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Farming the Ocean

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Was that salmon you ate for lunch caught in the wild, chill waters of the North Atlantic? What about the mussels you had last night? Did they arrive on your table through traditional capture techniques, or were they a product of the fish-farming industry? And if so, does it matter? What else in your daily life might be a result of deliberate culture of once wild species? Protein in your pet's food, gel in your toothpaste and cosmetics, thickener in your pasta sauce, the seaweed in your sushi? For the most part we pay little attention to where our foods and other products originate, although that is beginning to change as we strive to eat more healthily and to minimize our carbon footprint by buying local produce and other environmentally friendly products. As part of our healthier diet, we are reducing our consumption of meats and increasingly finding our protein in fish and other seafood. This trend toward increased use of fish and fish products is not only in developed countries. As countries with developing economies raise their standards of living, increased incomes fuel the demand for additional sources of protein, particularly for fish.

But the state of our world's fisheries is at this point problematic. The United Nations Food and Agriculture Organization reports that 60 percent of the commercial stocks are overfished, *The State of World Fisheries and Aquaculture 2006*, at 7, and some may be beyond recovery. Stocks of traditional species, such as cod, have been overexploited, with fewer and smaller fish being caught, in spite of increased efforts and more sophisticated technology. Around the globe there is excess fishing capacity, which means too many boats chasing too few fish, resulting in overfishing and depletion of stocks. Evidence of the negative impact on fish species can be seen in the shifts that fishers have made over time to less desirable species as the traditional stocks are exhausted. The current level of take for many species is simply unsustainable.

Because of increasing demand for fish products and decreasing wild supply, considerable time, attention, and money are being devoted around the world to studying and promoting aquaculture (cultivating aquatic organisms) and mariculture (cultivating ocean species). Farming of fish is not new. It dates back to ancient Egypt and China, possibly earlier, and has been carried out in various regions and in various forms. In the United States, early aquaculture efforts were mostly in hatcheries raising game fish for release. One of the most familiar examples of commercial U.S. aquaculture has been the production of freshwater fish, primarily catfish, typically in ponds or tanks.

Fish meal and fish oil not only provide an important food source, they are major products of both capture fisheries and aquaculture and used in a variety of commercial goods, including fertilizer, pet and poultry food, and even feed for aquaculture operations. Expanded aquaculture is viewed in countries such as Indonesia not only as a source of food but as a method for increasing income for traditional small-fish farmers. The Asian Development Bank recently loaned over $33 million to a government program in Indonesia to promote community-managed freshwater fish farms.

Although other countries have longer histories of aquaculture and more extensive fish farms than the United States, U.S. officials are seriously pushing to increase the domestic industry both to provide jobs and to reduce reliance on imports. America imports 80 percent of its seafood, leading to a trade deficit of over $8 billion dollars. In the United States, aquaculture is already a billion dollar industry, and the National Oceanic and Atmospheric Administration's Marine Fisheries Service (NOAA Fisheries) in the U.S. Department of Commerce, has set a target value of $5 billion for the aquaculture sector by 2025. At the request of the Bush administration, the U.S. House of Representatives introduced legislation, the National Offshore Aquaculture Act of 2007 (pending as of July 2007), to promote and regulate offshore mariculture operations. H.R. 2010, 110th Cong. (2007). This legislation would expand the current regulatory scheme, described below, which relies primarily on the Clean Water Act (CWA).

A major proponent of aquaculture both domestically and abroad is the American soybean industry. It projects that aquaculture will continue to grow at a rapid rate and has financed research to increase the use of soy in many fish diets, including those of normally carnivorous fish. The soybean industry has also invested in projects such as the design of offshore ocean cages for testing in China to improve aquaculture methods. China's burgeoning aquaculture industry is the largest importer of U.S. soybeans.

Although a great deal of aquaculture occurs onshore in freshwater ponds, much attention is being focused on cultivation in coastal areas of high-value species, such as salmonids and shrimp. This farming is typically done in near-coastal areas. These activities may impact not only the water resources of the country where the farming occurs, but the water resources of other countries with abutting coastal areas or countries close enough in proximity to be negatively affected.

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In addition to operations in national waters, there is growing interest in mariculture far offshore in areas beyond national jurisdictions. Experiments are underway to determine whether large-scale, offshore projects are feasible, but this raises oversight questions. Regulation of aquaculture by individual states in their own territory is often poor; regulation in federal waters is complicated; and regulation of mariculture in the high seas is nonexistent.

Americans are perhaps most familiar with mariculture when it comes to farmed salmon as both restaurants and stores distinguish between wild and farmed varieties. However, other types of plants and organisms are farmed. For example, Americans might be surprised to learn that algae, both in micro form and as seaweed, a macro form, is the subject of farming efforts. Kelp, in various forms, has been harvested for centuries in the wild and produced in farming operations primarily in Asia. Kelp is used as food, fertilizer, and as part of pharmaceutical production. Although most aquaculture enterprises are monocultures, mixed operations of kelp, fish, and even mollusks are sometimes established, which provide a more diverse and natural setting. This is beneficial to both plants and animals because the kelp is habitat for the fish, and fish wastes provide nutrients for the plants. Mollusks are filter feeders and clean the water column while consuming nutrients in fish wastes.

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If the public thinks of algae at all, they probably see it as a nuisance, the result of stagnant water. But there are ongoing micro-algae operations and growing interest in this form of aquaculture. Algae, including plankton, are used in foodstuffs, fertilizers, and a range of other products. The organisms have figured in other proposals somewhat related to farming but aimed at increasing stocks of wild fish. It has been suggested that seeding what are viewed as "barren" ocean areas with iron will promote the growth of algae, which will then nourish fish, increasing the stocks and making them available for commercial fisheries.

Seeding is also promoted by some as a method for capturing carbon from the air and sequestering it as a mechanism to combat global warming. One company is undertaking the first commercial efforts in this method and plans to dissolve tons of iron over a 2,47-million-acre stretch of open ocean. This will be a first step in determining the extent to which carbon can be captured and used as a method of carbon sequestration in carbon-trading programs, which are akin to planting additional forests on land. Enthusiasm for this endeavor varies among scientists, with some expressing serious misgivings about such manipulation of ocean waters and others challenging the scientific basis for and workability of such efforts.

Environmental Concerns in Farming the Ocean

With increasing production of farmed fish comes increasing environmental concerns that generally fall into three categories. First, fish-farming facilities are often located in fragile waters, and their construction and operating practices, including feeding and medicating the fish, can have serious, adverse impacts on the waterbodies. Excess food, fecal matter, and antibiotics can contaminate the waters in which the facility is located and smother organisms such as shellfish. The actual construction of the facilities, which are typically floating pens anchored to the seabed, can have detrimental effects on the sea bottom, and maintenance can introduce toxic chemicals such as pesticides and antifoulants into the water column. Placement of the facilities is a consideration. In Asia, for example, shrimp farming has destroyed huge acreages of important mangroves, eliminating habitat and fouling the waters. In Israel, the government has directed that fish farming in areas of the Red Sea be halted because of damage to coral reefs. Interestingly, Israel is promoting fish farming in desert areas using brackish groundwater. The water, enriched by waste from the aquaculture operation, is then reused in crop irrigation.

A second concern is the detrimental effect that escapees from farm facilities can have on wild species, as farmed fish can carry diseases and parasites and compete with wild fish for forage. Farmed fish are typically bred to be voracious feeders, so escapees may out-compete wild fish for food and mating. Farm-raised fish may also be less healthy and vital, diluting the gene pool through interbreeding to the detriment of the wild stocks. California has banned raising salmon in state waters to protect native stocks; established comprehensive regulatory measures to address the threats of pollution, drugs, and chemicals posed by fish farming; and banned transgenic fish, fish that have been genetically modified to enhance characteristics that make them suitable for farming.

Third, farming carnivorous species, such as salmon and shrimp, requires that other species be fished to provide food for the farmed stock in a greater proportion than the amount of farmed fish produced. To yield one kilogram of farmed fish, it generally requires at least three kilograms of food fish. This may reduce the forage-species populations and lessen the amount available to wild fish, interfering with food webs of

which they are a component. Moreover, there may be questions about the safety of the feed used in fish farming. The recent controversy over contaminated protein products from China originally involved pet foods, but it was later discovered that adulterated protein was also used in fish food. Importation of certain farm-raised Chinese fish also was challenged by the U.S. Food and Drug Administration because of contamination from various substances, including antibiotics. *F.D.A. Issues Alert on Chinese Seafood*, N.Y. TIMES, June 29, 2007.

In addition to environmental concerns, another point to consider is the impact that U.S. patterns of consumption and production may have on fishers and fish farmers in other countries. To the extent that we focus on high-end carnivores and deplete the small fish used for fish food, we may interfere with local fish populations on which poor fishing communities depend. And as demand for fish meal increases to meet the needs of carnivore farming, small-fish farmers producing primarily for local markets can be priced out of the market.

Existing Regulation of Ocean Farming

These advances in the aquaculture industry do not come without environmental costs, as noted above, and the regulatory systems currently in place do not address them adequately. A report by the Pew Oceans Commission in 2003, *America's Living Oceans: Charting a Course for Sea Change*, and a report by the U.S. Commission on Ocean Policy in 2004, *An Ocean Blueprint for the 21st Century*, both noted the fragmented regulatory system, which includes numerous government agencies and a variety of legislative measures. Most prominent for offshore aquaculture projects are NOAA Fisheries and the Environmental Protection Agency (EPA). The commissions both recommended that a comprehensive and environmentally sound regulatory program for offshore aquaculture be developed.

The geographical area over which the United States has regulatory authority stretches from shore out 200 nautical miles to the end of our Exclusive Economic Zone (EEZ), an area one and a half times the size of the landmass of the lower 48 states. Within the U.S. EEZ, states retain primary jurisdiction over areas out to three nautical miles from their respective shorelines. The extent to which various laws apply may depend on where in these geographic areas a particular aquaculture facility will be located.

In general, U.S. aquaculture facilities are regulated under the CWA, 33 U.S.C. §§ 1251–1387 (2006). To the extent they discharge to U.S. waters, they must obtain a permit under the CWA's National Pollutant Discharge Elimination System (NPDES) program. 33 U.S.C. § 1342. Ocean discharges are also subject to the CWA's Ocean Discharge Criteria. 33 U.S.C. § 1343. Additionally, fish-farming projects fall under the CWA's specialized aquaculture section (Section 318). 33 U.S.C. § 1328. Pursuant to Section 318, EPA has promulgated regulations that direct the manner in which aquaculture activities can be carried out. 40 C.F.R. Part 451 (2006).

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The overall scheme of the CWA focuses on point sources, typically conveyances such as pipes, and requires end-of-pipe treatment for the waste discharges. Aquaculture facilities that are on land may be amenable to end-of-pipe treatment, but many are located in open water either inland or along the coasts. Open-water aquaculture facilities are usually large pens anchored to the bottom, with floats for movement among the pens for feeding and other tasks. Some may be stationary while others can be raised and lowered to minimize damage from waves and storms and to facilitate harvest. Obviously, end-of pipe treatment is inapplicable, so the primary thrust of the regulations under Section 318 is to require best-management practices for open-water facilities. Those practices are aimed at minimizing the amount of waste feed emanating from the facility, assuring that antibiotic use is no more than needed and does not interfere with water quality or impact indigenous species, and assuring that feces and other pollutants do not interfere with water quality. Pens must also be designed to withstand wind and wave action and must prevent the escape of farmed fish. This is a difficult task when the pens are not in sheltered areas but are exposed to storms and violent weather. Even with conscientiously designed systems, accidents do happen. Estimates of escapees are in the millions, with individual releases sometimes in the hundreds of thousands. Weather is not the only cause of escapes. Seals, sea lions, and other predators attracted by the prospect of dinner in a box can tear net pens and allow the caged fish to escape. In the process, it is not uncommon for seals and sea lions to become entangled in the nets and drown. Although escapees may represent only a fraction of farmed fish, such releases can have a serious impact on local wild populations.

In addition, the CWA's dredge and fill permit program (Section 404) may be relevant. 33 U.S.C. § 1344. Section 404, along with Section 10 of the Rivers and Harbors Act (RHA Section 10), 33 U.S.C. § 401, is designed to prevent interference with navigation, so structures to be built in U.S. waters must be permitted by the U.S. Army Corps of Engineers. Section 404 applies to materials deposited into the water, which applies to an aquaculture facility being constructed with solid bottom fixtures. If it is merely anchored, then Section 404 may not apply, but RHA Section 10 would.

The NPDES and Section 404 permit programs have been interpreted as being limited to 3 nautical miles from shore, which coincides with state ownership of submerged lands. This interpretation appears to rely in part on the fact that the

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CWA was established by Congress as a collaborative federal-state program, and the states may assume authority to carry out its primary aspects, including Sections 402 and 404.

The primary conduct prohibited by the CWA is the "addition of any pollutant to navigable waters from any point source." 33 U.S.C. § 1362(12)(A). While navigable waters extend only 3 miles from shore, subsection (B) also prohibits "any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft." 33 U.S.C. § 1362(12)(B). So while floating craft are not covered, stationary sources would be. Accordingly, permanently anchored aquaculture facilities should be point sources covered by the CWA to the extent of the 200-mile EEZ. Thus, EPA's regulations for aquaculture would cover all point sources within 3 miles of shore and all point sources that are not vessels or other floating craft to the extent of the EEZ 200 miles from shore.

An additional provision of the CWA that is relevant is Section 401, which requires the state where the discharge is occurring to certify that it will not interfere with the waters attaining state water-quality standards. 33 U.S.C. § 1341. The state may deny certification or condition it. A similar but not so strict requirement is found in Section 307 of the Coastal Zone Management Act (CZMA). 16 U.S.C. § 1456. CZMA Section 307 mandates that federal activities, including licensing and permitting, that impact the state coastal zones must be consistent with a state's coastal-zone management plan. It is somewhat broader in scope than Section 401 because it applies not only to the state where the discharge occurs, but to any state that is affected by the activity. Unlike Section 401, however, the mandates of CZMA Section 307 may be overridden by the federal government. Under either statute, the impact of the activity on the environment must be assessed to some extent. If the proposed National Offshore Aquaculture Act is enacted, it would address this complicated regulatory system by giving NOAA the authority to issue permits in federal waters. *See* H.R. 2010, 110th Cong. (2007). It would not, however, generally supersede other relevant laws.

As technology improves, the possibility of open ocean facilities beyond the national jurisdictions increases. Although this would be logistically difficult, there are at least some entrepreneurs who are considering the possibility. The United Nations Convention on the Law of the Sea (UNCLOS) recognizes that freedom to fish the high seas is enjoyed by all states, subject to the requirement in Articles 87 and 116 that due regard be paid to the interests of other states and to the duty in Articles 117 and 119 to conserve living resources and collaborate with other states in managing those resources. UNCLOS, Dec. 10, 1982, 1833 U.N.T.S. 397. Although nothing in these provisions pertains directly to mariculture, arguably states would be required under Article 118 to assure that their farming practices did not endanger wild stocks and interfere with their conservation. Article 192 more generally imposes an obligation to protect and preserve the marine environment. Although the United States is not a party to UNCLOS, it has recognized most of its provisions as customary international law and acknowledged it is bound by them.

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In addition to UNCLOS, the 1972 Stockholm Declaration Principle 7 obligates states to "take all possible steps to prevent pollution of the seas . . . liable . . . to harm living resources and marine life . . . or to interfere with other legitimate uses of the sea." *Stockholm Declaration of the United Nations Conference on the Human Environment*, 11 I.L.M. 1416 (1972). More generally, Principle 17 of the Rio Declaration on Environment and Development of 1992, 31 I.L.M. 874 (1992), calls for environmental impact assessments by national authorities of proposed activities within their authority with a potentially significant, adverse impact on the environment. States may have authority over activities by their nationals even though the activities are beyond national jurisdiction.

It is obvious that the aquaculture industry will continue to grow and that appropriate regulatory measures are needed at the federal level in the United States. Although the promotion of offshore aquaculture is a prime goal of pending U.S. legislation, it must contain adequate environmental safeguards. At the international level, we must consider ways to coordinate national efforts and arrive at agreement on the proper means for addressing ecological problems created by offshore aquaculture. The oceans have been called the last untamed commons, and we must protect them accordingly.