities[4] consist of systems (e.g., cages, net-pens, longline arrays) that can be free-floating, secured to a structure, moored to the ocean bottom, or towed by a vessel.[5] Currently operating commercial facilities in nearshore waters use cages moored to the ocean bottom. In addition, there has been some experimentation in offshore shellfish culture on the bottom (seabed) and from suspended ropes and longlines. Offshore seaweed culture may also be considered.

Internationally, research and commercial open ocean aquaculture facilities are in operation or under development in Australia, Chile, China, France, Ireland, Italy, Japan, Mexico, and Norway.[6] Currently, two commercial open ocean facilities are operating in U.S. state/territorial waters. Cates International, Inc., cultivates moi

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[1] Federal agencies also have regulatory authority over aspects of aquaculture development in nearshore waters under state/territorial jurisdiction.

[2] For example, the Gulf of Mexico Offshore Aquaculture Consortium's site was located 26 nautical miles offshore in federal waters.

[3] *Marine aquaculture* and *mariculture* are broader terms, also referring to the land-based culture of marine organisms as well as their culture in nearshore, coastal, and exposed environments.

[4] Descriptive information on different culture systems was available on Mar. 28, 2006, at [http://hmsc.oregonstate.edu/projects/msap/system.html].

[5] Towed cages have been used to hold bluefin tuna prior to harvesting to optimize marketing; see 69 *Federal Register* 39435-39436 (June 30, 2004).

[6] For more information on international efforts, see Biliana Cicin-Sain et al., "Chapter 6: Lessons from the International Arena," in *Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 Mile U.S. Ocean Zone* (Newark, DE: Univ. of Delaware, Center for the Study of Marine Policy, 2001), available at [http://darc.cms.udel.edu/SGEEZ/SGEEZ1final.pdf], on Mar. 28, 2006.

(Pacific threadfin) near Hawaii[7] and SnapperFarms, Inc., cultivates cobia (ling) near Puerto Rico.[8] In September 2005, Kona Blue Water Farms of Hawaii celebrated its first harvest of kahala (*Seriola rivoliana*), reared in deepwater pens in state waters.[9] Although these are open ocean operations, all U.S. commercial facilities are currently sited in waters under state or territorial jurisdiction.

Challenges to Open Ocean Aquaculture

Eight major challenges to open ocean aquaculture development are (1) choosing appropriate species and culture techniques; (2) obtaining sufficient start-up capital investment; (3) remaining competitive in a global market; (4) negotiating a complicated legal and regulatory environment; (5) designing and constructing facilities able to withstand the open ocean marine environment; (6) evaluating potential social and economic impacts; (7) addressing potential environmental impacts; and (8) developing necessary shoreside infrastructure.[10]

Species and Culture Techniques. Appropriate species and culture techniques, including species selection, egg/larval production, and nutritional/dietary requirements, need to be identified and developed. New culture techniques may be required for rearing species not presently grown.

Many economically important species are currently being studied for possible culture, including halibut, haddock, cod, flounder, and blue mussels at the University of New Hampshire; black sea bass at the University of South Carolina; mutton snapper and flounder at the Universities of Miami and North Carolina; cobia at various universities in Virginia, South Carolina, Mississippi, and Texas; yellowtail snapper at the University of Texas; amberjack at the Oceanic Institute; several deep-water snappers at the University of Hawaii; and corvina at Hubbs-SeaWorld Research Institute in California. Additional universities are experimenting with mahimahi, red drum, tuna, striped bass, and other species. 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; information on nutrition requirements; definition of carrying

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[7] "Moi to the World," *Hawaii Business* (March 2004), at [http://www.hawaiibusiness.com/archivearticle.aspx?id=717&qr=moi], visited Mar. 28, 2006.

[8] Snapperfarms, at [http://www.snapperfarm.com/], visited Mar. 28, 2006.

[9] Kona Blue Water Farms, at [http://www.blackpearlsinc.com/3_4.shtml], visited Mar. 28, 2006; also "Kona Blue Marks First Ocean Harvest," *Pacific Business News*, Sept. 22, 2005.

[10] Detailed discussions of many of the issues discussed in this section are available in *Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 Mile U.S. Ocean Zone* (2001) by the University of Delaware's Center for the Study of Marine Policy, available at [http://darc.cms.udel.edu/sgeez/sgeez1final.pdf], visited Mar. 17, 2006; and *Recommendations for an Operational Framework for Offshore Aquaculture in U.S. Federal Waters* (October 2005) by the University of Delaware's Gerard J. Mangone Center for Marine Policy, available at [http://darc.cms.udel.edu/sgeez/sgeez2final.pdf], visited Mar. 17, 2006.

capacity of offshore waters; development of appropriate mooring systems; development of drifting and self-powered cages; federal regulatory structure; and development of environmental monitoring technology.

Financing. New and developmental technology, the risk and uncertainty associated with operating in exposed open ocean locations, lack of operational experience, and high capital start-up costs make estimating profitability and securing financing difficult for new open ocean aquaculture companies. In addition to capital costs, the location of the aquaculture facilities away from shore will necessitate high variable costs such as fuel, feed, and security and/or surveillance. Proponents of open ocean aquaculture development assert that, without some form of long-term (at least 25-year term) leasing[11] of the water surface, water column, and seabed, open ocean aquaculture will have significant problems in securing capital from traditional funding sources, obtaining suitable insurance on the capital investment and stock, and protecting investments from vandalism and other property threats. Such leasing may be problematic until property rights beyond the territorial sea are clarified.

Fostering industry/academic partnerships may be beneficial to open ocean aquaculture development.[12] Some suggest that, for development to occur, one must accept that open ocean aquaculture is "big science" along the lines of atomic/nuclear physics research and the Human Genome Project. In this light, the developing open ocean aquaculture industry may benefit by seeking and promoting partnerships with large multinational industrial, agricultural, and pharmaceutical corporations.[13] Proponents argue that this is the most likely way for open ocean aquaculture to obtain the ocean engineering, marine technology, and floating platform infrastructure necessary to match the sophistication of current biological knowledge.

The availability of insurance coverage on stock and equipment is relevant to, and can facilitate obtaining, front-end capital for offshore aquaculture. The insurance sector has more than 30 years of experience in managing and insuring risks to conventional aquaculture stock and equipment in a variety of situations and conditions. Although the insurance industry is unlikely to view pilot projects favorably, the earlier the insurance industry is brought into developing open ocean

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[11] In addition, some nations (e.g., Canada) lease nearshore areas with implied automatic renewal of tenure as long as the lessee meets current licensing requirements. Alternatives on leasing for short time periods include issuing research permits or vesting tenure in a federal or state agency initially to streamline the process and allow greater control over eventual ownership of tenure issues.

[12] However, critics caution that funding open ocean aquaculture development through universities has the potential to slow commercial development if academic solutions are insufficiently pragmatic for commercial industry.

[13] Potential partners include oil and gas companies with related support industries, defense contractors developing large floating structure technology and platforms, and ocean engineering companies laying submarine cable and developing affiliated technology for telecommunications corporations. Others may include corporations exploring wind and/or wave-energy generation, ocean thermal energy conversion and related deep ocean water upwelling systems, carbon sequestration and mitigation, and ocean fertilization.

aquaculture, the earlier the industry is likely to become comfortable with the risks that must be insured.

Reliance on private capital may ensure that the innovation for U.S. development of open ocean aquaculture will come from other countries already investing in technology development. Proponents of open ocean aquaculture suggest that, if profits are to be made, sufficient investment capital must be available as soon as property rights, permitting, and environmental concerns are resolved. More pessimistic critics suggest that open ocean aquaculture is unlikely ever to have an adequate economic return on investment, and that investment should rather be focused on improving nearshore aquaculture.

Market Competitiveness. The United States has been, for the most part, a technological innovator, and the use of marine resources to farm new species with higher market potential could give the United States a competitive edge. On the other hand, the U.S. commercial fishing industry has been losing market share to foreign aquaculture production. Dependable air freight has allowed aquaculture operations to market globally. For example, the worldwide salmon farming industry has displaced jobs in Alaskan coastal communities. The primary challenge for developed nations, such as the United States, is how to minimize capital, labor, energy, permitting, and other costs compared to those for aquaculture in other countries and to wild stock harvesting. The potential competitive disadvantage posed by the higher costs for goods and services in the United States also increases the difficulty in obtaining commercial investment for U.S. open ocean aquaculture development. More simply, a major challenge is likely to be whether U.S. open ocean aquaculture operations can produce their product at prices competitive with foreign aquaculture. As competition increases with global development and expansion of aquaculture production, controversy could arise if U.S. open ocean aquaculture operators seek to relocate to nearshore locations to reduce costs and remain competitive. Government assistance could promote initial development of a U.S. open ocean aquaculture industry, but global market forces would likely determine whether it matures or withers.

Legal and Regulatory Environment. Legal and regulatory challenges may be particularly time-consuming and costly, although some suggest that moving aquaculture away from the coast, and out of the view of the majority of people, could alleviate some public concerns. The complexities of multi-agency permitting are not clearly understood by all interested parties, leading to uncertainty for the open ocean aquaculture industry and making it difficult to plan and finance operations. Current permitting requires approval by at least three federal agencies that have jurisdiction over various aspects of aquaculture — the U.S. Environmental Protection Agency, the Army Corps of Engineers, and NOAA Fisheries. The review required under each of these agencies' responsibilities can delay or deny a permit. Some of these agencies will likely be involved in future decisions that provide legal rights to open ocean aquaculture operators.

For aquaculture projects in offshore federal waters, the lead federal permitting agency must assure consistency with approved programs in adjacent states under the Coastal Zone Management Act (16 U.S.C. §§1451 et seq.). In addition, state waters are traversed both to operate open ocean aquaculture sites and to bring harvested fish

ashore for processing. States with approved plans may veto federal permits for activities that are inconsistent with the state's Coastal Zone Management Plan. This oversight ensures that operations occurring in federal waters adjacent to state waters will neither cause harm to that state's interests nor be inconsistent with state policies.

The U.S. Environmental Protection Agency regulates the discharge of pollutants into waters of the United States from finfish aquaculture facilities under the Clean Water Act (CWA; 33 U.S.C. §§1251, et seq.). Under the CWA's National Pollutant Discharge Elimination System, such facilities are regulated under the category "concentrated aquatic animal production facilities."[14] For aquaculture facilities located in offshore federal waters, §403(c) of the CWA requires an additional review to prevent unreasonable degradation of the marine environment. Discharges that cause unreasonable degradation are prohibited.

Because of navigation concerns, the Army Corps of Engineers has jurisdiction 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). 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). In addition, the Department of Defense may become involved, reviewing proposals for possible interference with naval operations.

Through a NOAA General Counsel opinion,[15] NOAA has assumed the lead agency role in promoting open ocean aquaculture development and has been supportive of this industry. In some cases, NOAA Fisheries authorizes open ocean aquaculture operations for scientific purposes through an exempted fishing permit and has defined marine aquaculture as fishing, under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§1801 et seq.).[16] In addition, the Magnuson-Stevens Act requires the federal permitting agency for any aquaculture facility to consult with NOAA for potential impacts to designated essential fish habitat (EFH). EFH is designated for all marine species for which there is a federal fishery management plan (FMP). 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.). These reviews could conflict with promoting open ocean aquaculture.

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[14] 40 C.F.R. Part 451; see 69 *Federal Register* 51891-51930 (Aug. 23, 2004).

[15] Jay S. Johnson and Margaret F. Hayes, *Regulation of Aquaculture in the EEZ*, Memorandum, Office of the General Counsel, NOAA, Washington, DC, Feb. 7, 1993, 5 p.

[16] Based on a legal opinion by NOAA General Counsel, landings or possession of fish in the Exclusive Economic Zone from a commercial marine aquaculture operation producing species managed under FMPs constitutes "fishing" as defined in the Magnuson-Stevens Act. Therefore, to allow such commercial production in the EEZ, FMPs must be amended to allow for such activity for managed species and for the regulation of the activity by NOAA Fisheries. Scientific activity for marine aquaculture in the EEZ is regulated by the federal role for exempted fishing permits (50 C.F.R. §600.745).

Also under the authority of the Magnuson-Stevens Act, several regional fishery management councils have exercised regulatory oversight over open ocean aquaculture. The New England and Gulf of Mexico Councils have been particularly active in this respect.[17] The New England Council has established evaluation criteria for open ocean aquaculture proposals that encourage the use of the best management practices aimed at reducing environmental and fishery impacts. For other regional management councils, although the key installation, navigation, and water quality permits can be obtained from the agencies mentioned above after a thorough permit development and public review process, commercial aquaculture is less likely to occur in offshore federal waters because there are no aquaculture FMPs or generic aquaculture amendments to all the appropriate FMPs for species that could be cultured. In addition, it is unclear what regulatory authority NOAA Fisheries and the regional councils might have over species, like mussels, that are not managed through a federal FMP.

Finally, using offshore waters will probably be legally controversial. Traditionally, nearshore waters and their resources under state jurisdiction are considered to be held and managed "in the public trust." Open ocean aquaculture may be perceived by some as the de facto privatization of the ocean, which has historically been considered a common property resource.[18] Precedents in the leasing of offshore areas for the development of oil and gas resources may be relevant to these concerns. However, significant questions remain concerning whether an appropriate mechanism exists for any federal agency to provide an open ocean aquaculture lease applicant with the necessary property rights to begin construction and operation. Siting and site tenure in federal waters are important issues for development and private investment — without assurances and protection of exclusive rights, there is little incentive for financial investment.

Technical Aspects. Since open water aquaculture is a relatively new industry, many potential operators are inexperienced with the technical requirements for open ocean facilities. Current development has been limited by technology that requires water depths between about 100 feet and 150 feet; this narrow band of acceptable depths exists from 1/4 mile to 50 miles offshore. Open ocean aquaculture facilities, moored or floating miles off the coast in a high-energy environment, experience numerous environmental conditions that differ from nearshore aquaculture operations, including exposure to wind and wave action from all directions, short and steep wave 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.[19] Systems have

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[17] "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 Mar. 28, 2006.

[18] The government regularly grants exclusive use of public resources when there are public benefits, establishing a precedent for ocean leasing for commercial aquaculture to increase domestic fish supply. For a more detailed discussion of these issues, see CRS Report RL32658, *Wind Energy: Offshore Permitting*, by Aaron M. Flynn.

[19] A pilot study cage in the Gulf of Mexico was torn from its mooring in December 2000 and (continued...)

been developed to overcome these obstacles, including cage designs that do not deform under current and wave loads,[20] submersible cages, and single-point moorings.[21] Cage-mounted autonomous feeding systems have been developed that can operate both at the surface and submerged.[22] Others have developed closed containment systems for open ocean use to address environmental concerns.[23] Universities and private-sector research interests are developing automated buoys that can monitor the condition of stock and feed fish on a regular basis for weeks at a time. Other research groups are working on automated, floating cages that would travel with the currents and be tracked by satellite.[24] These ship-like structures could float on favorable oceanic currents or be held geostationary with low-energy thrusters.

As noted above, technological solutions provided from an academic perspective may not always be pragmatic enough for commercial use. Private industry has often been at the forefront in addressing and solving pragmatic technical issues in a new field. Proponents of development also suggest that there has been inadequate research funding of the amount and duration needed to develop and demonstrate suitable technologies for meeting open ocean aquaculture's technical challenges.

Social and Economic Impacts. Some Members of Congress, especially those from coastal areas with strong fishing communities, are interested in the social and socioeconomic impacts of open ocean aquaculture development. The development of open ocean aquaculture could increase competition for wild-caught fish, lowering prices and driving commercial fishermen out of business. Thus, open ocean aquaculture could replace current fish production (from commercial fishing) instead of supplementing (adding to) fish production, with little or no change in domestic fish production/value, especially if open ocean aquaculture development is not compatible with existing capture fisheries. From another perspective and with appropriate research support, open ocean aquaculture might provide opportunities for commercial fishermen who no longer pursue harvests in managed capture fisheries.

Due to international markets and foreign production, the socioeconomic impacts of open ocean aquaculture production (e.g., changes in prices and markets) will likely occur whether the United States permits or denies open ocean aquaculture development (for example, the state of Alaska prohibited salmon aquaculture, but its development elsewhere resulted in significant socioeconomic impacts for Alaska).

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[19] (...continued)
was later found off the coast of Louisiana after a long search.

[20] Ocean Spar cages at [http://www.oceanspar.com/seastation.htm], visited Mar. 28, 2006.

[21] See [http://www.masgc.org/oac/abstract12.html], visited Mar. 28, 2006.

[22] See [http://web.mit.edu/seagrant/aqua/cfer/robofeeder.html], visited Mar. 28, 2006.

[23] Sargo™ products, see [http://www.sargo.net/], visited Mar. 28, 2006.

[24] See [http://www.wired.com/wired/archive/12.05/fish.html], visited Mar. 28, 2006. Critics question whether this type of floating-unmanned-remote control cage could ever be permitted, due to the major navigational hazard it could present.

Concerned parties suggest that social and economic impact assessments should be part of any aquaculture development plan from the onset.

In addition, if many of the proposed species for open ocean aquaculture are carnivores, it is possible that increased imports of fishmeal derived from small pelagic wild fish will be required to feed to the farmed fish. If so, these increased imports could increase the U.S. trade deficit. Open ocean aquaculture development also has the potential to interfere with maritime transportation and commercial fisheries, and potential conflicts over access and transit rights may need to be mediated.[25] Because of this potential for conflict, a process may need to be developed to identify the more suitable areas in federal waters for open ocean aquaculture development. Also, safety issues with offshore facilities may need to be addressed.

The proponents of offshore aquaculture assert that economic benefits will result from the development of this industry. Individuals familiar with the experiences of coastal aquaculture have raised questions about the sustainability of offshore fish farming in relation to its impact on local communities. The potential cumulative impacts of open ocean aquaculture development on coastal communities have not yet been researched. Based on the history of salmon farming, some have questioned the claims of aquaculture as a jobs creator, especially since it will likely become a highly automated industry. Additionally, little evidence has been provided for the economic benefits of open ocean aquaculture development beyond the general acknowledgment that marine aquaculture has proven profitable elsewhere, especially in areas with little or no environmental regulation and/or enforcement (e.g. Chile). Profitability aside, there are indications that marine open ocean aquaculture, like salmon farming, could produce unintended harm to local economies and commercial fishing. Many of the species under consideration for open ocean aquaculture are important or valuable fish that support commercial fisheries and contribute to the national seafood supply. Aquaculture of these species could create a competing supply, perhaps lowering prices and harming commercial fishermen and communities. Environmentalists and advocates of sustainable wild fisheries express fear that an open ocean aquaculture industry could harm traditional commercial fisheries and the local communities they support, as has been the case in coastal areas of Alaska, where many commercial fishermen have been put out of business and there have been dramatic changes to coastal communities as a result of expanded salmon farming in other parts of the world.[26] The governor of Alaska recently asked the U.S. Secretary of Commerce for a five-year moratorium on open ocean aquaculture development.[27]

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[25] Submerged technologies for open ocean aquaculture may reduce or eliminate some of these concerns.

[26] Norwegian Directorate of Fisheries, *Key Figures from Norwegian Aquaculture Industry, 2000*, Directorate of Fisheries, Department of Aquaculture (Bergen, Norway: 2001), 15 p.; Neal Gilbertson, "The Global Salmon Industry," *Alaska Economic Trends*, v. 23, no. 10 (Oct. 2003), pp. 3-11; Rosamond L. Naylor et al., "Salmon Aquaculture in the Pacific Northwest: A Global Industry with Local Impacts," *Environment*, v. 45, no. 8 (Oct. 2003), pp. 18-39.

[27] See [http://gov.state.ak.us/archive.php?id=1241&type=1], visited Mar. 28, 2006.

Environmental Impacts. Proponents of open ocean aquaculture and many environmental groups suggest that open ocean finfish aquaculture systems may encounter similar, but fewer, environmental concerns than those experienced by nearshore aquaculture systems. This in part may be due to the theory that dissolved and particulate waste products and excess feed may be assimilated and recycled more efficiently in the open ocean environment. However, the scope of any effects may vary greatly, depending on the technique, location, size/scale, and species raised.[28] Some critics of open ocean aquaculture cite concerns with the escape of fish, water pollution from uneaten feed and waste products,[29] use of antibiotics and other animal drugs, alteration of benthic habitat by settling wastes, and the spread of waterborne disease from cultured to wild fish.[30] The present lack of knowledge — owing to limited experience, lack of research funding, and few studies focusing specifically on open ocean aquaculture — limits our understanding of potential environmental concerns. Critics of open ocean aquaculture hope that regulation of this emerging industry will be stringent.

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. An opposing view holds that open ocean waters are normally nutrient-deficient, and nutrients released from open ocean aquaculture operations may increase wild production in adjacent areas, much like coastal areas benefitting from natural upwelling. A related concern is whether large operations will result in significant waste settling that could alter benthic habitat. However, current research indicates that currents may keep water around fish cages well circulated, dissipating waste products quickly, resulting in minimal impact of open ocean aquaculture facilities on water quality.[31] Critics, however, question whether the experience with experimental facilities is relevant to future commercial operations, which will likely need to be much larger to be profitable.[32] A possible solution suggested is to combine finfish operations with the culture of seaweeds or bivalves to consume the excess nutrients; this approach is being tested by the University of New Hampshire at their open ocean aquaculture research project, but may be more appropriate for

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[28] An extended discussion of most of the issues summarized in this section can be found in *Guidelines for Ecological Risk Assessment of Marine Fish Aquaculture* (Dec. 2005) by NMFS, available at [http://www.nwfsc.noaa.gov/assets/25/6450_01302006_155445_NashFAOFinalTM71.pdf], visited Mar. 17, 2006.

[29] Pollution from wastes will also include drugs, chemicals, and any other inputs, since there is no way to recover wastes in these systems, and they are simply discharged into the ocean.

[30] Institute for Agriculture and Trade Policy, *Open Ocean Aquaculture*, at [http://www.environmentalobservatory.org/library.cfm?RefID=37057], visited Mar. 28, 2006.

[31] See [http://www.lib.noaa.gov/japan/aquaculture/proceedings/report28/Helsley.pdf], visited Mar. 28, 2006.

[32] Critics assert that the experience with research facilities poorly indicates the impacts that can be expected when the open ocean aquaculture industry reaches the size/scale NOAA is promoting. Proponents argue that this research has been conducted with an awareness that impacts will vary in proportion to size of the operation. Cumulative impacts, both in terms of multiple farms combining to cause impacts and in terms of multiple impacts from farms examined as a whole, have not been studied.

nearshore operations where waste diffusion is slower and nutrient concentrations are higher.[33]

Another environmental concern is the use of pharmaceuticals, antibiotics, growth-enhancing chemicals, other animal drugs, and antifouling agents used on gear and enclosures in open water environments.[34] Drugs, some of which were developed and approved for use in a contained or controlled environment, are often introduced to cultured fish in their feed. The unconsumed feed, and the metabolic waste from the fish feeding on it, pass through and out of the containment system, where some of this escaped feed may be consumed by wild organisms. However, the use of some of these products may be declining, as efficacious vaccines eliminate the need for antibiotics and other therapeutants. Proponents of open ocean aquaculture suggest that, because of the more pristine and better oxygenated water conditions offshore, no use of antibiotics has been necessary in any of the offshore areas being tested in the United States.[35]

Most fish currently proposed for open ocean aquaculture are carnivorous and require feeds containing fishmeal and fish oil, which are obtained from wild stocks. As a result, three or more pounds of wild fish are required to produce one pound of farmed fish. Although some question whether aquaculture production could exacerbate pressures on ocean fish stocks,[36] others assert that a feed conversion rate of three pounds feed to one pound of farmed product is favorable compared to wild production.[37] While concerns could be addressed by improving feed formulations or by raising more herbivorous fish,[38] open ocean aquaculture facilities may need to

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[33] Critics of this approach point out that, because of the practical limits of photosynthetic rates of seaweed and filtering rates of bivalves, such a nutrient recycling system might have to be 50 or more times the size of the finfish operation to handle the anticipated nutrient loads. The cost of such a massive nutrient recycling operation might far exceed any potential benefits.

[34] Most of the chemicals used have to be approved for use by the Food and Drug Administration, and their application is overseen by a veterinarian to ensure proper application and minimal environmental impact.

[35] Personal communication from Dr. James P. McVey, Aquaculture Program Director, National Sea Grant College Program, NOAA, September 2005.

[36] Rosamond L. Naylor, et al., "Effect of Aquaculture on World Fish Supplies," *Nature*, v. 405 (June 29, 2000), pp. 1017-1024. Critics of this concern, however, point out that it may indicate the mismanagement of forage fish stock harvesting, rather than be attributable to aquaculture.

[37] Actual feed conversion rates can range widely, with wild production often considered to be around 10 pounds of feed per pound of growth. At one extreme, a feed conversion rate of 20 pounds of feed per pound of farmed tuna is reported (see Sergi Tudela, "Tuna Farming: Grab, Cage, Fatten, Sell," *Samudra*, No. 32 [July 2002], pp. 9-17). At the other extreme, feed conversion rates approaching 1.2 pounds of feed per pound of farmed Atlantic salmon are reported (see British Columbia Environmental Assessment Office at [http://www.eao.gov.bc.ca/epic/output/documents/p20/1051572085662_da81e53841c84e47b5ea9ab15075741a.pdf], visited Mar. 28, 2006).

[38] However, there has been little research on these species. NOAA has shown minimal (continued...)

initially grow and process high-value fish or shellfish species to offset large investment costs. Plant protein sources, such as canola, algae, or soybean meal,[39] are being used to partially replace fishmeal, with significantly positive results emerging, especially where soybean meal is supplemented with certain essential amino acids. Another approach might use more waste from fish-processing plants to alleviate pressures to increase wild harvest for fishmeal. In some operations, the feed may contain as little as 30% fishmeal. An obstacle to increasing the amount of plant material that can be substituted for fishmeal appears to be the presence of anti-nutritional factors in the plant-derived materials.[40]

Another concern involves the spread of fish-borne disease[41] and genetic anomalies that could possibly occur if wild fish are exposed to or interbreed with hatchery-raised fish.[42] This issue might arise if genetically modified or non-native fish escaped from aquaculture facilities and interbred with wild fish.[43] Critics speculate that, since selectively bred and genetically modified fish may grow faster and larger than native fish, they could displace native fish in the short term (both through competitive displacement and interbreeding),[44] but might not be able to survive in the wild for the long term.[45] This is especially a concern in states such as California, Maine, Maryland, and Washington, where genetically modified fish are banned within state waters but could be grown offshore in federal waters. A related concern is the introduction of exotic species, such as Atlantic salmon in British Columbia. Escaped fish could be a problem in open ocean facilities battered by

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[38] (...continued)
interest in these species and has not offered much direction in addressing the "net-loss" of fish protein issue.

[39] See [http://www.soyaqua.org/quickfacts.html], visited Mar. 28, 2006. See also "Freedom Feeds" at [http://www.freedomfeeds.com/], visited Mar. 28, 2006.

[40] G. Francis, H. P. S. Makkar, and K. Becker, "Antinutritional Factors Present in Plant-Derived Alternate Fish Feed Ingredients and Their Effects in Fish," *Aquaculture*, v. 199, no. 3-4 (2001), pp. 197-227.

[41] However, current scientific knowledge suggests the opposite is occurring — that wild fish are transmitting disease to farmed fish. For example, a 2003 outbreak of infectious hematopoietic necrosis virus in British Columbia farmed salmon was confirmed to be a virus that had been circulating in wild fish for many years.

[42] The potential interbreeding problem can be greatly reduced if only sterile fish are farmed. Fairly simple technology exists to accomplish such sterilization.

[43] Rebecca J. Goldburg, 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), pp. 6-9. See [http://www.pewtrusts.org/pdf/env_pew_oceans_aquaculture.pdf], visited Mar. 28, 2006.

[44] Others suggest that escaped fish may be less competitive due to inadequate preparation for the demands of foraging in the wild.

[45] The *Trojan gene* hypothesis (William M. Muir and Richard D. Howard, "Possible Ecological Risks of Transgenic Organism Release When Transgenes Affect Mating Success: Sexual Selection and the Trojan Gene Hypothesis," *Proceedings of the National Academy of Sciences of the United States*, v. 96, no. 24 [Nov. 23, 1999], pp. 13853-13856).

storms.[46] The experience with salmon farming indicates that escaped fish could easily be a problem, either through interbreeding with closely related native species (genetic interactions) or through competitive displacement of native species. Although management techniques at net pen sites are improving and modified cage designs better prevent escapes, closed containment systems may be the only way to address this problem. Problems with the transfer of sea lice from salmon farms to wild salmon have been noted recently.[47]

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 or loosely hung netting 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. However, experience has shown that dolphins and other marine mammals do get entangled in fish farms.[48] In addition, shellfish farms have many ropes/longlines and could be problematic. Sound devices at farms to harass animals and keep them away could harm marine mammals. Open ocean facilities could potentially affect some endangered species, such as North Atlantic right whales, as they migrate or alter essential habitat for feeding, breeding, nursing, etc. Also, there could be renewed interest in killing "problem" animals, as has been the case with salmon farmers killing seals and sea lions. In addition, there could be problems with other predatory animals such as sharks. For example, great white sharks, an endangered species, have found their way into tuna farms in Australia on several occasions.

Shoreside Infrastructure. Supportive shoreside infrastructure, including hatcheries and nurseries, does not exist and will need to be developed.

Opportunities

Proponents of open ocean aquaculture see this development as the beginning of a "blue revolution"[49] that might contribute to providing dietary protein for large populations in the developing world. These proponents believe that if future open

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[46] However, recent hurricanes and tropical storms in Hawaii, Puerto Rico, and the Bahamas have caused no damage or loss of fish in submerged cage-culture operations.

[47] Alexandra Morton, et al., "Sea Lice (*Lepeophtheirus salmonis*) Infection Rates on Juvenile Pink (*Oncorhynchus gorbuscha*) and Chum (*Oncorhynchus keta*) Salmon in the Nearshore Marine Environment of British Columbia, Canada," *Canadian Journal of Fisheries and Aquatic Sciences*, v. 61 (2004), pp. 147-157.

[48] See C. M. Kemper et al., "Aquaculture and Marine Mammals: Coexistence or Conflict?" In N. Gales, M. Hindell, and R. Kirkwood, eds., *Marine Mammals and Humans: Towards a Sustainable Balance* (CSIRO Publishing, 2003). However, bycatch also occurs in many harvest fisheries, where its extent may be greater and its control may be more difficult than at stationary aquaculture facilities.

[49] See p. 23 of *Open Ocean Aquaculture IV: From Research to Commercial Reality* at [http://nsgl.gso.uri.edu/masgc/masgcw01001.pdf], visited Mar. 28, 2006. The term "blue revolution" is analogous to the "green revolution" movement to increase agricultural yields, first used in the late 1960s.

ocean aquaculture development is positioned in appropriate ocean areas, with the right partners and adequate financing, the industry will be sustainable and ecologically friendly. They further argue that the development of open ocean aquaculture might produce sufficient food to slow the conversion of undeveloped land to agriculture production to feed the growing world population. In addition, the move of aquaculture further offshore could benefit the crowded coastal zone where increasing numbers of different interests, such as commercial and sport fishermen, recreational boaters, and coastal landowners, compete. Proponents of open ocean aquaculture development cite the need to increase domestic fishery production to address the growing U.S. seafood trade deficit, increase job generation in coastal communities, and minimize user conflicts prevalent with nearshore aquaculture as their main rationales for encouraging open ocean production.

In 2002, the United States imported 55% of its edible seafood,[50] with almost half coming from Asian nations.[51] Annual U.S. aquaculture production is currently valued at less than $1 billion (more than half of which is from freshwater production) and represents less than 1% of global aquaculture production. Some argue that this trade deficit is insufficient reason for the United States to subsidize expensive open ocean aquaculture operations. In addition, this trade deficit exists because U.S. seafood consumers benefit from less expensive seafood imports. These imports, including aquaculture production, increase the availability of an excellent protein source at a reasonable price.

Advocates of open ocean aquaculture operations view them as additional means to support the domestic seafood industry, which has some of the highest unemployment rates in the country.[52] Critics argue that the potentially higher cost of tending fish far from shore means these facilities are likely to be automated, and local employment benefits may be minimal.[53] However, employment is required for much more than tending to offshore farms — support roles are required in land-based hatcheries to provide sufficient numbers of fingerlings; feed mills are necessary to provide feed for the fish; manufacturing is essential to fabricate the cages and other culture materials; maintenance, logistics, and transportation employment is critical; and finally, all the fish raised in offshore farms would need to be harvested, processed, and sold, thereby increasing the use of presently underutilized fish

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[50] 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.

[51] However, the majority of these imports are shrimp, especially from aquaculture production in Asia and South America, and farming carnivorous finfish in the open ocean will not reduce our dependence on these shrimp imports. In addition to shrimp, imports include substantial quantities of salmon produced by foreign aquaculture.

[52] However, unemployment in the seafood industry/wild fisheries is also partly the result of the development of aquaculture, especially salmon farming.

[53] Many are researching ways to increase automation, especially with feeding and harvesting, to the extent that few workers may be needed. All the work may be able to be done from a computer in a shoreside office with a satellite-controlled robotic system attached to the offshore cages. Also, the history of salmon farming indicates that as the industry becomes more efficient, production per unit labor increases and employment decreases, especially compared to what it may be replacing.

processing plants along much of the coast.[54] Others question whether it is realistic to assume that these jobs can be filled by unemployed domestic seafood workers.

Another way of looking at opportunities is to consider lessons from past experience. Proponents of aquaculture development wonder what might have happened if Alaska — with its processing plants, distribution system, infrastructure, excellent water quality, and massive coastline — had decided to embrace salmon aquaculture rather than prohibit this industry. These proponents suggest that, if Alaska had decided differently, Alaska might still "own" the world salmon market and enjoy a major source of employment and economic development, rather than having to watch the marketing of wild Alaskan salmon falter under the aggressive development by Chile and other nations of salmon aquaculture.

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.[55] The council developed this policy, consisting of a variety of guidelines, to encourage environmentally responsible open ocean aquaculture, opposing the use of non-native species that have detrimental impacts on native species, and recommending that only FDA-approved therapeutic and chemical treatments be used as part of best management practices. This policy also contains guidelines 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.[56] In 1996, the New England Regional Council adopted Amendment 5 to its sea scallop fishery management plan to facilitate the SeaStead Scallop Aquaculture Project — one of the earliest U.S. open ocean aquaculture ventures. Some worry that regional management of open ocean aquaculture under the Magnuson-Stevens Act may add another layer of bureaucracy, especially if several regional fishery

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[54] The Gulf of Mexico Offshore Aquaculture Consortium estimated that, for a 12-cage offshore production system, eight individuals would be required to tend a sophisticated, automated offshore facility. However, they forecast that such an operation would produce an additional annual regional economic output reaching more than $9 million and provide additional employment for at least 262 persons, when all shoreside support was included. Although some suggest that, for every dollar of fish landed from fishing, there is a multiplier of as much as 5-7 in the shoreside economy (with the implication that this relationship would be roughly equivalent for aquaculture), others argue that these extreme multipliers may be suspect since the multiplier for the entire U.S. economy is around 2 — meaning that a new dollar entering the economy manages to generate an additional dollar's worth of goods and services before the demand "leaks out" (i.e., gets spent on imports). See [http://www.choicesmagazine.org/2003-2/2003-2-06.htm], visited Mar. 28, 2006.

[55] The Gulf of Mexico Council's open ocean aquaculture policy is available at [http://www.gulfcouncil.org/downloads/mariculture_policy_GMFMC.pdf], visited Mar. 28, 2006.

[56] 69 *Federal Register* 7185-7186 (Feb. 13, 2004).

management councils develop their own, possibly contradictory, open ocean aquaculture management policies.

NOAA developed a draft "National Offshore Aquaculture Act" that would have provided for long-term (10-, 20-, or 30-year) leasing of ocean tracts to enable longer-term business and assist entrepreneurs in securing financing,[57] offered certain exemptions for foreign ownership,[58] and established a "one-stop" permitting system for open ocean aquaculture operators.[59] Modified legislation was introduced in the 109th Congress as S. 1195, and would:

- authorize the Secretary of Commerce to issue offshore aquaculture permits and to establish environmental requirements where existing requirements under current law are inadequate;
- exempt permitted offshore aquaculture from legal definitions of fishing that restrict size, season, and harvest methods;
- authorize the establishment of a research and development program in support of offshore aquaculture; and
- require the Secretary of Commerce to work with other federal agencies to develop and implement a streamlined and coordinated permitting process for aquaculture in the Exclusive Economic Zone (3 miles-200 miles offshore).

This legislation would implement a U.S. Commission on Ocean Policy recommendation that a multi-agency aquaculture program be created.[60] Such an effort within NOAA could again result in the same agency being responsible for both promotion and regulation of the same industry.

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[57] See "Aquaculture for the Future" at [http://www.pnwer.org/meetings/Summer2004/Presentations/Chaves.pdf], visited Mar. 27, 2006. Critics, however, opposed the longer term leases (20+ years) and also wanted to make sure there was a way to evict operations if damage was found. These critics also believed that companies should post a bond when they start up to pay for any environmental cleanup or removal of facilities.

[58] A proposed exemption on foreign ownership raised concerns. If open ocean aquaculture is aimed at developing a domestic industry that will benefit Americans, how does changing the law to allow foreign corporations help the situation? From the experience with extensive Norwegian investment in Chilean salmon farming, profits are not necessarily reinvested in the producing country and community but instead mainly accrue to the foreign nation that has invested; the country where the aquaculture occurs may get pollution, exotic species, and a few low-paying jobs. In addition, some asserted that allowing foreign corporations to obtain a lease, essentially owning a stake in U.S. waters just a few miles from the coast, could be a potential concern regarding national security.

[59] Critics, however, suggested that "one-stop" permitting might not necessarily be a good thing. The many laws are here for specific reasons, they said, and some could be overlooked in the "one-stop" process. As an alternative, these critics argued for better coordination among permitting agencies.

[60] The U.S. Commission on Ocean Policy's final report, *An Ocean Blueprint for the 21st Century*, was available at [http://oceancommission.gov/documents/full_color_rpt/welcome.html] on Mar. 28, 2006.

In addition to the NOAA initiative, the Rigs to Reefs Act (§6521 of H.R. 4241, as reported by the Committee on the Budget on November 7, 2005,[61] and §21(b) of H.R. 4761) was introduced in the 109th Congress to authorize the use of decommissioned offshore oil and gas platforms for the culture of marine organisms. These provisions would exempt oil and gas companies from having to remove offshore production platforms within a year of lease termination and awarded them tax credits for allowing their platforms to be used for open ocean aquaculture, artificial reefs, or scientific study. Proponents see major potential in establishing aquaculture operations at decommissioned oil and gas platforms, while opponents argue that the oil and gas industry could use the provisions of this bill to avoid the substantial costs of removing offshore production platforms.[62] Some proponents of open ocean aquaculture view oil and gas platforms as less than optimal locations for their operations. Also in the 109th Congress, S. 796 and §162(b)(3) of S. 1224 would prohibit the issuance of permits for marine aquaculture facilities in federal waters until requirements for such permits are enacted. S. 1224 also proposes to establish a coordinated agency program for offshore permitting (§161), designate NOAA as the lead federal agency for marine aquaculture (§162(b)(1)), and require regulations that prohibit marine aquaculture where it would damage or alter seafloor habitat or alter water quality (§222).

Sporadic 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.[63] Some critics of federal funding argue that aquaculture development funds should be competitively awarded and that legislative earmarking to fund specific projects should be avoided.

As part of a National Marine Aquaculture Initiative (NMAI), the National Sea Grant College Program has initiated research throughout the United States on open ocean aquaculture.[64] For several years, NMAI also funded the Gulf of Mexico Offshore Aquaculture Consortium, whose research program was sited in federal waters beyond state jurisdiction. In addition, NMAI, through competitive grants, supported policy and regulatory analysis as well as pilot studies in Puerto Rico and Hawaii, research into fishmeal alternatives, and investigations of potential new

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[61] The House subsequently passed H.R. 4241 (amended) on Nov. 18, 2005, with the aquaculture provisions removed.

[62] Rachael E. Salcido, "Enduring Optimism: Examining the Rig-to-Reef Bargain," *Ecology Law Quarterly*, v. 32, no. 4 (2005), pp. 863-937.

[63] See the University of New Hampshire's open ocean aquaculture project overview at [http://ooa.unh.edu/overview.html], visited Mar. 28, 2006.

[64] Charles E. Helsley, "Open Ocean Aquaculture — a Venue for Cooperative Research Between the United States and Japan," In Y. Nakamura, 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 (2003), pp. 1-6.

species for culture.[65] Specific NMAI funding included $800,000 each in FY1999 and FY2000; $5.6 million in FY2001; $2.6 million in FY2002; and $700,000 in FY2004. Most of the NMAI-funded research has been conducted to support and help promote the aquaculture industry and often has been done in collaboration with the industry. There has been minimal independent research, especially on environmental and socioeconomic impacts.

Significant Events

09/26/1980 — The National Aquaculture Act of 1980 (P.L. 96-362, 16 U.S.C. §§2801 et seq.) established a national policy of encouraging development of aquaculture in the United States.[66]

11/25/1988 — A permit application was filed with U.S. Army Corps of Engineers seeking approval for operation by American Norwegian Fish Farm, Inc., of a large aquaculture facility in federal waters off Gloucester, MA.[67] For a variety of reasons, this project was never built.

— / — /1989 — First U.S. trials of offshore cages began in Washington state.

09/ — /1995 — Open ocean aquaculture was recognized by the federal Office for Technology Assessment as a potentially viable way to raise fish.[68]

01/14/1997 — NMFS closes an area south of Martha's Vineyard, MA, for the SeaStead sea scallop aquaculture project.[69]

— / — /1997 — The University of New Hampshire began its Open Ocean Aquaculture Demonstration Project, funded through Sea Grant.

— / — /1998 — SeaFish Mariculture, L.L.C., with Shell Oil Company, began culturing red drum in an offshore net-pen facility adjacent to an oil platform in the Gulf of Mexico, 34 miles off New Orleans, LA.

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[65] For a list of funded projects, see [http://www.lib.noaa.gov/docaqua/docresearch.html], visited Mar. 27, 2006.

[66] National Aquaculture Act of 1980 at [http://www.nmfs.noaa.gov/sfa/sfweb/aqua_act.htm], visited Mar. 28, 2006.

[67] This project envisioned occupying 47 square miles of ocean 27 miles east of Cape Ann, MA, and building 90 pens that would hold 45 million pounds of salmon.

[68] U.S. Congress, Office of Technology Assessment, *Current Status of Federal Involvement in U.S. Aquaculture*, available at [http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk1/1995/9554/9554.PDF], visited Mar. 28, 2006.

[69] 62 *Federal Register* 1829-1832.

— / — /1998 —	The Hawaii offshore research program was initiated by the University of Hawaii and the Oceanic Institute, as part of the NMAI.
02/01/2000 —	The Sea Grant Gulf of Mexico Offshore Aquaculture Consortium, a collaborative, Gulf-wide, university-based interdisciplinary research program, was formed to address social, environmental and technological issues that have plagued offshore aquaculture endeavors in the Gulf of Mexico. The project began the first fish culture in U.S. federal waters outside state jurisdiction, 22 miles off Mississippi.[70]
05/18/2000 —	The Gulf of Mexico Fishery Management Council approved a motion that the Council work closely with the Gulf of Mexico Offshore Aquaculture Consortium relative to all aspects of the development of offshore aquaculture in the Gulf of Mexico.
— / — /2001 —	The Puerto Rico offshore aquaculture research program was initiated by Snapperfarm, Inc, and the University of Miami's Rosenstiel School of Marine and Atmospheric Science, as part of the NMAI.
03/ — /2001 —	Cates International, Inc. opened a commercial open ocean aquaculture facility after its lease was authorized by the State of Hawaii.
09/ — /2003 —	After federal funding terminated, the Gulf of Mexico Offshore Aquaculture Consortium removed its offshore infrastructure.
12/23/2003 —	NOAA Fisheries announced disapproval of an exempted fishing permit for Florida Offshore Aquaculture, Inc.[71]
12/23/2003 —	A coalition of environmental and fishery groups wrote to NOAA Fisheries Assistant Administrator Hogarth to request that a legislative environmental impact statement be prepared on draft legislation proposing a permitting system for aquaculture in the EEZ.[72]
— / — /2004 —	NOAA submitted a draft "National Offshore Aquaculture Act" to the Office of Management and Budget for review.

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[70] The Mississippi Alabama Sea Grant Consortium's Offshore Aquaculture Consortium at [http://www.masgc.org/oac/], visited Mar. 28, 2006.

[71] 68 *Federal Register* 74217-74218.

[72] See [http://www.centerforfoodsafety.org/pubs/LetterNOAAforEIS12.23.2003.pdf], visited Mar. 28, 2006.

04/20/2004 — The U.S. Commission on Ocean Policy's preliminary report recommended that open ocean aquaculture be streamlined and that permitting be located within NOAA.

07/23/2004 — Sixteen House Members from coastal states sent a letter to NOAA Administrator Vice-Admiral Conrad Lautenbacher, calling for a legislative environmental impact statement (LEIS) on proposed legislation relating to offshore aquaculture.[73]

09/02/2004 — The Gulf of Mexico Fishery Management Council and NMFS announced their intent to prepare a draft supplemental environmental impact statement (DSEIS) in support of a proposed Generic Amendment for Offshore Aquaculture.[74]

06/08/2005 — S. 1195, the National Offshore Aquaculture Act of 2005, was introduced in the 109th Congress.

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[73] See [http://www.house.gov/apps/list/press/ca23_capps/pr040723_NOAA.html], visited Mar. 28, 2006.

[74] 69 *Federal Register* 53682-53683.