Chapter Six
GUIDING SUSTAINABLE MARINE AQUACULTURE

Farm-raised oysters, Eliot, Maine
Laura Stadig, Spinney Creek Shellfish, Inc.

A new industry is taking shape along our shores. Aquaculture—the farming of fish, shellfish, or aquatic plants—has grown rapidly over the past several decades, and that growth is accelerating. Today, some 4,000 aquaculture enterprises in the United States, most of them small to mid-size, supply Americans with Atlantic salmon, hard clams, oysters, shrimp, and nearly all the catfish and trout we eat. As the industry matures, it holds both great promise and great risk.

It holds great promise because demand for seafood is rising, yet the total global wild fisheries catch has leveled out since the mid-1990s as fish stocks have become depleted. In the U.S., 30 percent of the known wild fishery stocks are already overfished or in the process of being depleted through overfishing. Aquaculture represents another source of seafood to boost the fish supply. Although the majority of aquaculture operations raise freshwater species, our work focused on marine species. Some forms of aquaculture, such as mollusk farming, may aid the environment. Because mollusks, such as clams and oysters, filter large volumes of water, they can help to restore marine ecosystems polluted with nutrients and an overabundance of phytoplankton. The industry is also a source of new jobs. During a site visit in Florida, the Commission learned about a job-retraining program that redirects displaced gillnet fishermen into hard clam aquaculture.

But despite this promise, marine aquaculture poses significant risks (Figure One, page 74). Farmed fish that escape their pens may pose biological risks to wild populations. Improper facility design, siting, and operation can reduce water quality, damage the physical habitat, and harm wild populations in a variety of ways. Different species and production systems present different challenges and risks, complicating management.

...aquaculture is here to stay; the challenge is to ensure the young and growing industry develops in a sustainable manner and does not cause serious ecological damage.

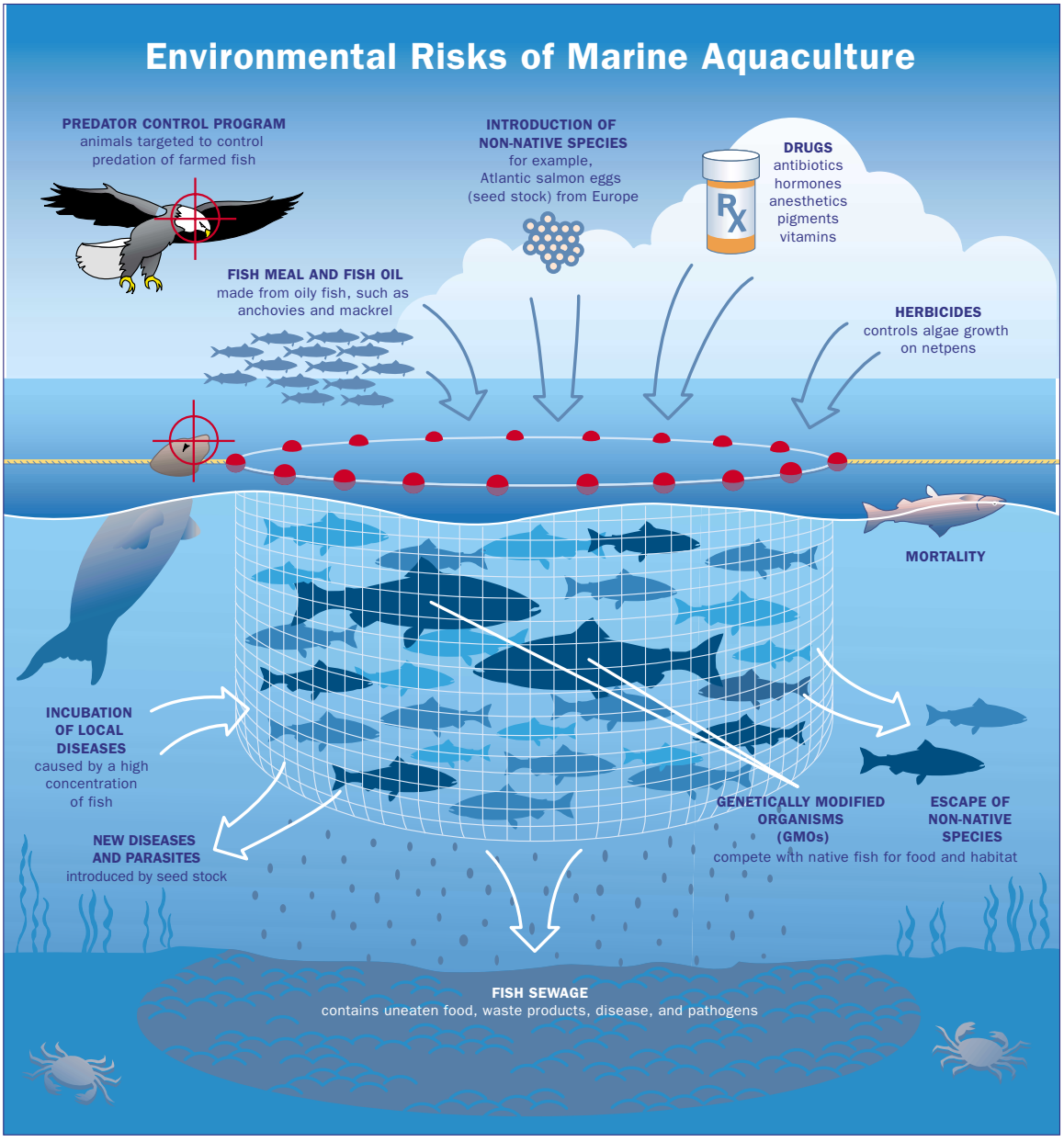
Rebecca J. Goldburg and others, 2001
Marine Aquaculture in the United States: Environmental Impacts and Policy Options

This combination of promise and risk has made marine aquaculture an important focus of the Commission's work. Because the aquaculture industry is still young and relatively small, there is time and opportunity for it to develop in an ecologically sound way. If we are to prevent, minimize, and mitigate the risks, we must develop a coherent policy framework for the industry.

PROFILE OF AN INDUSTRY

Aquaculture began on a small scale, thousands of years ago, as an ancient form of animal husbandry. Today, one-third of the fish products entering global markets are farm raised. The United States ranks eleventh in worldwide aquaculture production (just over one percent), farming roughly one billion pounds of aquatic species, mostly freshwater species such as catfish, valued at nearly one billion dollars in 1998. However, the U.S. ranks third in national consumption of seafood.

FIG. ONE



Art: John Michael Yanson

Like other forms of animal production, aquaculture can lead to environmental degradation. Non-native and genetically modified species that escape from netpens may compete with native species or contaminate the native gene pool. Large concentrations of fish in aquaculture facilities may incubate diseases and parasites and introduce them into surrounding ecosystems. The use of large quantities of wild-caught fish to feed carnivorous farmed species, such as salmon and shrimp, places additional stress on wild fisheries. Uneaten food, fish waste, and dead fish can contaminate waters near aquaculture facilities. Antibiotics, pesticides, hormones, and other chemicals used to improve production may have harmful effects in surrounding ecosystems. Lastly, the physical presence of aquaculture facilities alters natural habitat and attracts predators, such as marine mammals, which can be entangled in netpens or harmed by intentional harassment techniques.

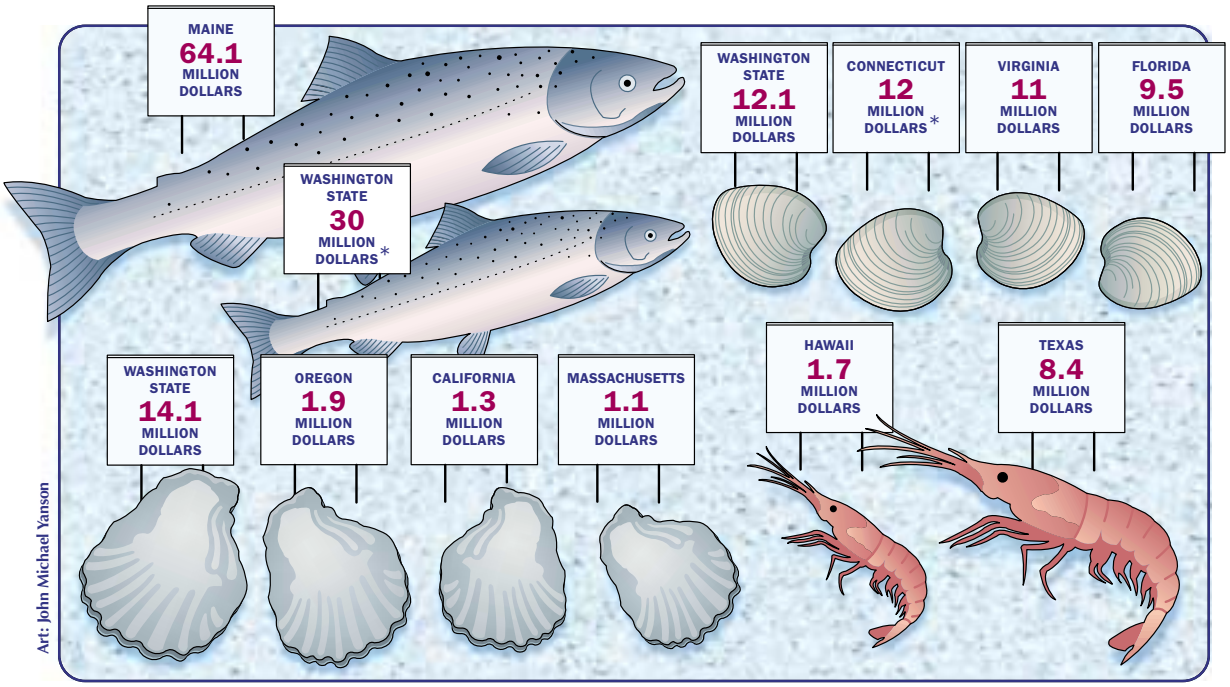
Source: Goldburg et al., 2001; art adapted from the David Suzuki Foundation, 1996.

FIG. TWO

1998 U.S. Aquaculture Production

Value of Prominent Farmed Marine Animal by Key-Producing States

The major marine animals farmed in the United States are salmon, clams, oysters, and shrimp. The 1998 production of these organisms is recorded here as the value of the farmed product in millions of dollars.



Art: John Michael Yanson

*Estimated; exact figures are not available due to confidential data.

Thus, our appetite for seafood relies on high levels of imports—much of which are farmed by nations with less rigorous environmental standards—to meet demand.

In the United States and other developed countries, where farmed salmon and shrimp sell for a high price, aquaculture is a profitable business. The U.S. industry grows nearly 30 marine species, but just four—Atlantic salmon, hard clams, oysters, and shrimp—contribute roughly one-quarter of the total U.S. aquaculture harvest (Figure Two). Salmon and clam production have increased most rapidly within the last several decades. Growth in farming other species has been limited by the lack of available high-quality coastal sites. Aquaculture operations need large areas with access to unpolluted water. The crowded and contested nature of our coasts precludes fish-farming in many areas.

The open seas are a different matter. Private and government interests are encouraging development of an offshore aquaculture industry in the U.S. Exclusive Economic Zone (EEZ), from 3 to 200 miles out to sea. The Department of Commerce's aquaculture policy calls for a fivefold increase in aquaculture production by 2025, and the open oceans

figure prominently in this call.

The aquaculture industry is therefore poised for a major expansion. Before this expansion occurs, it is essential that government and industry address the risks that come with aquaculture.

RISK TO WILD POPULATIONS

Since 1986, nearly one million non-native Atlantic salmon have escaped from fish farms in the Pacific Northwest and have established breeding populations in wild rivers. It is biological pollution—the escape of farmed species and their parasites and pathogens into the environment. This phenomenon represents the most significant threat posed by aquaculture to wild marine populations. Most marine aquaculture operations inadequately separate cultured fish and their diseases from surrounding seas, making such escapes and contamination inevitable.

Once released into an ecosystem, non-native species are extremely difficult to control or eradicate, and often become permanently established, threatening native species and entire ecosystems (Carlton, 2001). Non-native escapees from fish farms can compete with wild stocks for food, habitat, and spawning grounds (Myrick, 2002; Stickney and McVey, 2002). Interbreeding may change the genetic makeup of wild fish and decrease their survivability.

These concerns are especially important where remaining wild populations, such as wild salmon in Maine and the Pacific Northwest, are already endangered. For instance, a storm in December 2000 resulted in the escape of 100,000 salmon from a single farm in Maine. The escapees far outnumber the few wild salmon—only 75 to 110 adults in 2000—that still return to spawn in Maine rivers (NRC, 2002).

Fish farms can also serve as incubators for disease, which can infect wild populations. Infectious salmon anemia (ISA), a virulent and deadly disease, was found in farm-raised Atlantic salmon along the Maritime Provinces of Canada in the mid-1990s. Although many anticipated its spread into U.S. waters, nothing was done to prevent it. As a result, the disease appeared in Maine in 2001. In January 2002, the Maine Department of Marine Resources and the U.S. Department of Agriculture ordered the eradication of 1.5 million salmon located in seven facilities in Cobscook Bay that were infected with, or exposed to, ISA. The cost to the American public was 16.4 million dollars in federal assistance.

Another looming issue in marine aquaculture is the proposed use of genetically modified organisms, which represent another potential source of biological pollution. Although no transgenic fish products are commercially available in the United States, at least one company has applied for permission to market the first engineered animal for human consumption: a farmed Atlantic salmon.

Using genetic material inserted from Coho salmon and ocean pout, the altered salmon grows rapidly, allowing it to hit the market sooner at a reduced cost to growers. Transgenic species may act like invasive species if introduced into the wild. Scientists are concerned about the potential for competition between escaped transgenic fish and wild stocks. In addition, they fear that trans-

genic fish may introduce and spread modified genes throughout wild populations, and ultimately modify the wild gene pool (Hedrick, 2001; NRC, 2002). The ramifications of such irreversible changes are unknown.

Fish farms depend on pelleted fish feed to meet the dietary requirements of carnivorous species such as salmon and shrimp. Feeds typically contain fish meal and fish oil from wild-caught fish, such as anchovies and mackerel. Scientists estimate that producing one pound of farmed shrimp or salmon requires more than twice that amount of wild-caught fish. Large catches of these fish strain ecosystems. This problem will increase if the demand for feed products grows with the expansion of the aquaculture industry. Research to develop feed substitutes for fish meal, such as use of soybean oil, is making progress (Naylor et al., 2000; Goldburg et al., 2001).

Dean Abramson

This nearshore salmon aquaculture facility in Lubec, Maine, is among some 4,000 aquaculture enterprises in the United States. These seafood farms grow hard clams, oysters, shrimp, catfish, trout, and salmon.

RISK TO WATER QUALITY

Water flows freely over cultivated shellfish beds and through the mesh netpens on finfish farms, spreading farm by-products into the surrounding environment. Nutrient loading from aquaculture can be significant on a local scale. A salmon farm of 200,000 fish releases an amount of nitrogen, phosphorus, and fecal matter roughly equivalent to the nutrient waste in the untreated sewage from 20,000, 25,000, and 65,000 people respectively (Hardy, 2000).

Although the Clean Water Act regulates the discharge of these kinds and volumes of wastes from other sources, including city sewage systems and concentrated animal feeding operations (CAFOs), the act's provisions have not been applied to aquaculture operations. Effluents vary based on the type of aquaculture. However, they can include not only nutrients from uneaten feed and waste products, but also antibiotics, herbicides, hormones, anesthetics, pigments, minerals, and vitamins (Goldburg et al., 2001). The containment of drugs in aquaculture is more complicated than in terrestrial livestock operations because drugs typically must be administered in water, often as components of fish feed. Therefore, the drugs are directly introduced into the surrounding environment.

In certain cases, effluents from fish farms may alter the ecosystem by changing the physical and chemical environment. These

changes affect the composition of species residing beneath netpens or downstream from facilities (NRC, 1992).

Just the physical presence of aquaculture facilities can disrupt and modify natural habitats (Goldburg et al., 2001). For example, poor siting of aquaculture facilities can obstruct wildlife use of natural surroundings.

THE ROAD AHEAD

The Commission reviewed the development of other marine industries for guidance in aquaculture. In 1976, Congress passed the Fishery Conservation and Management Act (also known as the Magnuson-Stevens Act, or MSA), a federal law that promoted the development of the U.S. commercial fishing industry. However, it provided insufficient protection for marine ecosystems. Twenty years later, when Congress was faced with a crisis in marine fisheries, it passed the Sustainable Fisheries Act to begin correcting this oversight. Today, U.S. fisheries remain in crisis, with extensive closures in formerly major fisheries. Marine aquaculture may be able to avoid the same fate as wild-capture fisheries, but only if change begins today.

We have no comprehensive government oversight to minimize ecological harm caused by marine aquaculture. This leaves us ill prepared for the industry's planned fivefold expansion. Like the MSA before it, the National Aquaculture Act of 1980 and subsequent amendments promote industry development without sufficient environmental safeguards.

Nor do we have a federal framework to govern the leasing and development of marine aquaculture farther out to sea in the U.S. EEZ—the area with the greatest potential for expansion. Jurisdiction is divided among a number of agencies: The Army Corps of Engineers presides over navigable water; the EPA over pollution; the U.S. Fish and Wildlife Service over interactions with birds; NOAA over fisheries; and the Fish and Wildlife Service and NMFS split jurisdiction over marine mammals and endangered species.

Even where its jurisdiction is clear, the federal government has been slow to provide the necessary guidance to ensure the sustainability of aquaculture. The EPA only began work on effluent guidelines, required under the Clean Water Act, as the result of a lawsuit, and has not yet developed water-quality standards for federal waters. The Army Corps of Engineers grants permits for aquaculture sites on a case-by-case basis under the Rivers and Harbors Act. However, that act lacks clear environmental standards. Although underway, guidance for the use and marketing of genetically modified organisms is also lacking.

The majority of laws and regulations that authorize, permit, or control marine aquaculture are found at the state level because most facilities are located in nearshore, state-managed waters. Few states, however, have a comprehensive regulatory plan for marine aquaculture. Notable exceptions are Maine, Hawaii, and Florida. There is no formal coordination of coastal aquaculture activity among states within a region, yet aquaculture practices in one state can affect another state's marine resources.

This complex and ineffective mix of federal and state authority over marine aquaculture is confusing, difficult for all parties—including aquaculturists—to navigate, and fails to adequately protect marine ecosystems.

As a leading importer and consumer of seafood, the United States is in a position to provide leadership on the international stage, encouraging sustainable marine aquaculture practices in other countries. A recent World Trade Organization decision upheld the U.S. prohibition of shrimp imports that are harvested without the use of equipment to protect sea turtles—a requirement that applies to U.S. shrimp fishermen. The U.S. could use this model to negotiate trade agreements that encourage sustainable marine aquaculture practices—a position that would be strengthened by the adoption of appropriate aquaculture management measures for U.S. waters.

Over the past several years, a growing body of literature has documented the impacts of aquaculture on the environment (Costa-Pierce, 2002). Federal agencies are actively developing programs to control effluents (EPA, 2000) and to guide offshore aquaculture development (DOC, 2000). The United Nations Food and Agriculture Organization developed Codes of Conduct for Responsible Fishing, which include guidance for aquaculture development.

The time is pivotal to provide the guidance and tools for this industry to grow in an ecologically sustainable fashion. The U.S. should develop a proactive national marine aquaculture policy that protects marine ecosystems and provides international leadership by promoting sustainable aquaculture practices worldwide.

SUMMARY OF RECOMMENDATIONS

1. Implement a new national marine aquaculture policy based on sound conservation principles and standards.

Congress should enact legislation to regulate marine aquaculture pursuant to sound conservation and management principles. The legislation should establish national standards and comprehensive permitting authority for the siting, design, and operation of ecologically sustainable marine aquaculture facilities. The lead authority for marine aquaculture should reside in the proposed national oceans agency or the National Oceanic and Atmospheric Administration.

Until national marine aquaculture standards and policy are established, the administration or Congress should place a moratorium on the expansion of marine finfish farms. Likewise, until an adequate regulatory review process is established, the government should place a moratorium on the use of genetically engineered marine or anadromous species.

2. Provide international leadership for sustainable marine aquaculture practices.

The United States should negotiate and work with other nations to establish environmental provisions in international trade agreements to encourage ecologically sustainable marine aquaculture practices in the international community.