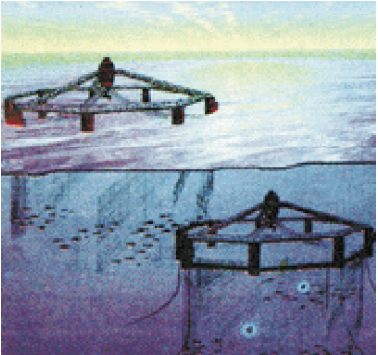
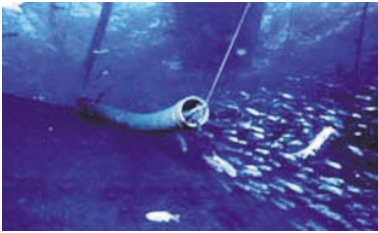


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# DEVELOPMENT OF A POLICY FRAMEWORK FOR OFFSHORE MARINE AQUACULTURE IN THE 3-200 MILE U.S. OCEAN ZONE



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## FOREWORD AND ACKNOWLEDGEMENTS

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Marine aquaculture is a promising new use of offshore waters in the United States. As one of the newer uses of the ocean, marine aquaculture needs to be developed in an environmentally sustainable manner taking into account impacts that may result for ocean resources, environments, and users. However, at present, there is no explicit policy framework at the federal level in the U.S. for managing and providing guidance for the development of offshore marine aquaculture.

This report addresses issues that must be confronted in the development of this new industry; especially those related to environmental impacts, effects on other users, and issues related to the exclusive private use of public waters. The study draws lessons from past efforts to address these concerns, and from the experience of coastal states and other nations in managing offshore marine aquaculture. A policy framework for managing aquaculture operations in federal waters in the U.S. Exclusive Economic Zone is proposed.

This work is the product of the research and discussions among a diverse and multidisciplinary research team, including scholars and practitioners in the fields of marine science, aquaculture industry, ocean policy, and environmental law. It is interesting to note that, notwithstanding the variety of perspectives and backgrounds represented on the research team, after extended discussions, the team was able to develop a broad consensus on the policy framework proposed here, although not always agreeing on every detail of the framework.

Much of the research and the writing of the report was carried out by the University of Delaware members of the research team (Susan Bunsick, Biliana Cicin-Sain, John Ewart, and Robert Knecht) with valuable input from Richard DeVoe (marine aquaculture, South Carolina Sea Grant Consortium), Tim Eichenberg (environmental law, legal consultant, San Francisco), Harlyn Halvorson (marine science and biotechnology, University of Massachusetts, Boston, and Robert Rheault (marine aquaculture industry, Rhode Island). Many thanks are due to Danielle M. Tesch, Center for the Study of Marine Policy, for her assistance in the project, especially in the analysis presented in Chapter 2 of the report, to Jorge A. Gutierrez, Center for the Study of Marine Policy, for technical editing, graphics, and formatting of the report, and to Catherine Johnston, Center Program Coordinator, for managerial support.

The project benefitted greatly from the advice and feedback provided by an advisory committee composed of distinguished individuals from the Congress, state and federal agencies, aquaculture industry, fishing industry, and environmental groups: Charles Chesnutt, U.S. Army Corps of Engineers; John Corbin, Hawaii Department of Agriculture; Tom Ellis, National Association of State Aquaculture Coordinators; Jean Flemma, Resources Committee, U.S. House of Representatives; Rebecca Goldberg, Environmental Defense; Betsy Hart, National Aquaculture Association; Roger



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Notwithstanding all the valuable inputs received from various reviewers, the members of the research team are solely responsible for the contents of the report. The views expressed here also do not represent those of the funding agency.

Dr. Biliانا Cicin-Sain  
Project Director

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# Executive Summary

This report is the first comprehensive assessment of federal policy with respect to the development of aquaculture as a new ocean industry in federally-controlled waters off the U.S. coast. Researched and written by an interdisciplinary, multi-institutional team, the report develops a set of policy approaches to address the gaps and deficiencies of current federal policy with respect to the siting and operation of aquaculture facilities in the U.S. Exclusive Economic Zone (EEZ). Developed in consultation with an advisory committee representing the full range of stakeholder interests (see Appendix 1), the report draws on the experience with marine aquaculture policy in U.S. coastal states and eight other nations and considers international guidelines for the development of environmentally sound and economically sustainable aquaculture.

The report:

- Describes the current status of marine aquaculture in the United States and the rationale for siting projects further offshore (Chapter 1)
- Reviews the major questions and policy issues in the governance of offshore aquaculture raised by earlier studies (Chapter 2)
- Provides case studies on the experience of the major offshore projects that have sought U.S. approval to date (Chapter 3)
- Presents an overview of the complex framework employed by federal agencies

in governing offshore aquaculture under current U.S. law and identifies major gaps and deficiencies in current policy (Chapter 4)

- Identifies alternative approaches based on a review of marine aquaculture policy in U.S. coastal states (Chapter 5)
- Reviews relevant international experience with respect to aquaculture, including approaches to marine aquaculture in eight other nations (Norway, Scotland, Ireland, Canada, Chile, Australia, New Zealand and Japan) and international guidelines for development of the aquaculture industry (Chapter 6)
- Proposes a set of policy approaches that address the full life-cycle of offshore projects (from planning through the issuance of permits/leases, operation and monitoring of facilities, and eventual abandonment at the end of an offshore aquaculture project), and advocates the development of an overall policy for planning and governing all activities in the U.S. EEZ, including aquaculture (Chapter 7).

## ► Scope of Study

The focus of this report is on the policy/regulatory issues involved in placing and operating marine aquaculture structures in the U.S. EEZ for purposes of raising native/locally present species and hybrids. The major policy

issues examined in this report are the absence of an explicit policy framework for offshore aquaculture, environmental impacts, public trust issues, and impacts on other users. The wide range of issues related to industry assistance and development, optimum economic development of the industry, and marine aquaculture involving the introduction of new species or genetically modified organisms (including transgenic species) are beyond the scope of the study.

### ► Research Results

#### Industry Status

Aquaculture is a rapidly growing industry worldwide, and currently accounts for about 25 percent of total seafood production. In the United States, however, the industry represents a relatively smaller share of the seafood market (about 8-9 percent).

Aquaculture is defined in the 1980 National Aquaculture Act as “the propagation and rearing of aquatic species in controlled or selected environments, including, but not limited to, ocean ranching.” Aquaculture operations involve hatcheries (land-based facilities to spawn and rear broodstock), nursery culture (the rearing of juveniles to a size conducive to growout), and growout facilities which bring the organisms to full size, ready for harvest.

The aquaculture industry in the United States encompasses a wide range of products, including food fish, bait fish, shellfish, ornamental fish, seaweed, and even alligators in Florida. U.S. aquaculture production totaled 768 million pounds in 1997, consisting largely of freshwater species (mainly catfish, trout, crawfish, tilapia, and striped bass). The major

marine species (salmon, oysters, clams, mussels and shrimp) accounted for less than 10 percent of the total. Between 1992 and 1997, production increased by 11 percent in terms of volume and 29 percent in terms of value. Despite its recent growth, U.S. aquaculture remains a relatively small industry, accounting for only about 2 percent of aquaculture production worldwide. Net seafood imports, which exceed \$6 billion annually, are among the top contributors to the U.S. trade deficit.

The marine aquaculture industry is technologically diverse, with ponds, raceways, silos, circular pools, closed (water reuse) systems, cages and net-pens, rafts, and long lines used according to the species cultured; it also includes sea ranching. Aquaculture practices range from extensive, with few inputs and modest output, to intensive, with high inputs and output. These diverse technologies have wide-ranging resource needs, produce differing environmental impacts, and require a suite of technological and management responses. The primary rationale for moving operations offshore is the theoretically greater availability of appropriate sites with potentially fewer user conflicts and environmental impacts than in coastal waters closer to shore.

#### Major Offshore Projects

Experience with offshore aquaculture projects in the United States is limited. A large-scale, private sector salmon project proposed offshore Massachusetts in the late 1980s (American Norwegian Fish Farm, Inc.), although never approved or built, drew attention to the issue of the need for a coherent federal policy for the industry. Since then, a small number of projects have been approved, including a federally funded experimental sea

scallop project also offshore Massachusetts (SeaStead), a seafood/oil industry venture based on an offshore platform in the Gulf of Mexico (SeaFish Mariculture), and federally sponsored demonstration projects in open waters off New Hampshire, Hawaii, and in the Gulf of Mexico. However, there are currently no active commercial projects in the 3-200 mile ocean zone.

For most offshore projects, the primary regulatory hurdle is a permit from the Army Corps of Engineers; fishery management regulations also present challenges for some types of projects. The major issues that have not yet been adequately addressed in the public policy arena relate to the need to ensure security of tenure for the project (i.e., conveying property rights in public waters that are traditionally free and open to all) while fulfilling public trust obligations, minimizing/mitigating impacts on other users, and ensuring that other government policy objectives, such as environmental protection, are not jeopardized.

### **Current Federal Policy**

Under current law, federal agencies have limited, and often unclear, statutory authority with respect to offshore aquaculture. There are few explicit references to aquaculture in the U.S. Code, and existing authorities do not address the specific issues associated with offshore marine aquaculture. With few exceptions, federal agency statutory authority over offshore marine aquaculture is based on agency interpretation of statutory authority over particular aspects of an aquaculture operation (e.g., waste discharges, placement of structures in navigable waters, etc.).

The key federal agencies currently involved in offshore marine aquaculture are: the Army

Corps of Engineers, which issues permits for activities on or in navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899; the Environmental Protection Agency, which issues permits for waste discharges into public waters under the Clean Water Act and is beginning to develop standards and effluent guidelines for the aquaculture industry; the National Oceanic and Atmospheric Administration, which manages U.S. fishery resources in the EEZ; and the Department of Agriculture, which chairs the Joint Subcommittee on Aquaculture to coordinate federal agency activities.

### **State Policies**

Although there has been little practical experience with offshore marine aquaculture in federal waters of the United States, commercial-scale marine aquaculture has developed in state waters along the U.S. coast. Maine and Washington are the most important states in the production of salmon, the primary food fish produced by the U.S. marine aquaculture industry. The main shellfish species for the U.S. aquaculture industry are oysters, clams, shrimp, and mussels. Shrimp are grown mainly in the south (Texas, South Carolina, Florida). Mollusks (clams, oysters, mussels) are produced in the northeast, Pacific Northwest, and the South, with Connecticut, Florida, and Washington among the largest producers.

The states have significant experience in managing aquaculture leasing programs in coastal waters under their jurisdiction. In recent years, a number of states have taken initiatives to coordinate/streamline the permitting process, establish institutional bodies to address aquaculture issues, adopt policies to address environmental/biological risks, incorporate

aquaculture in state legislation and regulation, and integrate aquaculture into their state coastal zone management plans. This experience, combined with responses to a questionnaire sent to state aquaculture coordinators as part of this project (Appendix 2) provide suggestions for planning, permitting, and operations elements to be included in federal policy for offshore aquaculture.

U.S. coastal state experiences with marine aquaculture policy provide useful lessons for the development of a federal approach to planning, permitting/leasing, and oversight of aquaculture facilities in the EEZ. Designation of a lead agency for aquaculture, regulatory flexibility, program consolidation, streamlined application processes, public reviews, environmental assessments, and monitoring of operations are important elements of state policies. A number of states have demonstrated the use of specific policy features such establishing aquaculture zones, requiring performance bonds, issuing experimental/research leases, allowing the extent of exclusivity to be negotiated, and identifying best management practices (BMPs). Some states have created new institutional authorities, and some have used legislation to specify lease conditions and criteria for lease approval.

### **International Comparisons and Guidelines**

While no other nations appear to have yet developed an explicit regulatory policy framework for their EEZs, a number of nations have had considerable experience with the management of offshore aquaculture located some distance from shore. Of particular interest are Norway, the United Kingdom (Scotland), Ireland, Canada, Chile, Australia, New Zealand, and Japan.

In general, it is clear that offshore marine aquaculture policy needs to be flexible and responsive to industry changes, with simplified, well-coordinated regulatory processes and technically competent staff. Specific approaches used by the countries examined in this study include: 1) a two step approach in which a lease for a particular location is issued first, followed by a license to operate a specific facility; 2) siting criteria or advance determination of “areas suitable for aquaculture” to minimize conflicts; 3) criteria for determining the “capacity” of specific sites (i.e. number and density of fish per site or per net cage); 4) aquaculture management plans; and 5) interagency processes that promote efficient siting and monitoring of aquaculture facilities.

In addition, international organizations, in particular the UN Food and Agriculture Organization (FAO), provide guidance in the application of principles of sustainable development to world fisheries, which include aquaculture. Of particular relevance are FAO’s Code of Conduct for Responsible Fisheries and its companion guidelines that explicitly address application of the code of conduct to aquaculture development. The chief guidance from the broader international environmental community relates to the application of a precautionary approach to aquaculture. These guidelines set forth the types of questions that must be asked of aquaculture development (e.g., whether aquaculture development conserves land, water, plant, and genetic resources; is environmentally non-degrading; and is technologically appropriate, economically viable, and socially acceptable) and requires the parties proposing the development and the governmental agencies managing the development to provide evidence on potential impacts.

## ► Proposed Policy Framework

The framework presented in this report is designed to meet the following criteria:

1. Encourages responsible open ocean aquaculture in the US EEZ.
2. Promotes a decision-making process that is efficient, coordinated, and predictable.
3. Employs a precautionary approach to avoid and minimize environmental impacts and promote integration into the ecosystem.
4. Applies separate criteria to native and non-native species.
5. Is consistent with existing U.S. laws and agency responsibilities.
6. Is equitable and fair to offshore aquaculture and to other U.S. users of the EEZ.
7. Is consistent, to the maximum extent possible, with the coastal, water, environmental, and aquaculture policies of adjacent coastal states.
8. Is consistent with U.S. obligations under international agreements.
9. Will fit within the context of an overall framework for sustainable development of the U.S. EEZ.
10. Produces a fair return to the public for the use of federal ocean space.
11. Is conducted in a transparent manner with opportunities for public involvement.

12. Is adaptive and promotes opportunities for innovation, data collection, and learning.

Recommendations are organized according to the various stages involved in locating and operating a marine aquaculture facility in offshore waters (planning, permitting, operation, monitoring, and abandonment ). They also address the need to establish or modify agency roles in order to provide a more effective framework for offshore marine aquaculture.

### Planning

Appropriate planning is needed to identify suitable (and not suitable) areas for offshore aquaculture, avoiding environmentally sensitive areas and avoiding undue interference with other users (navigation, national defense, fishing, recreation, etc.). Planning should take place before areas are offered for aquaculture leasing.

Legislation to provide an overall plan for the mapping, management, development, and conservation of the U.S. Exclusive Economic Zone needs to be developed. In the interim, through executive action, the National Oceanic and Atmospheric Administration and the Department of Interior should be given an explicit mandate to develop assessments of EEZ areas suitable for various uses (including aquaculture) through mapping and analysis.

### Joint Permitting

A joint federal/state permitting process for offshore marine aquaculture should be established under the coordination and leadership of the U.S. Army Corps of Engineers in consultation with the (new) NOAA Office of



Offshore Aquaculture (see below), first through executive action using an inter-agency memorandum of understanding, and ultimately in new congressional legislation on offshore marine aquaculture.

The joint federal/state permitting process shall involve the use of one comprehensive application form and procedure to meet the application requirements of all agencies involved, that would involve the submission of a proposed operational plan.

### **Environmental Review**

Review of offshore marine aquaculture projects should employ the precautionary approach, adhere to the environmental review requirements of the National Environmental Policy Act, and consider mitigation measures to address adverse impacts on other ocean uses.

A set of special standards related to the impact of offshore aquaculture operations on the natural and human environments should be taken into account in the environmental review process (e.g. factors such as minimization of drugs, use of environmentally-friendly feeds, etc.). In general, an environmental assessment should be performed as part of the leasing process, and Environmental Impact Statements should be prepared for individual projects.

The extent of the review process should reflect the risks associated with the project under consideration (e.g., smaller operations using well-understood species/methods vs. larger projects with potential impacts that are not generally agreed upon in the scientific community).

### **Leasing**

Leases (short-term or long-term) giving the aquaculturist exclusive rights to occupy the site

and exclusive rights to the cultured organisms should be developed. Such leases should be guided by a set of principles relevant to public trust responsibilities and should specify the scope, size, duration, and other terms of the lease.

The degree of exclusivity will be negotiable, and some form of compensation to the public for the exclusive rights granted will be expected. Rents collected should be used to establish a special fund to support offshore aquaculture management and to provide revenue-sharing to states for impact mitigation.

### **Monitoring**

A monitoring process, which may involve conditions on operations such as insurance, bonds, or environmental monitoring requirements, should be put in place to insure the safety of operations, and, in the case of termination of operations, the removal of structures and the return of the area to its previous state.

### **Public Participation**

The leasing, permitting, and environmental review processes should be conducted in an open and transparent manner with opportunities for participation by the public and by affected interests.

### **Administering Agency**

The creation of a new NOAA Office of Offshore Aquaculture (OOA) is recommended to oversee the leasing, environmental review, and subsequent monitoring of offshore aquaculture, including the eventual abandonment of offshore aquaculture facilities.

The draft policy framework discussed above is offered for the consideration of interested parties in the Administration, Congress, industry, environmental, and academic community for discussion and deliberation. No doubt parts of the proposed framework will need to be revised and changed, other parts fleshed out, other parts dropped entirely. There may be alternative ways of accomplishing the goals and directions we have suggested. We do think,

however, that the broad directions we have put forth on the basis of our review of the issues present in this area, of past work, and of the experiences of coastal states and other nations, are the appropriate directions toward which we should move in order to develop an economically sustainable and environmentally sound offshore marine aquaculture industry in the United States.



# Chapter 1



## MARINE AQUACULTURE IN THE UNITED STATES: POTENTIAL AND OBSTACLES

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### INTRODUCTION

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As fisheries decline, nations around the world are increasingly turning to aquaculture to satisfy needs for food and protein. Currently, one-fourth of all fish consumed globally is produced from fish farms or aquaculture operations. Anticipating this trend, the U.S. Congress declared in 1980 that aquaculture was in the national interest, and established a national policy to encourage its development to reduce the existing large trade deficit in fisheries products, augment existing commercial and recreational fisheries, induce job growth, and help meet future U.S. food needs. (National Aquaculture Act of 1980, 16 USC 2801 *et seq.*). Prospects for the U.S. aquaculture industry are especially promising in offshore areas, where there are fewer competing uses and greater water flow to dissipate waste discharges than in nearshore areas. However, the United States has yet to develop the necessary mechanisms for adequately considering, siting, and monitoring offshore aquaculture operations. Nor have

fundamental assessments been undertaken of the carrying capacity for aquaculture in areas of the ocean or effluent standards been established for industry discharges.

A governance framework is a critical prerequisite if offshore aquaculture is to become commercially viable and environmentally sustainable in the United States. Offshore aquaculture constitutes a new use of ocean space under U.S. jurisdiction. Therefore, development of an aquaculture governance framework will have to be crafted with great care, and in an economically and environmentally sustainable manner (see Figure 1.1). Such a framework also must provide due concern for the impacts that may be created for ocean resources and ecosystems, for competing users of ocean space (such as fishing, navigation, national defense, conservation, recreation, mineral development), and for the public.

**Figure 1.1. Definitions of Sustainability****Sustainable Development**

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- (1) The concept of needs, in particular the essential needs of the world’s poor, to which overriding priority should be given; and
- (2) The idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs.”

—*Prepared by the World Commission on Environment and Development [the Brundtland Commission] in its report Our Common Future, (Oxford: Oxford University Press, 1987)*

**Economically Sustainable**

“The characteristic of prolonged, careful, efficient, and prudent (wise and judicious) use of resources (natural, fiscal, human), products, facilities, and services. It is based on thorough knowledge and involves operating with little waste and accounting for all costs and benefits, including those which are not marketable and can result in savings.”

—*The International Institute for Sustainable Development, Wordwatch glossary*

**Environmentally Sound**

“The maintenance of a healthy environment and the protection of life-sustaining ecological processes. It is based on thorough knowledge and requires or will result in products, manufacturing processes, developments, etc. which are in harmony with essential ecological processes and human health.”

—*The International Institute for Sustainable Development, Wordwatch glossary*

## ► Major Purpose and Orientation of the Study

This study is a collaborative effort by a multidisciplinary team of ocean policy and law specialists, aquaculture scientists, and an aquaculture industry member to examine the issues surrounding expansion of the aquaculture industry offshore and to develop the key features of a national policy for governing open ocean aquaculture in the United States.

The study focuses specifically on the federally controlled ocean zone—from the limits of coastal state control (3 nautical miles offshore for most states) to the 200 nautical mile limit of the U.S. Exclusive Economic Zone (EEZ). The U.S. EEZ covers a total area of nearly 3.4 million square nautical miles, including areas within state jurisdiction and areas around U.S. territories in the Caribbean and the Pacific Ocean.

The study identifies the issues that must be confronted in managing offshore aquaculture—most prominently, issues related to environmental impacts, effects on other users, and the absence of appropriate regulatory and policy guidance, and examines how these issues might be addressed. This is done through an examination of past U.S. experiences with offshore aquaculture and the problems that have arisen; the findings and recommendations of past studies on these issues; the experiences which U.S. coastal states have encountered in their efforts to manage offshore aquaculture; the experiences of other nations with active aquaculture industries; and the guidance offered by international entities, such as the UN Food and Agriculture Organization’s Code of Conduct for Responsible Fisheries (FAO 1995) and its technical guidelines for aquaculture development (FAO 1997b). The lessons drawn from these sources are aggregated and applied to propose a policy framework for governing aquaculture in the U.S. EEZ.

The policy framework developed in this study is intended to be neither unduly promotional of the industry nor arbitrarily restrictive. While recognizing that the development of the industry has been declared to be in the national interest (National Aquaculture Act of 1980), the framework seeks to ensure that marine aquaculture activities that occur in the U.S. EEZ take place in an environmentally safe and sensitive manner with due respect for the legitimate interests and activities of other ocean users and the public. Also, in view of the fact that little meaningful information on the possible impacts of offshore aquaculture is yet available, it is anticipated that some aspects of the framework will be adaptive in nature evolving over time as additional information and data are obtained.

Several caveats should be noted. Our report only addresses the policy/regulatory issues involved in placing and operating marine aquaculture structures in the U.S. EEZ. It does not address the wide range of issues related to industry assistance and development, and the roles of various federal agencies in this regard. The study also does not directly address issues related to the optimum economic development of the industry; some economic studies on these questions are ongoing at the Marine Policy Center, Woods Hole Oceanographic Institution (Hoagland et al., ongoing). Finally, the report explicitly addresses marine aquaculture utilizing native/locally present species and hybrids, but does not address marine aquaculture involving the introduction of new species or genetically modified organisms (including transgenic species). The study recognizes that there is a need for the development of a policy and framework that takes into account the legitimate environmental concerns about the use of transgenic species in aquaculture, as well as the potential for these technologies. However, consideration of this issue is outside the scope of this report.

### ► **The Absence of a Policy Framework for Offshore Aquaculture**

Commercial-scale offshore aquaculture has the potential to compete for resources in federal waters with other activities—such as navigation, fishing, offshore oil development, military activities, recreation, and conservation. These other legitimate uses of ocean space operate under regulatory regimes that may need to accommodate potential conflicts with new aquaculture operations (see Eichenberg 1993). Similarly, the governing framework for the offshore aquaculture industry will need to

consider the potential for interference with other offshore activities and with ocean conservation. Opportunities for integration with existing uses of offshore ocean areas need to be considered as well, such as the possibility of using offshore oil platforms for aquaculture operations (instead of abandoning them at the end of their useful oil production life) or the use of aquaculture sites as data collection points in support of oceanographic, environmental, and meteorological research.

Two major issues must be taken into account in devising a policy and management framework for offshore aquaculture. The first relates to the mechanism by which an aquaculture facility will be granted exclusive rights to the use of public ocean space for private business activities. Regardless of the form such an authorization takes (e.g., lease, license, permit, etc.), it should include provisions for the payment of reasonable fees, royalties, or other forms of compensation to the public, as well as due consideration of the impacts on and mitigation for other users. The second issue is the need to launch this new ocean industry on an environmentally sustainable path utilizing the precautionary principle (see Figure 1.2), under which decision-makers err on the side of protecting environmental quality and other principles of sustainability in cases of uncertainty over impacts of aquaculture siting and operations.

The lack of a regulatory regime for open-ocean aquaculture has been much discussed and cited as a serious obstacle to the industry's development in the United States. A major National Research Council report, *Marine Aquaculture: Opportunities for Growth* (NRC 1992), highlighted the problems involved in the absence of a federal framework to manage the leasing of offshore submerged lands and waters for marine aquaculture purposes and noted the following:

**Figure 1.2. The Precautionary Approach**

**UNCED/Rio Declaration, 1992**

- "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective management to prevent environmental degradation"  
(Principle 15)

**FAO Code of Conduct, 1995**

- "States...should apply a precautionary approach to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available."  
(Art. 6.5)

- "The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment." (Art. 6.5)

A framework is needed to provide an orderly process for the leasing and conduct of marine aquaculture operations to reduce the uncertainty that industry now faces in future planning activities. A management framework should have an environmental impact assessment requirement whereby potential environmental impacts can be identified and addressed; it should be aimed at identifying potential impacts on other users and evaluating appropriate strategies; it should provide a fair return to the public from the use of public waters, in the form of lease payments, royalties, and rents (NRC 1992, p. 87).

## ISSUES CONFRONTING MARINE AQUACULTURE

### ► Aquaculture in the United States

Aquaculture is defined in the 1980 National Aquaculture Act as “the propagation and rearing of aquatic species in controlled or selected environments, including, but not limited to, ocean ranching.” As noted in Figure 1.3, there are various types of aquaculture operations involving hatcheries (land-based facilities to spawn and rear broodstock), nursery culture (the rearing of juveniles to a size conducive to growout), and growout facilities which bring the organisms to harvest size.

The aquaculture industry in the United States encompasses a wide range of products, including food fish, bait fish, shellfish, ornamental fish, seaweed, and even alligators in Florida. U.S. aquaculture production totaled 768 million pounds in 1997 (Figure 1.4), consisting largely of freshwater species (mainly catfish, trout, crawfish, tilapia, and striped bass). The major marine species (salmon, oysters, clams, mussels and shrimp) accounted for less than 10 percent of the total. Between 1992 and 1997, production increased 11 percent, largely due to increased investment in catfish and salmon. The increase in terms of value - 29% - was even more impressive, due in large part to an increase in both the market price and volume of catfish production. In contrast, the value of salmon production declined, despite increasing volumes, due to price declines (Table 1.1).

Despite its recent growth, U.S. aquaculture remains a relatively small industry, accounting for only less than two percent of aquaculture production worldwide. Its share of the U.S. seafood market is only about 8-9 percent, compared with an overall share of 25 percent for

aquaculture worldwide (Naylor et al. 2000). Nevertheless, aquaculture has considerable market potential in the United States. In particular, the industry could compete with imported seafood (much of which is farm-raised), which now supplies more than half of the annual demand for seafood in the United States. Net seafood imports, which exceed \$6 billion annually, are among the top contributors to the U.S. trade deficit. Aquaculture also has the potential, if properly managed, to supplement declining supplies from commercial fisheries in the United States, although some have argued that marine finfish aquaculture may contribute to further net depletion of fish stocks worldwide due to nearshore habitat destruction, pollution, non-native introductions, and the use of fish meal and oils in feed (see, for example, Naylor et al. 2000). However, the industry continues to evaluate the practicality of various lower-cost, plant-based dietary alternatives to fish meal.

### ► Nature of the Marine Aquaculture Industry

The marine environment, in theory, has great potential for supplying seafood to the U.S. market. By virtue of the vast area of the U.S. EEZ, offshore aquaculture has the theoretical potential to overtake the production seen in nearshore and land-based facilities; however, in U.S. waters that potential is still unknown, despite current efforts to evaluate the economic viability of certain types of offshore operations (e.g., Hoagland et al., in preparation). A number of species have been grown or are contemplated for offshore aquaculture in different regions of the United States. Some examples include: the SeaStead Project offshore Massachusetts



**Figure 1.3. Major Types of Offshore Aquaculture Operations**

***What is aquaculture?***

Aquaculture is defined in the National Aquaculture Act of 1980 as the “propagation and rearing of aquatic species in controlled or selected environments, including, but not limited to, ocean ranching.”

***Types of aquaculture***

**Hatcheries**

Conventional hatcheries involve land-based facilities to spawn and rear broodstock

**Nursery culture**

This involves the rearing of juveniles to a size conducive to growout

**Growout**

Includes shellfish culture, finfish culture, and seaweed culture

***Shellfish culture***

Floating longlines or hanging cages or lantern nets

Free planted— “bottom ranching”

**Bottom cages**

***Finfish culture***

**Net pens or sea cages**

Either for the conventional rearing of hatchery-reared fingerlings or for “fattening” to add value to wild-harvested fish (such as tuna)

Including: traditional floating pens  
submersible  
possibly mobile

**“Ranching”**

Release of juveniles that either return or are “trained” to aggregate for harvest

***Seaweed culture***

Longlines for aquatic plants

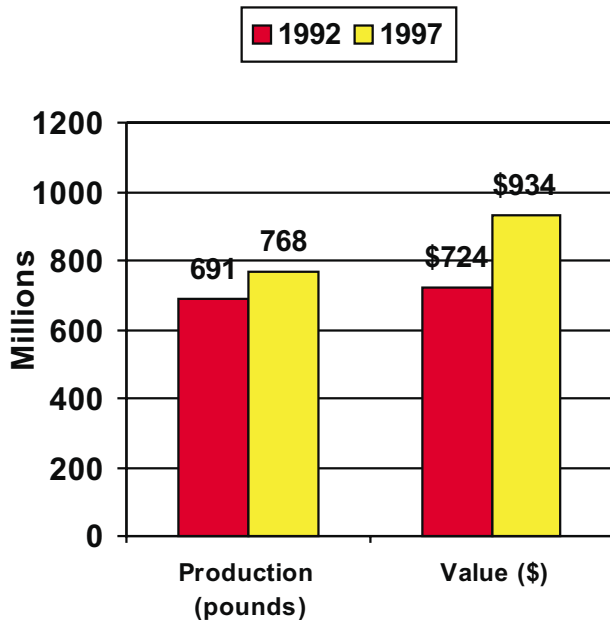
***Stock enhancement***

Typically considered aquaculture, but this is a “gray area”

***Three factors help to determine if a practice falls within our working definition of aquaculture:***

- 1) Are aquatic species being reared or propagated (defined as spawning, feeding, nurturing, predator control, disease prevention, etc.)?
- 2) Is some degree of exclusive use of an area required by the operation?  
For instance, free planting of shellfish on the bottom does not require a structure and requires little or no husbandry once the seed are released, but to justify the investment in the seed and early husbandry exclusive harvest rights must be granted.
- 3) Will the operation require placing a structure in the water?

**Figure 1.4. U.S. Aquaculture Production and Value.  
1992 and 1997**



Source: National Marine Fisheries Service 1998

involving sea scallops (Smolowitz et al. 1998a and 1998b); the New Hampshire Open Ocean Demonstration Project involving summer flounder, cod, and blue mussels; the Seafish Mariculture project in the Gulf of Mexico involving red drum; and culture of Pacific threadfin in Hawaii (see Chapter 3).

The marine aquaculture industry is technologically diverse, with ponds, raceways, silos, circular pools, closed (water reuse) systems, cage and net-pens, sea ranches, rafts and long lines used according to the species cultured (JSA 1983). Aquaculture practices range from extensive, with few inputs and modest yields, to intensive, with high inputs and yields. These diverse technologies have wide-ranging resource needs, produce differing environmental impacts, and require a suite of technological and management responses (DeVoe 2000b).

New technologies should provide additional opportunities for the growth of offshore aquaculture. Two possibilities where new technologies are expected to enhance the potential for offshore aquaculture are the use of drifting cages (Goudey 1998a, 1998b) and the combination of renewable energy (windmills) with aquaculture. Similarly, new advances in disease management, feeding, engineering, and species development will also give the industry a boost. While the economic potential of offshore marine aquaculture has not yet been fully demonstrated in the United States, it has been shown to be successful in other countries, as the following example from Japan illustrates

### ► Example of Economic Success of Offshore Aquaculture in Japan

One of the most successful international examples of offshore marine aquaculture is in Japan where sea scallop aquaculture has been dramatically improved by collecting spat and outgrowing them offshore (Rappaport 1999). In Japan per capita fish consumption is nearly nine times greater than in the United States, and the wild capture fishing industry and the aquaculture industry are seen as complementary to one another. The Japanese sea scallop fishery was active as far back as 1915. The sea scallop fishery exhibited wide fluctuations in landings through the 1930s, presumably driven by variability in larval recruitment, similar to trends in the U.S. scallop fishery.

In the last several years, the Japanese scallop fishery (Ito 1998) became based almost entirely on an intensive and directed effort to collect spat scallop from ocean waters. The fastest growing 10% of juveniles are selected for “outgrowing” in the ocean in hanging nets or on hanging lines. The remaining 90% of the juvenile scallops are

**Table 1.1. Estimated U.S. Aquaculture Production, 1992-1997**

	1992	1993	1994	1995	1996	1997
	<b>Volume (millions of pounds)</b>					
<b>Finfish</b>						
Baitfish	20.6	20.6	21.7	21.8	20.8	19.9
Catfish	457.4	459.0	439.3	446.9	472.1	524.9
Salmon	23.9	25.3	24.7	31.3	30.7	39.7
Striped bass	3.6	6.0	7.6	8.3	7.9	8.4
Tilapia	9.5	12.5	13.0	15.1	16.0	16.9
Trout	56.3	54.6	52.1	55.9	53.6	56.7
<b>Shellfish</b>						
Clams	4.3	6.1	4.9	4.3	3.8	8.1
Crawfish	63.0	56.8	49.1	58.1	46.6	49.2
Mussels	0.3	0.3	0.4	0.4	1.0	3.0
Oysters	24.0	24.4	28.1	23.2	18.5	15.7
Shrimp (SW*)	4.4	6.6	4.4	2.2	2.9	2.6
<b>Miscellaneous</b>	24.0	6.6	20.5	23.4	19.8	22.6
<b>Total</b>	<b>691.2</b>	<b>678.8</b>	<b>665.6</b>	<b>691.0</b>	<b>693.7</b>	<b>768.0</b>
	<b>Value (millions of dollars)</b>					
<b>Finfish</b>						
Baitfish	61.2	63.0	68.7	75.5	70.3	73.6
Catfish	273.5	325.4	344.5	351.2	365.0	372.5
Salmon	75.2	68.4	61.9	76.0	61.0	65.1
Striped bass	8.3	14.3	18.8	21.2	20.3	21.8
Tilapia	10.3	15.6	16.2	22.6	23.9	29.5
Trout	53.9	54.3	52.6	61.4	57.0	60.2
<b>Shellfish</b>						
Clams	11.5	12.1	14.0	19.7	20.3	30.9
Crawfish	34.9	28.5	27.0	34.7	34.8	49.2
Mussels	1.2	0.9	1.2	1.2	5.1	3.4
Oysters	82.4	76.1	69.9	70.6	64.4	39.0
Shrimp (SW*)	17.6	26.5	17.6	8.8	11.5	10.6
<b>Miscellaneous</b>	94.2	97.2	58.6	75.2	152.2	178.0
<b>Total</b>	<b>724.2</b>	<b>782.4</b>	<b>751.1</b>	<b>815.3</b>	<b>885.6</b>	<b>933.7</b>

\*SW = Saltwater

*Note: Table may not add due to rounding. Clams, oysters and mussels are reported as meat weights (excludes shell) while other identified species such as shrimp and finfishes are reported as whole (live) weights. Some clam and oyster aquaculture production are reported with U.S. commercial landings. Weights and values represent the final sales of products to processors and dealers. "Miscellaneous" includes ornamental/tropical fish, alligators, algae, aquatic plants, eels, scallops, crabs, and others. The high value and low production of "miscellaneous" occurs because production value, but not weight, are reported for many species such as ornamental fish.*

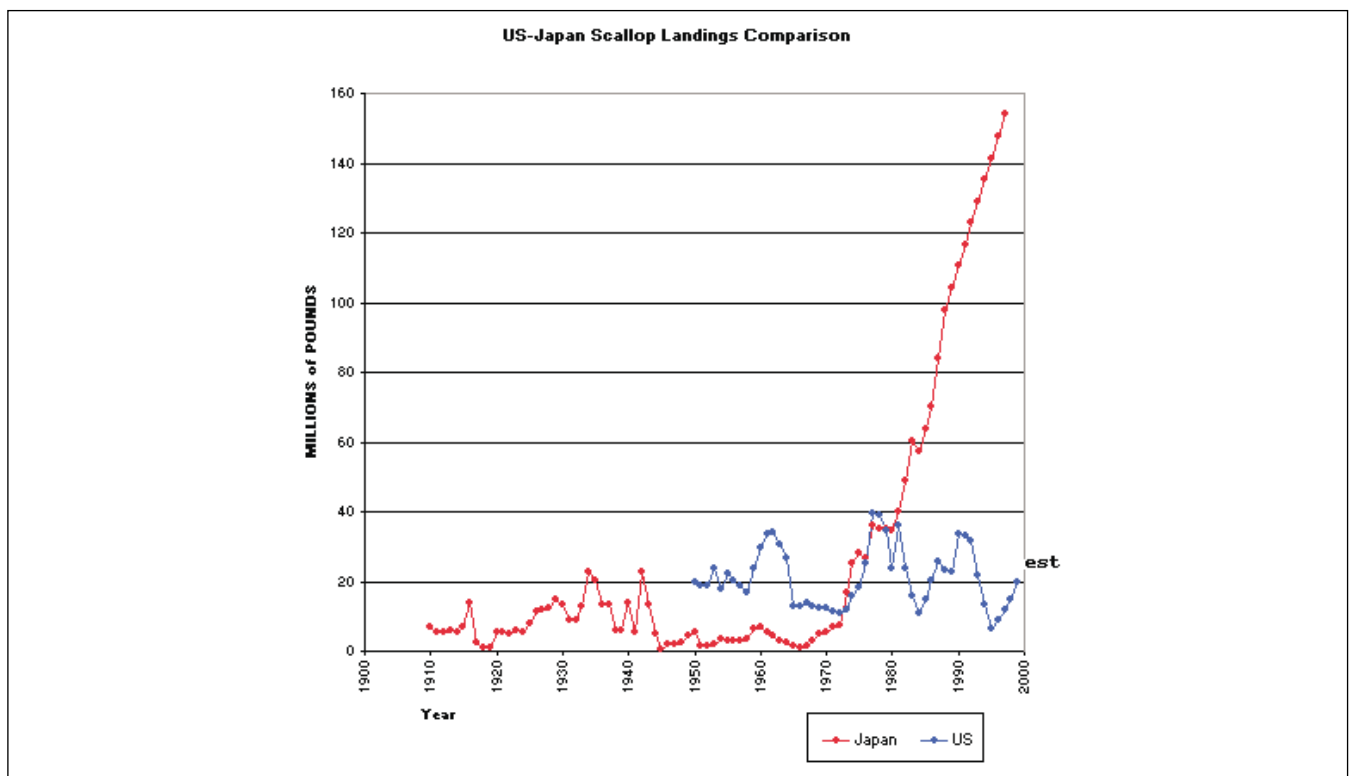
*Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.*

seeded directly on the bottom in areas where scallops are left to grow to market size. Scallop production continues to increase dramatically each year, with about half the annual output in weight contributed from the spat collection, contained raising of juveniles, bottom sowing, and rotational harvesting methodology (*see [www.seascallop.com](http://www.seascallop.com)*). Pre-WWII landings peaked at about 21.8 million pounds in 1934. Postwar landings averaged 2.7 to 5.5 million pounds until the late 1960s and have steadily increased in 1997 to over 150 million pounds (550,000 metric tons whole weight) using these methods (Ito 1998). In contrast, as noted in Figure 1.5, U.S. landings averaged around 22 million pounds over this same period.

## ► The Nature of the Issues Confronting the Development of Marine Aquaculture in the United States

Marine aquaculture represents a relatively new use of the nation's coastal and ocean areas, and it must compete for access to these areas (Nixon 1994). Newcomers to the industry, as well as local authorities, often suffer from a lack of experience, inappropriate advice on site selection, inadequate evaluation of market opportunities and product diversification, and a lack of understanding of marine aquaculture development in relation to other forms of competition (Chamberlain and Rosenthal 1995). Much of this confusion stems from its uniqueness and complexity.

Figure 1.5. Scallop Landings in the United States and Japan



Source: Atlantic Sea Scallop web page (<http://www.seascallop.com/US-Japan.comp.gif>)

Further complicating the development of marine aquaculture is the complexity that stems from unique factors that distinguish it from other forms of agricultural activity, including: (1) interaction of marine aquaculture with other marine and coastal activities and interests—interactions that are often characterized by conflict; (2) the fact that although marine aquaculture is ocean-based, it often depends on the use of land and freshwater resources as well; and (3) numerous environmental and regulatory considerations involved in the development and use of coastal zone land and water resources, usually held in the public trust (NRC 1992). The discussion below describes each of these major issues.

### **Coastal and Ocean Use Conflicts**

Use conflicts represent one of the primary issues U.S. marine aquaculturists must face and are likely to become more pronounced and frequent in the future (Chamberlain and Rosenthal 1995, DeVoe 2000b). The escalating costs of acquiring access to coastal lands and waters in the country exacerbate the problem.

Increasing pressures along the coastal zone may mean that recirculating (closed) systems on land and confined systems in the open ocean may prove the best opportunities for future commercial aquaculture development (NRC 1992). However, despite the emphasis of research and development (R & D) on closed system aquaculture rather than offshore facilities during the past 20 years, the economic viability of closed system aquaculture remains elusive. The United States is only now exploring the potential for establishing facilities in unprotected offshore areas.

### **Aquaculture and the Environment**

Much has been published over the last 15 years on the environmental impacts of marine aquaculture. One of the major challenges to the marine aquaculture industry in the United States will be how it responds to these environmental issues (see DeVoe 2000b and deFur and Rader 1995 for representative references).

Aquaculture practices can generate environmental impacts as a function of (1) the technique applied, (2) site location, (3) size of the production, (4) capacity of the receiving body of water (Ackefors and Sodergren 1985), and (5) type of species raised (Eichenberg 2000). These can include impacts on water quality, the benthic layer, the native gene pool, other fisheries and the ecosystem as a whole, as well as impacts from non-native species, disease, and chemicals (DeVoe 2000b, Naylor et al. 2000).

The state of knowledge regarding the environmental impacts of marine aquaculture is rapidly improving. Whereas two decades ago very little research data were available, there has been a surge in the number and scope of research and monitoring programs seeking to document these effects (see, for example, Reichhardt 2000, Naylor et al. 2000 and 1998, Goldberg and Triplett 1997, Webber 1997). Much work worldwide has focused on the effects of net-pen culture on the environment, with the International Council for the Exploration of the Seas (ICES) leading the way. In the United States, early research efforts dealt with fish hatchery effluents and catfish ponds. As the domestic industry diversified, so did environmental research, with major federal studies examining the impacts of marine shrimp pond culture and salmon net-pen culture, and the issues regarding species introductions, the use of

chemicals in aquaculture, and effluent discharges.

### **Legal and Regulatory Issues**

The current regulatory environment for marine aquaculture in the United States is a major constraint to its development (e.g., NRC 1978, NRC 1992, JSA 1993, Smolowitz et al 1998), particularly at the federal level, where no formal framework exists to govern the leasing and development of private commercial aquaculture activities in public waters. Major aquaculture problems that arise from state laws and regulations are caused by the lack of uniformity of laws among the states, the sheer number of permits, licenses and certifications that must be obtained, and the difficulty in obtaining them. Each state has its own unique legal, political and economic climate for aquaculture, and culturists must navigate the regulatory environment differently in each. State agencies vary greatly as well as to what standards they apply to aquaculture, and some still apply laws designed for other applications such as those for public fisheries management and agriculture.

Federal agencies that establish the ground rules that most state agencies must follow have adopted vague, confusing and poorly conceived regulations or none at all (McCoy 1989). This translates into inconsistencies in the development and application of laws and regulations at the state level. Few states have a comprehensive regulatory plan that satisfactorily balances economic development and environmental protection. Complicating matters is the fact that existing permit programs do not have provisions for determining the capacity of the coastal ecosystem for aquaculture (deFur and Rader 1995).

The complexity that results from the involvement of many federal, state and local agencies responsible for all aspects (including advocacy, promotion, conduct and regulation) of marine aquaculture leads to an array of laws, policies and regulations (NRC 1992). Federal laws are applied differently in various geographic regions of the country, and the industry remains concerned about the lack of coordination among agencies regulating aquaculture (Smolowitz et al. 1998).

Another limitation to the current regulatory regime for marine aquaculture in the United States is the lack of long-range and whole systems planning (deFur and Rader 1995). Aquaculture policy appears to be made by granting permits on a case-by-case basis (Rubino and Wilson 1993), and the requirements are often determined using regulations and technical standards not originally developed or intended for aquaculture (Ewart et al. 1995). Each permit is considered individually by the issuing agency, usually with no provision for examining cumulative impacts (deFur and Rader 1995).

### **► Other Impediments to Industry Development**

In addition to the problems discussed above, new aquaculture operations in the U.S. EEZ will also have to overcome a number of financial and technological challenges.

Firms will have to compete in the global market against established firms working in countries that may have substantial subsidies, lax regulations or cheap labor costs. They will also have to compete against firms that have lower costs because they are operating in nearshore areas where both capital and operating expenses are likely to be lower. As the industry develops, it will be critical to develop suitable

plant-based dietary protein supplements to replace limited and expensive fish meal and fish oils.

Availability of capital has been a problem for the aquaculture industry for years and will continue to be a problem for firms planning to work offshore. Banks and financial institutions typically demand that crop ownership be well defined and that all permits be obtained in advance. They will also require security of tenure in the form of long-term, renewable leases. For the lease itself to have any value as collateral, there must usually be provisions to allow transfer of the lease to another firm using similar techniques and technologies. Banks typically require a track record of profits and significant prior experience in the field. Both of these are in short supply. Venture capitalists are attracted to low-risk ventures that offer significant returns over short timeframes. Aquaculture rarely fits these demands.

Technological challenges also significantly affect the industry. There is still much to be learned about the severity of the physical forces in these operating environments, and the tackle required to withstand these forces. As the industry develops, some of these questions will be resolved, but the learning curve will be steep and the cost of knowledge may be high. The industry will also need to develop techniques to address the various environmental challenges that will be encountered. Some of the concerns that plague nearshore growers (disease, escapement, predators, environmental degradation and use conflicts) may perhaps be diminished in the EEZ, but will still have to be addressed to the satisfaction of the permitting agencies, concerned environmental groups, and the public.

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## MAJOR QUESTIONS IN THE GOVERNANCE OF OFFSHORE AQUACULTURE

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We should note that the major problems in the governance of offshore aquaculture pertain to federal waters—the 3 to 200 mile ocean zone. Currently, most aquaculture in coastal ocean waters of the United States takes place in nearshore areas, primarily in sheltered bays, estuaries, and inlets. Although a number of federal permits are required, siting decisions are largely a state and local responsibility. A variety of approaches to aquaculture in coastal waters under direct State jurisdiction (out to 3 miles for most states) have been identified (e.g., DeVoe and Mount 1989, Ewart et al. 1995). Recent State and regional initiatives have begun to integrate (or consider integrating) open ocean aquaculture into coastal zone and fishery management activities. The Massachusetts state aquaculture policy and plan (developed by the

state's Office of Coastal Zone Management) and the New England Fishery Management Council's Aquaculture Policy are two examples (Massachusetts 1995, NEFC 1999). There is thus much to be learned from a careful examination of state experiences with offshore aquaculture siting and monitoring. Such lessons may well be applicable to aquaculture operations in U.S. federal waters.

As one moves up the levels of government and aquaculture projects move further offshore into federal waters, responsibilities become less clear. At the regional level, for example, what is the role, if any, of fishery management councils? In federal waters, which agency has ultimate approval authority, and how much say do states have with respect to siting decisions off their

coasts? Such questions are largely unsettled and hinder the development of the industry. The current framework of federal laws related to aquaculture development has been described as “an unfinished patchwork quilt. All the squares exist but some remain incomplete and they have not been assembled into a pattern or sewn together” (Hopkins et al. 1997, p. 239).

As noted by Hopkins et al. (1997), several federal agencies have asserted authority over open ocean aquaculture under existing federal laws—i.e., the Army Corps of Engineers (under the Rivers and Harbors Act and the Outer Continental Shelf Lands Act); the Environmental Protection Agency (under the Clean Water Act and the Ocean Dumping Act); the National Marine Fisheries Service (under the Magnuson-Stevens Fishery Conservation and Management Act and the Marine Mammal Protection Act); the Department of Agriculture (under the National Aquaculture Act); and the U.S. Fish and Wildlife Service (under the Lacey Act Amendments\*). None of these Acts, however, have been written or established with marine aquaculture in mind, and as the authors note, “considerable uncertainty exists as to whether the agencies’ assertions of jurisdiction over open ocean aquaculture under these statutes, principles and protocols will withstand legal challenge” (Hopkins et al. 1997, p. 240).

The problems arising from the absence of an appropriate policy framework for governing aquaculture in federal waters have been evident in several U.S. offshore areas, particularly in the New England region. Hopkins et al. (1997) recount the difficulties encountered by three projects proposing offshore aquaculture facilities—the American Norwegian Fish Farm, Inc. project (approximately 40 miles off Gloucester, Massachusetts), the Westport Scallop Project (approximately 12 miles off

Martha’s Vineyard, Massachusetts), and the Sea Pride Industries, Inc. project (approximately 4 miles off Fort Morgan, Alabama). As noted by Smolowitz et al. (1998b, p. 1) with respect to the Westport Scallop Project, “the existing mechanisms cope with rather than direct and channel the gathering energies of our emerging open ocean farming industry in the United States.” In the case of the American Norwegian Fish Farm, for instance, the Conservation Law Foundation of New England contested in court the company’s proposal to develop a 47-square-mile salmon farm off Cape Ann. The litigation raised key questions as to whether such an enterprise represents the best use of public waters, whether lease charges should be levied, and whether an environmental impact statement should be required (*National Fisherman* 1991).

Policy and legal issues related to open ocean aquaculture (such as the public trust doctrine) have been examined and discussed in detail. Regulatory gaps and overlaps have been identified, for example, by the Office of Technology Assessment (1994), by a Marine Law Institute report and article (Eichenberg and Vestal 1992), and in the results of a symposium on open ocean aquaculture published in a special issue of *Ocean and Coastal Law Journal* (see e.g., Barr 1997, Brennan 1997, Hopkins et al. 1997, Rieser 1997, and Underwood 1997). Major problems presented by the incoherent federal framework for offshore aquaculture include: (1) the limited availability of property rights or other interests that can secure a producer’s investment; (2) poorly defined standards that fail to reduce conflicts among competing users of public resources; (3) poorly defined agency jurisdictions leading to delays in defining applicable standards or regulations; (4)

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\* The Lacey Act, as amended (Title 16, U.S.C. 3371) regulates the movement of live fish between states.



the existence of redundant regulations due to overlapping agency responsibilities; and (5) inappropriate restrictions designed to protect wild stocks (Rieser 1997).

In addition to deliberations and writings on the part of academics, nongovernmental organizations (NGOs), and others noted above, the need to create an appropriate offshore aquaculture governance regime has also been raised with increasing frequency and urgency by the federal government itself. Recently, for example, the federal agencies involved in the interagency Joint Subcommittee on Aquaculture (JSA), as well as NOAA's Aquaculture Taskforce, have begun to consider the question of possible governance frameworks for offshore aquaculture (JSA undated (a), Mieremet 2000). Several congressional bills proposing an offshore aquaculture policy framework have also been introduced and considered in recent years (for example, Senate Bill 1192—the Marine Aquaculture Act of 1995), but none have yet been enacted.

Notwithstanding the absence of a governance framework, federal agencies are already making investments in demonstration projects on offshore aquaculture. NOAA, for example, is funding research efforts that include a project off the coast of New Hampshire designed to demonstrate the feasibility of such projects. Although much of the New Hampshire project is dedicated to examining the scientific, engineering, and economic feasibility of open-ocean aquaculture, another important

element in the feasibility equation is the regulatory framework. Before investing millions of dollars in what are likely to be high-risk operations, potential investors will need information about the regulatory requirements and associated costs. Where will such projects be allowed? On what basis will they be approved? Which agencies and levels of government will be involved? What possible up front and annual fees can they expect to pay? Before accepting a new program that would facilitate the allocation of rights to exclusive use of ocean space, the public will also need to be assured that existing rights are adequately protected. What environmental protection measures will be required? What areas will be protected? What mechanisms will be included to protect the rights of competing users? Will the public be adequately compensated?

Policy development for aquaculture management in the 3-200 mile U.S. ocean zone will also benefit from comparisons with other countries—such as Canada, the United Kingdom, Ireland, Norway, Chile, Australia, New Zealand, Japan—that have more highly developed aquaculture industries (see, for example, NRC 1992, Appendix A; OECD 1989b; British Columbia Environmental Assessment Office 1997; Norway 1994-1995). In addition, international organizations such as the U.N. Food and Agriculture Organization (FAO) have developed guidance on the conduct of aquaculture operations (see for example FAO 1997b), which may be useful in structuring aquaculture policy development in U.S. ocean areas.

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## ORGANIZATION OF THE REPORT

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In Chapter 2 of the report we present a review of nineteen studies that have addressed issues related to offshore marine aquaculture and summarize their findings and recommendations. In particular, we focus on

findings and recommendations relevant to the major factors affecting offshore marine aquaculture: absence of an explicit policy framework, environmental impacts, public trust issues, and impacts on other users. In Chapter 3,

we present an analysis of major past and current efforts to operate marine aquaculture facilities in federal waters, including a large-scale, private sector salmon project offshore Massachusetts (American Norwegian Fish Farm, Inc.), a federally-funded experimental sea scallop project also offshore Massachusetts (SeaStead), a seafood/oil industry venture based on an offshore platform in the Gulf of Mexico (SeaFish Mariculture), and federally-sponsored demonstration projects in open waters off New Hampshire and Hawaii and in the Gulf of Mexico. Lessons are drawn on the problems faced by these efforts and what they reveal about the nature of the current governance regime for offshore aquaculture.

Existing federal laws and regulations as they might be applied to offshore aquaculture are discussed in Chapter 4. We first provide an overview of federal legislation and activities established to stimulate the development of the aquaculture industry (freshwater and marine), and then address more specifically the federal roles and legislative authorities relevant to the management and regulation of offshore aquaculture. The discussion reveals a number of gaps and problems in federal agency authorities and roles that need to be addressed.

Chapter 5 presents an analysis and draws lessons from relevant experiences with offshore aquaculture in selected coastal states. Several U.S. coastal states have significant experience with offshore aquaculture in state waters; we review and discuss these experiences, making reference to a survey of state practices in offshore aquaculture that we conducted for this study. Survey questions focused specifically on leasing/permitting requirements and the overall framework governing marine aquaculture in the state (e.g., designation of a lead agency, existing

laws, regulations and policies). We were particularly interested in what state officials consider the best features of their state's approach to marine aquaculture, what they thought could be done to improve policy, and their views on federal policy for aquaculture in the EEZ beyond state jurisdiction.

In Chapter 6, we examine the policy experiences of other countries which have established offshore aquaculture industries, notably Norway, the United Kingdom, Ireland, Canada, Chile, Australia, New Zealand, and Japan. All of these countries have extensive experience with the management of offshore aquaculture located some distance from shore and a number of them have developed policy approaches to address offshore aquaculture which suggest some lessons for possible application in the United States. In this chapter, we examine, as well, the guidance that has been provided by international entities such as the U.N. Food and Agriculture Organization on how to conduct marine aquaculture operations on an environmentally sound and sustainable basis.

Chapter 7, the final chapter, presents a proposed policy framework for U.S. offshore aquaculture. This chapter first presents a set of criteria for evaluating policy options for governing offshore aquaculture, and then presents our recommendations for a policy framework for offshore marine aquaculture. The recommendations are organized according to the various stages involved in locating and operating a marine aquaculture facility in offshore waters: planning, permitting, operation, monitoring, and abandonment of facilities. Recommendations are also presented for establishing or modifying agency roles and responsibilities in order to provide a more effective framework for offshore marine aquaculture.



# Chapter 2



## REVIEW OF PAST STUDIES ON MARINE AQUACULTURE

### INTRODUCTION

A variety of reports, studies, and articles have addressed issues relevant to offshore marine aquaculture. Most of these sources have addressed *aquaculture* generally, while a smaller number have addressed issues related to *marine aquaculture* and still a smaller number have addressed issues related to *offshore marine aquaculture*.

In this chapter, we first provide a brief overview of a number of efforts which have addressed issues related to offshore marine aquaculture and then discuss in greater detail findings and recommendations of these efforts in relation to the three major themes we identified in Chapter 1: 1) Absence of an explicit policy framework, 2) Environmental impacts, and 3) Public trust issues and impacts on other users.

### HISTORICAL OVERVIEW OF MAJOR STUDIES

In this section, we present a brief overview of major past efforts to address policy issues related to the development of offshore marine aquaculture in the United States. We begin with an examination of several early studies (1992-93), which set the foundation for addressing marine aquaculture issues in the United States. We continue with a review of studies focusing on two important considerations: 1) the technological prospects

for offshore marine aquaculture in the United States and 2) environmental concerns. We conclude by noting several attempts to document today's complex regulatory framework and examining policy development initiatives since 1995. Each of the references discussed below is summarized in Table 2.1, which provides: *the date, title, author and sponsor, major themes addressed, extent to which marine aquaculture is addressed, extent to which offshore marine*

*aquaculture is addressed, major findings, and major recommendations.*

## ► Laying the Policy Groundwork

### The Marine Board's landmark study (1992)

One of the first major systematic efforts to examine issues associated with marine aquaculture was made by the National Research Council's Marine Board in 1992. The committee worked to define the national interest in marine aquaculture, to assess the state of practice of marine aquaculture in the United States, to identify opportunities, establish requirements, and recommend strategies for the advancement of marine aquaculture in the United States. In addition to identifying research and development needs, the report addressed the barriers that were frustrating development of marine aquaculture and recommended legal and administrative reforms. With respect to offshore marine aquaculture, the study highlighted the problems involved in the absence of a federal framework to manage the leasing of offshore submerged lands and waters for marine aquaculture and noted the following:

A framework is needed to provide an orderly process for the leasing and conduct of marine aquaculture operations to reduce the uncertainty that industry now faces in future planning activities. A management framework should have an environmental impact assessment requirement whereby potential environmental impacts can be identified and addressed; it should be aimed at identifying potential impacts on other users and evaluating appropriate strategies; it should provide a fair return to the public from the use of public waters, in the form of lease payments, royalties, and rents (NRC 1992, p. 87).

### Review of water quality laws and the public trust doctrine (1992)

The same year that the Marine Board study was issued, a thorough legal review by the Marine Law Institute (1992) examined two critical issues that remain important today in developing a federal framework for offshore marine aquaculture: the role of environmental/water quality laws and the public trust doctrine. This report was among the first to bring to the attention of policy makers, aquaculturists, and concerned citizens the legal doctrines and body of law pertaining to marine aquaculture. In reviewing the application of the public trust doctrine and analyzing the implications of riparian rights, the authors concluded that 1) marine aquaculture uses do not enjoy the same private property rights as agricultural users, whose land-based property rights are well-established, and 2) coastal states will need to address use conflicts, licensing and lease criteria, and expectations of adjacent landowners in overseeing development of marine aquaculture. In examining the legal issues related to water quality, the authors pointed out the need for measures to protect aquaculture from effects of non-point source pollution as well as to regulate waste discharges from aquaculture operations.

### Regulatory guide (1993)

One year after the Marine Law Institute's review of legal issues, a guidebook, *Issues in Aquaculture Regulation* (Rubino and Wilson 1993), addressing the full range of regulatory issues for the aquaculture industry was published. Its intended purpose was to serve as a common reference for state and federal resource managers, policy makers and legislators, public

and private aquaculturists, and representatives of citizen, fishing, environmental, and farm groups. The report identifies key environmental regulatory issues for aquaculture and reviews options and recommendations for regulatory policy. It also warns that states that do not address problems with current regulatory approaches may lose aquaculture development opportunities to other states and countries. Although not explicitly addressing marine aquaculture, the guide covers a range of issues that are relevant for an offshore aquaculture facility, including water column use, waste discharge, protection of wild species, introduction of non-indigenous species, aquatic animal health, and use of drugs and chemicals.

### **Marine aquaculture policy workshop (1993)**

Also in 1993, the Policy Center for Marine Biosciences and Technology at the University of Massachusetts, Dartmouth hosted a workshop, *Aquaculture and the Marine Environment: The Shaping of Public Policy* (Halvorson 1993), which brought together experts from diverse fields to focus specifically on issues related to marine aquaculture policy. The goal of the workshop was to formulate an interdisciplinary approach to making policy for the expansion of marine aquaculture in the United States. The report of the workshop pointed out that there was a tremendous opportunity for the United States to develop marine aquaculture, and identified the major hindrances as the lack of a national policy, confusing regulatory controls, failure to use modern scientific techniques to improve efficiency, and failure to adequately address environmental concerns

## **► Assessing the Technological Prospects for Offshore Aquaculture**

### **The OTA study (1994)**

In 1994, the Offshore Aquaculture Committee prepared one of the first in-depth reviews of the technological and policy issues associated with offshore marine aquaculture. In a draft report submitted to the Office of Technology Assessment, *Offshore Aquaculture: Technology and Policy Issues* (OTA 1994), the committee points out the numerous advantages of moving aquaculture offshore (potentially fewer use conflicts, better dispersal of wastes, etc.) and identifies the range of constraints that need to be addressed before the offshore aquaculture industry can mature. Based on its finding that environmental impacts are reduced by moving aquaculture operations offshore, the study recommends a simplified permitting process for offshore projects.

### **Gulf of Mexico feasibility study (1998)**

In 1998, a study commissioned by the National Oceanic and Atmospheric Administration examined the feasibility of establishing offshore finfish mariculture operations in the northern Gulf of Mexico (Waldemar 1998). Based on analyses across a range of issues (economics, environmental impact, regulatory), the study found that an offshore marine aquaculture industry could be established using existing technology. In addition to identifying two candidate species (red drum and striped bass), the report indicated adequate availability of oil industry platforms for potential use as centers of farming operations. Capital costs for an independent

operation not associated with oil and gas production were estimated in the range of \$6 million, with annual costs of \$3 million. For a single, large operation, both socioeconomic and environmental impacts (water quality, native fish stocks, protected species) were not considered significant. The study also suggested statutory and regulatory revisions to address fisheries management issues, security of tenure, and platform abandonment and liability issues.

### **Blueprint for developing sea scallop aquaculture (1999)**

In 1999, the Second Sea Scallop Summit examined the prospects for sea scallop aquaculture in New England, including the potential for the industry at offshore sites. With the New England scallop fishery seriously threatened by overfishing (6,000 square miles of the most productive bottom is closed and pressures on inshore areas may lead to more closures), the stage has been set for the “evolution of an open sea shellfish growout industry to develop as a viable component for the nearshore fisheries” (Halvorson et al. 1999, p. 3).

### **► Environmental Perspectives**

Balancing initiatives to identify and remove unnecessary regulatory barriers to the development of the aquaculture industry in the United States are studies highlighting not only the environmental impacts of individual projects but also the cumulative impacts of aquaculture development on carrying capacity and ecological systems.

### **The Environmental Defense Fund’s *Murky Waters Report* (1997)**

A major report by the Environmental Defense Fund, a well-respected environmental organization, identifies environmental problems caused by aquaculture and recommends approaches to establishing an environmentally and economically sound aquaculture industry (Goldburg and Triplett 1997). The report considers open ocean aquaculture potentially less polluting than near-shore operations, and recommends a federal government effort, under the direction of the National Marine Fisheries Service, to develop a regulatory framework for open-ocean aquaculture that includes strong environmental protections.

### **An ecological perspective (2000)**

In a respected scientific journal, *Nature*, a team of scientists reviewed the ecological links between aquaculture and wild fish stocks, and cautioned that the use of wild fish to feed farmed fish puts direct and indirect pressure on fisheries resources (Naylor et al. 2000). The indirect pressures come from habitat modification, food web interactions, introduction of exotic species, etc. The article recommends that the government support research and development on environmentally sound aquaculture systems, eliminate subsidies for ecologically unsound practices, and establish/enforce regulatory measures to protect coastal ecosystems.

### **► Documenting the Current Policy Framework**

Increasing interest in marine aquaculture and the recognized complexities of the current regulatory framework prompted the need for

reliable information on a range of state and federal regulatory requirements.

### **Congressional Research Service report (1997)**

The Environment and Natural Resources Policy Division of the Congressional Research Service, which supports the U.S. Congress, compiled information on *Aquaculture and the Federal Role* (Becker and Buck 1997). It stresses the role of federal agencies and departments in promoting as well as regulating aquaculture industry development.

### ***Aquaculture in the Gulf of Maine: A Multijurisdictional Compendium (1999)***

One of the areas in which the marine aquaculture industry is fairly well-established is in the Gulf of Maine, which straddles the border between the United States and Canada. The Gulf of Maine Council on the Marine Environment—which includes representatives from Nova Scotia, New Brunswick, Maine, New Hampshire, and Massachusetts—focuses on common issues within each jurisdiction, including the impacts of aquaculture on the Gulf of Maine ecosystem. As part of its mission to gain a better understanding of aquaculture-environmental interactions, the Council's Aquaculture Committee commissioned a study of the laws, regulations, policies, protocols and issues pertinent to each of the jurisdictions represented by the Gulf of Maine Council. The *Compendium* (Brennan 1999) gives the Committee a common base of knowledge about aquaculture in each member's jurisdiction. However, it does not evaluate different management regimes or their effectiveness.

### **Offshore aquaculture permitting in the Gulf of Mexico (2000)**

The Gulf of Mexico Offshore Aquaculture Consortium (see Chapter 3) is conducting a federally funded research and demonstration project in an exposed area of the ocean off the coast of Mississippi. This project includes a legal/regulatory component to develop a guide to the range of state and federal permits required for operations in the Gulf of Mexico. In support of the project's efforts to obtain the necessary permits from state and federal agencies, the Mississippi-Alabama Sea Grant Legal Program compiled a detailed listing, *Offshore Aquaculture Permitting Process in the Gulf of Mexico* (Fletcher and Weston 2000), examining the regulatory structure for placing offshore aquaculture facilities in the Gulf of Mexico.

## **► Policy Development**

Acting on the results of earlier policy studies, government agencies have begun to consider strategies for dealing with the barriers and regulatory constraints for the development of a marine aquaculture industry. Summarized below are a state level initiative in Massachusetts, a regional study for the New England Fisheries Management Council, and a workshop considering specific policy alternatives for aquaculture in the open ocean.

### **The Massachusetts White Paper (1995)**

Acting on the behalf of the Governor of Massachusetts, the Massachusetts Executive Office of Environmental Affairs initiated a study to identify how the state can further the status of aquaculture (Massachusetts Coastal Zone Management 1995b). The purpose of the paper was to review the biological, technical, and legal/regulatory status of aquaculture in the



state. Based on this review, the state developed a strategy for state action, including a coordinated permitting process.

### **A study for the New England Fishery Management Council (1995)**

Faced with growing interest in marine aquaculture development in fishery areas it was responsible for managing, the New England Fishery Management Council funded a study, *Background Information and Recommendation for New England Fishery Management Council Development of an Aquaculture Policy and Management Strategy* (Brennan 1995), to provide better information on its legal authorities and policy options with respect to aquaculture in the Exclusive Economic Zone (EEZ). In response to this study, the Council has taken the lead in developing a coordinated permit review process among federal agencies in the region.

### ***Ocean and Coastal Law Journal special issue (1997)***

A special issue of *Ocean and Coastal Law Journal* in 1997 featured several papers presenting alternative approaches and additional considerations for managing aquaculture operations in federal waters. These options included:

- State-based management with federal oversight (Rieser 1997)

- Modifications to make the existing federal regulatory framework more protective to the environment and less burdensome to open ocean aquaculture developers (Hopkins et al. 1997)
- A role for regional fisheries management councils and possible management options under the Magnuson Sustainable Fisheries Act (Brennan 1997)
- Special sensitivity to potential impacts of aquaculture operations affecting certain areas, such as essential habitat areas of National Marine Sanctuaries (Barr 1997)

### **A recent assessment (1999)**

At a 1999 workshop on Trends and Future Challenges for U.S. National Ocean and Coastal Policy, a member of our project team summed up the current policy situation with respect to offshore marine aquaculture:

...while recent evaluations of marine aquaculture suggest that offshore locations may represent a viable alternative (NRC 1992), no formal policies have been developed to manage aquaculture developments in the U.S. Exclusive Economic Zone. As a result, federal policies vary from one agency to another (and may even differ among divisions within the same agency) and the permitting process can be time-consuming, complex, and costly (DeVoe 1999).

**Table 2.1 Summary of major past studies relevant to marine aquaculture**

Title/Author	<i>Marine Aquaculture: Opportunities for Growth</i> Marine Board, National Research Council	<i>Improving the Legal Framework for Marine Aquaculture: The Role of Water Quality Laws and the Public Trust Doctrine</i> Marine Law Institute
Year	1992	1992
Major themes	<ul style="list-style-type: none"> <li>• Status of global and U.S. aquaculture</li> <li>• Policy issues of aquaculture</li> <li>• Environmental issues</li> <li>• Research and development opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Conflicts between competing water uses</li> <li>• Governmental regulation of water quality</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is the focus of the report	Explicit focus on marine aquaculture
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is explicitly addressed	Offshore marine aquaculture is mentioned in context of coastal waters
Major findings	<ul style="list-style-type: none"> <li>• More leadership and coordination is needed from and among federal agencies</li> <li>• Opportunity for technology and increased knowledge will provide solutions to many of the constraints</li> </ul>	<ul style="list-style-type: none"> <li>• Provisions for state leasing systems need to be tailored within the context of its existing law, existing regulatory context, and priorities</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>• A \$12 million research and development initiative to develop marine aquaculture technology, etc.</li> <li>• JSA should design a planning and permitting process; include marine aquaculture in the CZMA; evaluate the impact of the Lacey Act; recommend legislation to Congress</li> <li>• Strengthen the USDA lead role</li> <li>• Strengthen other federal agency roles               <ul style="list-style-type: none"> <li>— FWS: anadromous species</li> <li>— NMFS: management and assessment of stock-enhanced marine fisheries</li> <li>— NOAA/Sea Grant: research and extension programs on marine aquaculture</li> </ul> </li> <li>• Congress should complete a federal policy framework; revise laws that impede development of marine aquaculture; and create a Congressional Committee or subcommittee on aquaculture</li> </ul>	<ul style="list-style-type: none"> <li>• States should use the Public Trust Doctrine to promote productive use of state-owned waters as a common resource</li> <li>• All coastal states should have some form of submerged and intertidal leasing laws for aquaculture</li> <li>• Local government should adopt measures to protect aquaculture from effects of non-point source pollution and to protect operations from common law nuisance claims</li> <li>• States should consider marine zoning or mapping programs</li> <li>• Leasing laws should include provisions granting lessees specified rights to occupy the site; exclusive rights to the cultured species; and prohibiting leasing of lands to remain in the public domain</li> <li>• States should adopt laws that treat aquaculture fish wastes like agricultural wastes to facilitate disposal</li> </ul>
Title/Author	<i>Aquaculture and the Marine Environment: The Shaping of Public Policy</i> Harlyn O. Halvorson, Policy Center for Marine Bioscience and Technology, University of Massachusetts—Dartmouth	<i>Issues in Aquaculture Regulation</i> Michael C. Rubino and Charles A. Wilson, Bluewaters, Inc.
Year	1993	1993
Major themes	<ul style="list-style-type: none"> <li>• Waste management</li> <li>• Interaction of aquatic species with native stocks</li> </ul>	<ul style="list-style-type: none"> <li>• Public resource topic issues raised by aquaculture, including land use, water column use, water and water discharge, protection of wild species, non-indigenous species, aquatic animal health, and use of drugs and chemicals</li> <li>• Focuses on federal and state policies and regulations</li> </ul>

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Extent to which marine aquaculture is addressed	Explicit focus on marine aquaculture	Addresses aquaculture generally; marine aquaculture explicitly mentioned
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture not explicitly addressed	Offshore marine aquaculture is explicitly addressed
Major findings	<ul style="list-style-type: none"> <li>Tremendous opportunity for the United States to develop marine aquaculture and to benefit from it as a source of high-quality food</li> <li>Major hindrances to the development of U.S. aquaculture include the lack of a national policy, confusing regulatory controls, failure to use modern scientific techniques to improve efficiency, and failure to adequately address environmental concerns</li> <li>Future policy regulations must be based on multi-disciplinary input</li> </ul>	<ul style="list-style-type: none"> <li>States that do not address problems with current regulatory approaches may lose aquaculture development opportunities to other states and countries</li> <li>Constructive aquacultural policies and regulations can accentuate the benefits of cooperation</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>Create an opportunity for growth by streamlining and harmonizing regulations</li> <li>Strengthen USDA's role as lead agency for previous recommendation and reaffirm support for JSA</li> <li>Create a strong "Right to Farm" policy for aquaculture, providing the same opportunity for marine aquaculture as for agricultural industries</li> </ul>	<ul style="list-style-type: none"> <li>Define aquaculture as agriculture in state and federal laws</li> <li>Identify a lead agency in each state to coordinate aquaculture regulations</li> <li>Streamline the permitting process</li> <li>Adopt conflict resolution mechanisms</li> <li>Include aquaculture in government planning</li> <li>Formulate regulations in consultation with representatives of aquaculture industry and other affected constituencies</li> <li>Encourage adoption of best management practices</li> <li>Expand and support research, education, and extension efforts</li> </ul>
Title/Author	<i>Offshore Aquaculture: Technology and Policy Issues (Draft)</i> Offshore Aquaculture Committee Office of Technology Assessment	Aquaculture White Paper Massachusetts Coastal Zone Management
Year	1994	1995
Major themes	<ul style="list-style-type: none"> <li>Advantages of moving aquaculture facilities offshore</li> <li>Constraints to offshore aquaculture that will need to be addressed before it, as an industry, can mature</li> </ul>	<ul style="list-style-type: none"> <li>Status of aquaculture, inland and coastal, in Massachusetts</li> <li>Aspects of the aquaculture industry</li> <li>Regulatory issues</li> <li>Massachusetts and federal statutes regulating aquaculture</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is explicitly addressed	Addresses aquaculture generally; no explicit mention of marine aquaculture
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is the focus of this report	Offshore marine aquaculture addressed in context of coastal waters
Major findings	<ul style="list-style-type: none"> <li>There is no U.S. policy that specifically addresses the development of offshore aquaculture</li> <li>Coastal state cooperation will likely be necessary to see successful aquaculture development</li> </ul>	<ul style="list-style-type: none"> <li>Massachusetts has reacted to the aquaculture industry on a case by case basis with very little attention to the larger picture</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>Because the environmental impact of offshore aquaculture decreases as facilities move from nearshore to offshore, easing of permitting requirements seems appropriate</li> <li>A simple permitting process is preferable to a complex leasing program</li> </ul>	<ul style="list-style-type: none"> <li>Develop a "user friendly" brochure on what agencies need to be contacted and who to contact within those agencies to help the permitting process</li> </ul>

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Title/Author	<i>Background Information and Recommendations for New England Fishery Management Council Development of an Aquaculture Policy and Management Strategy</i> William J. Brennan, Marine and Environmental Affairs Consultant	<i>"Mariculture in Offshore Critical Habitat Areas: A Case Study of Stelwagen Bank National Marine Sanctuary"</i> Bradley W. Barr
Year	1995	1997
Major themes	<ul style="list-style-type: none"> <li>Management options available to the New England Fishery Management Council (NEFMC) concerning its role in EEZ-based aquaculture management</li> </ul>	<ul style="list-style-type: none"> <li>Discussion of the present federal programs that identify and protect essential habitats within the EEZ</li> <li>Development of lease programs is essential to provide compensation to the public for the private utilization of common resources within the EEZ</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is explicitly addressed	Marine aquaculture is explicitly addressed
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is explicitly addressed	Offshore marine aquaculture is the focus of this article
Major findings	<ul style="list-style-type: none"> <li>The Magnuson Act provides discretionary authority to regulate fishing within the EEZ and delegates to the regional fishery management councils, including NEFMC, the authority to prepare fishery management plans</li> <li>Aquaculture facilities are subject to the Magnuson Act and NEFMC can, at its discretion, subject such facilities within the EEZ to regulation</li> <li>NEFMC has the legal authority (through the Magnuson Act) to manage aquaculture in the EEZ, although it is not compelled to because of the roles other federal agencies play in the process</li> </ul>	<ul style="list-style-type: none"> <li>The Endangered Species Act critical habitat designations do not necessarily preclude mariculture but may affect how or to what extent it is conducted</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>NEFMC should develop an aquaculture policy that will aid in the development of an aquaculture management strategy</li> <li>NEFMC should develop one overarching aquaculture Fishery Management Plan which would allow the Council to administer all forms of aquaculture that may be proposed for EEZ waters</li> <li>NEFMC should work closely with federal agencies and appoint a representative to JSA</li> <li>NEFMC should be a point of contact for aquaculture developers, providing information and application materials in a way similar to the cooperative application and review procedure used by several states</li> </ul>	<ul style="list-style-type: none"> <li>The public must be brought into the discussions regarding proposed mariculture regulations</li> <li>Leasing programs will be key to reimbursing the public for use of common resources</li> <li>The issue of privatizing public resources must be addressed</li> </ul>
Title/Author	<i>"To Be or Not to Be Involved: Aquaculture Management Options for the New England Fishery Management Council"</i> William J. Brennan	<i>"An Environmental Critique of Government Regulations and Policies for Open Ocean Aquaculture"</i> D. Douglas Hopkins, Rebecca J. Goldberg, Andrea Marston
Year	1997	1997

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Major themes	<ul style="list-style-type: none"> <li>• Exploration of NEFMC’s legal authority to affect aquaculture and its corresponding management options</li> <li>• Formulating a management strategy will benefit aquaculturists and traditional fishermen alike</li> </ul>	<ul style="list-style-type: none"> <li>• Review of the most significant environmental concerns raised by open ocean aquaculture</li> <li>• Description of key elements of the current federal framework regulating aquaculture in federal waters and its deficiencies</li> <li>• Suggestions to improve the environmental productivity of the framework and to reduce burdens to developers</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is explicitly addressed	Marine aquaculture is addressed
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture and NEFMC’s role in management are the focus of this article	Offshore marine aquaculture and the environmental aspects are extensively addressed
Major findings	<ul style="list-style-type: none"> <li>• In the opinion of the NOAA General Counsel, aquaculture facilities are subject to the Magnuson Act</li> <li>• Any vessel used to support aquaculture activities and facilities is considered a fishing vessel under the Magnuson Act</li> <li>• Management options of NEFMC are limited to two mechanisms: <ul style="list-style-type: none"> <li>• preparation of an FMP amendment for the proposed project</li> <li>• an amendment that provides blanket permission/exemption from provisions of an FMP to accommodate aquaculture generally</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Principal reasons aquaculture will move offshore are to avoid use conflicts, to avoid regulation under state law, and to minimize regulatory compliance burdens</li> <li>• Current framework of federal law that protects the environment from aquaculture is an “unfinished patchwork quilt”</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>• A general aquaculture FMP could greatly reduce the burden of NEFMC to amend existing FMPs to accommodate projects for various species under its management</li> <li>• The Council should develop an aquaculture policy that will aid in the development of an aquaculture management strategy</li> <li>• The Council should carefully choose which issues to address in formulating the strategy</li> <li>• See <i>Background Information</i> (Brennan 1995) for additional recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• NMFS is well-suited to assume the role of lead federal agency to be responsible for protecting the environment from open ocean aquaculture operations under NEPA</li> <li>• NMFS should use its broad authority under the Magnuson Act to create regulations requiring facilities be approved by NMFS through an FMP</li> <li>• Other federal agencies could fill in specific gaps as needed</li> </ul>
Title/Author	<p>“<i>Defining the Federal Role in Offshore Aquaculture: Should it Feature Delegation to the States?</i>,”  <i>Ocean and Coastal Law Journal</i>  Alison Rieser</p>	<p><i>CRS Report for Congress: Aquaculture and the Federal Role</i>  Geoffery S. Becker and Eugene H. Buck  Environment and Natural Resources Policy Division, Congressional Research Service</p>
Year	1997	1997
Major themes	<ul style="list-style-type: none"> <li>• Description of the important attributes of an effective legal framework for open ocean aquaculture and can federal agencies supply these attributes</li> <li>• What are the legal and regulatory barriers to the development of aquaculture in the United States</li> <li>• Description of elements of an improved government framework</li> </ul>	<ul style="list-style-type: none"> <li>• The role of the federal agencies and departments in assisting or regulating aquaculture</li> <li>• Issues that Congress will look at when considering new legislation addressing U.S. aquaculture policy</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is addressed	Addresses aquaculture generally; little discussion of marine aquaculture

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture and the regulation issues are explicitly addressed	Offshore marine aquaculture is not explicitly addressed
Major findings		<p>The three major programs and resources for aquaculture are located within the Departments of Agriculture, Commerce, and Interior</p> <ul style="list-style-type: none"> <li>• The USDA has the lead role as coordinator of JSA and of national information on aquaculture</li> <li>• Inconsistent statistical collection and analysis of aquaculture in the U.S. makes it difficult to compile standard nationwide data that will provide a full picture of the industry</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>• Marine zones should be identified that are favorable to sea farming</li> <li>• All state and federal permits and leases should share a common application procedure, siting criteria, site evaluation and monitoring protocols</li> <li>• Leases should convey exclusive property interest in the cultured species and the right to harvest it from the leased area</li> <li>• State and federal agencies should adopt memoranda of understanding on coordinating enforcement, research and technical assistance</li> </ul>	<ul style="list-style-type: none"> <li>• Improved information and economic forecasting is needed to support freshwater and marine aquaculture sectors</li> <li>• Amendments to existing legislation could provide more policy direction for the 105<sup>th</sup> Congress</li> </ul>
Title/Author	<i>Murky Waters: Environmental Effects of Aquaculture in the United States</i> Rebecca Goldberg and Tracy Triplett, Environmental Defense	<i>Feasibility Study--Offshore Mariculture.</i> Waldemar Nelson International, Inc. Report prepared for NOAA
Year	1997	1998
Major themes	<ul style="list-style-type: none"> <li>• Environmental effects of aquaculture</li> <li>• Introduction of native/non-native species through escapement</li> <li>• Predation of stocks by wild animals</li> <li>• Reducing nutrient, chemical and biological pollution</li> </ul>	<ul style="list-style-type: none"> <li>• Feasibility of establishing offshore finfish mariculture operation in the northern Gulf of Mexico</li> </ul>
Extent to which marine aquaculture is addressed	Addresses aquaculture generally; little discussion of marine aquaculture	Addresses finfish mariculture
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is addressed in context of a regulatory framework	Focus is on offshore marine aquaculture associated with oil and gas platforms
Major findings	<ul style="list-style-type: none"> <li>• Growth in U.S. aquaculture has resulted from declining harvests of wild stocks, greater overall demand for seafood, and government promotion of aquaculture</li> <li>• Other countries have had problems developing an aquaculture program</li> </ul>	<ul style="list-style-type: none"> <li>• Offshore mariculture in northern Gulf of Mexico is feasible with existing technology, and is likely to occur soon</li> <li>• Two species, red drum and striped bass are suitable</li> <li>• Platform availability is adequate</li> <li>• Regulatory constraints will not impede development in the Gulf in the long term</li> <li>• Costs will be substantial</li> <li>• A single, large mariculture operation will not create significant adverse impacts on water quality, native fish stocks, protected species, socioeconomic considerations</li> </ul>

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Major recommendations	<ul style="list-style-type: none"> <li>• Aquaculturists should adopt environmentally sound management strategies and technologies</li> <li>• Industry should move away from raising finfish in netpens</li> <li>• Fish farmers should raise fish that require little fishmeal in their diets</li> <li>• Organic certification programs should be established that empower consumers to choose products grown in an environmentally sound manner</li> <li>• EPA should implement the CWA for aquaculture by developing effluent standards</li> <li>• The federal government should develop a comprehensive oversight framework for introduction of potential biological pollutants</li> <li>• The federal government should also develop a regulatory framework for open-ocean aquaculture that includes strong environmental protections (led by NMFS)</li> <li>• Government research and other support programs should emphasize environmental protection and long-term social and economic benefits</li> </ul>	<ul style="list-style-type: none"> <li>• Need property rights to protect investment, including security of ownership of fish in cages and security of tenure</li> <li>• Federal law should exempt aquaculture from NMFS regulations on minimum size and quotas</li> <li>• No need to change federal law to foster mariculture industry using oil and gas platforms; argues against an overall federal framework or a federal delegation to the states</li> <li>• Need to monitor operations to verify environmental assumptions and ensure operators work closely with regulatory agencies</li> <li>• Need to address platform liability/abandonment issue</li> </ul>
Title/Author	<p><i>“Marine Aquaculture in the United States: Current and Future Policy and Management Challenges”</i>  <i>Trends and Future Challenges for U.S. National Ocean and Coastal Policy</i>  M. Richard DeVoe</p>	
Year	1999	
Major themes	<ul style="list-style-type: none"> <li>• Understanding of respective aquaculture-environmental interactions focusing on their impact on the Gulf of Maine ecosystem</li> <li>• The role of Canadian and U.S. federal agencies, state and provincial agencies in aquaculture in the Gulf of Maine</li> <li>• Issues of Gulf-wide interest</li> </ul>	<ul style="list-style-type: none"> <li>• U.S. marine aquaculture</li> <li>• Issues confronting marine aquaculture</li> <li>• Coastal and ocean use conflicts</li> <li>• Aquaculture and the environment</li> <li>• Legal and regulatory structures and federal policy</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is explicitly addressed	
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is not explicitly addressed	
Major findings	<ul style="list-style-type: none"> <li>• Canada’s federal role in aquaculture is more clearly delineated than the U.S. federal role</li> <li>• The State of Maine has adopted a joint state/federal approach such that the Department of Marine Resources provides an aquaculture applicant with a comprehensive package that includes application materials and instruction for all the necessary permits</li> <li>• Siting and monitoring of facilities generally rest with the state or provincial authorities</li> </ul>	<ul style="list-style-type: none"> <li>• Aquaculture is practiced in more than 80 percent of the U.S. states and territories</li> <li>• Some 50 federal statutes have a direct impact on the industry and over 120 statutory programs significantly affect aquaculture development</li> </ul>

**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Major recommendations	None	<ul style="list-style-type: none"> <li>Government must show its support by clearly defining aquaculture, providing supporting policy statements and implementation strategies, offering incentives to underscore its commitment and defining/streamlining its regulatory and legal requirements</li> <li>The U.S. must: <ul style="list-style-type: none"> <li>reevaluate and reaffirm the Nation's aquaculture policy</li> <li>support sustainable marine aquaculture</li> <li>strengthen policy development through improved coordination among agencies</li> </ul> </li> </ul>
Title/Author	<i>Sea Scallop Aquaculture: 1999 Blueprint Background, Discussion, &amp; Policy Recommendations</i> Halvorson et al., Sea Scallop Working Group	<i>Offshore Aquaculture Permitting Process in the Gulf of Mexico</i> Kristen M. Fletcher and Ginger Weston, MS-AL Sea Grant Legal Program
Year	1999	2000
Major themes	<ul style="list-style-type: none"> <li>Recent projects in New England</li> <li>Update of the Sea Scallop fishery since the 1995 Sea Scallop Blueprint</li> <li>Regulatory issues, user conflicts and science needs</li> </ul>	<ul style="list-style-type: none"> <li>Background of law, policy and regulations</li> <li>The agencies that have regulatory or consultative authority regarding any aspect of offshore aquaculture</li> <li>Critiques of offshore aquaculture</li> </ul>
Extent to which marine aquaculture is addressed	Marine aquaculture is explicitly addressed	Marine aquaculture is explicitly addressed
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is addressed in the context of permitting for aquaculture in the EEZ	Offshore marine aquaculture is addressed in the context of the Gulf of Mexico
Major findings	<ul style="list-style-type: none"> <li>Promotion of the regulatory, technical, siting and research capability to launch the demonstration of spat collection, seeding of the ocean floor, and rotational farming of sea scallops in state and federal waters with associated economic, social, and ecological analysis is important</li> </ul>	<ul style="list-style-type: none"> <li>Opposition to aquaculture is founded primarily upon ignorance about aquaculture, pollution in other states because of poor technology, interference with public use and enjoyment of the ocean, or the negative impact it may have on existing recreational/commercial fisheries</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>Develop a single process for aquaculture permitting in the EEZ</li> <li>Develop security for farmers</li> <li>Set up a national information center on aquaculture</li> <li>Research more effective hatchery conditions for sea scallops, especially nutritional requirements and bacterial control</li> </ul>	<ul style="list-style-type: none"> <li>The ideal system of pollution control is one that collects the waste products, harvests them and does something economically viable with the waste</li> </ul>
Title/Author	"Effect of Aquaculture on World Fish Supplies"; <i>Nature</i> R. L. Naylor, R. J. Goldburg, J. H. Primavera, M. Kautsky, M. C. M. Beveridge, J. Clay, C. Folke, J. Jubchenco, H. Mooney, and M. Troell	
Year	2000	
Major themes	<ul style="list-style-type: none"> <li>Aquaculture trends in the past 10-15 years, focusing on finfish, bivalves and crustaceans</li> <li>Total world aquaculture production adds to net global fish supplies, even though many types of aquaculture result in a net loss of fish</li> <li>Ecological links between aquaculture and wild fish stocks</li> <li>Sustainable aquaculture</li> </ul>	



**Table 2.1 Summary of major past studies relevant to marine aquaculture (Continued)**

Extent to which marine aquaculture is addressed	Addresses marine aquaculture in the context of scientific and biological information
Extent to which offshore marine aquaculture is addressed	Offshore marine aquaculture is not explicitly mentioned
Major findings	<ul style="list-style-type: none"> <li>• Feed requirements for some types of aquaculture systems place a strain on wild fish stocks, for example, fish meal, fish oil, etc.</li> <li>• The use of wild fish to feed farmed fish puts direct pressure on fisheries resources and indirect pressure through habitat modification, food web interactions, introduction of exotic species, etc.</li> </ul>
Major recommendations	<ul style="list-style-type: none"> <li>• The aquaculture industry should prioritize the following goals: <ul style="list-style-type: none"> <li>– expansion of the farming of low trophic level fish</li> <li>– reduction of fish meal and fish oil inputs in feed</li> <li>– development of integrated farming systems</li> <li>– promotion of environmentally sound aquaculture practices and resource management</li> </ul> </li> <li>• There needs to be a shared aquaculture vision between public and private sectors</li> <li>• The government should support research and develop on environmentally sound aquaculture systems, eliminate subsidies for ecologically unsound practices, and establish/enforce regulatory measures to protect coastal ecosystems</li> </ul>

Source: Prepared by Danielle Tesch, Center for the Study of Marine Policy, University of Delaware, 2000.

## **FINDINGS AND RECOMMENDATIONS OF PAST STUDIES ON THREE MAJOR ISSUES**

In this section, we review the relevant findings and recommendations of past studies on the three major themes we identified in Chapter 1 as problem areas in the development of offshore marine aquaculture: 1) Absence of policy framework, 2) Environmental impacts, and 3) Public trust issues and impacts on other users.

### **► Absence of Policy Framework**

The coastal ocean has always been viewed as public property, and by its very nature has a high degree of interaction between ocean resources and marine processes, and between the users of those resources and the health of the ocean (NRC 1992). Aquaculture represents an exclusive use of the water column (and/or submerged lands), having the potential to

conflict with commercial and recreational fishermen, oil operators, marine transportation, military operations, and scientific research. Unfortunately, there is an absence of a policy framework to govern marine aquaculture, which causes this lack of a policy framework to be addressed by many of the studies examined.

This issue receives special emphasis in the Marine Board's report, *Marine Aquaculture: Opportunities for Growth* (NRC 1992). The complexity of the aquaculture industry requires the involvement of numerous federal, state, and local agencies responsible for the advocacy, conduct, and regulation of marine aquaculture. The Marine Board report stresses the need for aquaculture to be addressed explicitly within a coordinated and coherent policy framework in federal, regional, and state ocean and coastal

planning activities. Additionally, the report stresses “the need for such a framework will become very apparent in the future when advances in technology allow marine aquaculture operations to go further offshore” (NRC 1992).

The report contains several recommendations for solving this issue, while emphasizing the necessity for a framework to provide an orderly process for the leasing and conduct of marine aquaculture operations to reduce uncertainty (NRC 1992). The management framework should have an Environmental Impact Assessment requirement to identify and address environmental impacts and potential impacts on other users. The Marine Board also states the need for a predictable and orderly process that ensures fair returns to the operator and to the public for the use of public resources (NRC 1992). On the Congressional level, Congress needs to create a legal framework to foster appropriate development, to anticipate potential conflicts over proposed uses, to assess potential environmental impacts of marine aquaculture, to develop appropriate mitigation measures for unavoidable impacts, and to assign fair public and private rents and returns on such operations. Aquaculture must also be explicitly included in coastal zone plans and within the Coastal Zone Management Act.

Becker and Buck (1997, “Summary”) raise a question in their report as to whether the government faces “an inherent conflict when it attempts both to promote the [aquaculture] industry, and also to regulate its impacts on aspects of public health and the environment.” This report, done for the Congressional Research Service (CRS), presents two opposing views about the regulatory responsibilities of the federal government. One view is that many of

the government’s regulatory responsibilities could be ceded to the private sector, possibly using an existing or establishing a new industry body for internal regulation. This plan revolves around industry cooperation and consultation with the federal government rather than solely following rules set by the government. The other view argues that the integrity of the industry is preserved through the rigorous government oversight in the areas of food safety, product quality, and environmental protection (Becker and Buck 1997).

The lack of a harmonious national policy on aquaculture impedes its development drastically, and there is a need for a well-designed and well-informed national aquaculture policy. Halvorson (1993) and Halvorson et al. (1999) assert that to create an opportunity for a strong and competitive aquaculture industry, regulations must be streamlined and harmonized and a single process for aquaculture permitting in the EEZ must be established. In conjunction with the streamlining of regulations, the respective roles of federal and state agencies need reconciliation and clarification. Expanding on this idea, DeVoe (1999) argues the JSA should design the streamlined planning and permitting framework for marine aquaculture in the coastal zone, and develop a coordinated management and regulatory framework for offshore aquaculture activities, in consultation with all relevant federal and state agencies.

Rubino and Wilson (1993) provide several regulatory framework recommendations, which can act as a summary of the recommendations previously mentioned in this section. These recommendations include: defining aquaculture as agriculture in state and federal laws; identifying a lead agency in each state to coordinate aquaculture relations; streamlining

the permitting process; including aquaculture in government planning; formulating regulations in consultation with representatives of aquaculture industry and other affected constituencies; encouraging adoption of best management practices (BMPs); and expanding and supporting research, education, and extension efforts.

The *Murky Waters* report (Goldburg and Triplett 1997) also supports the need for a regulatory framework for open-ocean aquaculture, but suggests any federal framework needs to include strong environmental protections, which will be discussed further in the following section.

### ► Environmental Issues

The aquaculture industry relies heavily upon the quality of the environment to produce high quality products. It also involves some degree of impact or manipulation of the environment (Rubino and Wilson 1993). A diversity of concerns and impacts exist, including: wastes from cages or ponds, introduction of non-indigenous species or disease, genetic alterations of wild stocks through escapement of cultivated animals or intentional releases for stock enhancement, and the presence of infrastructure associated with culture operations in public waters (discussed in the next section) (NRC 1992). The severity of impacts depend on two categories of factors: 1) size of the facility, intensity of culture, type and efficiency of feeding, amount of water recirculation, and type of water treatment; and 2) the relationship of the output to the depth, volume, flow rates/current, temperature, and geographic location of receiving waters (Rubino and Wilson 1993).

To preserve existing natural habitats and to protect human and environmental health,

governments have enacted increasingly strict air and water quality regulations on natural resource users, including aquaculturalists (Rubino and Wilson 1993). General regulatory programs for natural resources and specific aquaculture regulations affect the industry. These regulations can be beneficial (reducing industrial wastes), but the permitting process is time consuming, costly and confusing because of the lack of a coordinated framework (as discussed in the previous section). One of the often cited reasons for moving aquaculture to offshore sites is that environmental impacts from the facility on native species can be reduced; the dispersal of nutrients released from fish and shellfish farms is enhanced in offshore sites (OTA 1994).

Environmental issues are addressed in a wide number of studies and receive special attention in the *Murky Waters* report (Goldburg and Triplett 1997). One of the environmental concerns addressed in this report is the introduction of unwanted non-native species to natural ecosystems. Introduction of non-indigenous species increases the possibility that introduced species will: compete with native organisms for existing ecological niches; alter the food web; modify the environment; introduce new diseases; and dilute native gene pools through interbreeding, hybridization, or ecological interaction (NRC 1992; Rubino and Wilson 1993; Brennan 1999; Goldburg and Triplett 1997; Naylor et al 2000). Environmental groups call for avoiding raising non-native species unless there is compelling evidence that escaped fish cannot establish wild populations. This recommendation is echoed in the OTA report (1994) which recommends avoiding the use of exotic species in offshore aquaculture. Unfortunately, we lack the necessary information about long and short term consequences of introducing species to a habitat to which they are not native (NRC 1992).

Another major environmental issue discussed in *Murky Waters* is pollution, with an emphasis

on preventing or reducing the production of pollutants, by employing “source reduction” of nutrient, synthetic, chemical or biological pollutants. Aquaculture facilities can produce and discharge a large volume of effluents to surface waters, and are faced with growing environmental regulatory scrutiny (NRC 1992). The report cites several techniques that can be utilized to achieve this goal of reducing pollutants:

- employ feeds with low fishmeal content which lessen aquaculture’s pressure on wild fisheries
- utilize feeds with nutritional value and other characteristics that help aquaculturists minimize feed wastes
- raise different species together (such as finfish with hydroponic vegetables or with mollusks) in order to make optimum use of water and nutrients and to minimize farm wastes
- collect and treat wastes from contained aquaculture systems such as ponds and tanks
- minimize the use of aquaculture drugs by stocking fish free of pathogens and parasites, minimize stresses on fish, and vaccinate fish against disease (Goldburg and Triplett 1997).

*Aquaculture and the Marine Environment: The Shaping of Public Policy* (Halvorson 1993) also looks at the environmental concerns of waste management and the introduction of exotic species. Concerning the possible effects of waste pollution from aquaculture sites, enhanced programs need to be established to provide guidance and assistance to producers working to optimize site production through

Best Management Practices, health care management, etc. (Halvorson 1993). Concerning the introduction of exotic species, current regulations are loosely adapted from regulations designed for agricultural operations. The use of native stocks would be preferable over the use of non-native stocks. If there is a need for the use of non-native stocks, sound scientific-based risk assessment protocols should be used to evaluate the merit of non-indigenous stock introduction (Halvorson 1993).

The *Murky Waters* report provides several recommendations, for both the private sector and for the government. In the private sector:

- Aquaculturists should adopt management strategies and technologies that make aquaculture environmentally sound.
- The aquaculture industry should move away from raising finfish in netpens due to problems with fish waste and fish escapes.
- Fish farmers should preferentially choose to raise, and consumers should preferentially choose to purchase, fish that require little fishmeal in their diets. These include catfish, tilapia, crawfish, clams, oysters, mussels, scallops and herbivorous species and exclude highly carnivorous species such as shrimp, trout and salmon.
- Organic certification and potentially other “eco-certification” programs should be established that empower consumers to choose aquaculture products grown in an environmentally sound manner and that give aquaculturists incentives to produce products which can bring higher prices (Goldburg and Triplett 1997).

In the government:

- The U.S. Environmental Protection Agency (EPA) should implement the Clean Water Act for aquaculture by developing effluent limitations. In the absence of federal standards, limitations on the discharge of fish sewage vary considerably by state (and may be non-existent).
- The federal government should develop a comprehensive oversight framework for introduction of potential biological pollutants from aquaculture and other human activities. The current approach is at best piecemeal, and may result in ecological harm.
- The federal government should develop a regulatory framework for open-ocean aquaculture that includes strong environmental protections. This effort could be led by the National Marine Fisheries Service (NMFS).
- Government research and other support programs for aquaculture should emphasize environmental protection and the development of aquaculture operations that provide long-term social and economic benefits to economically distressed communities (Goldburg and Triplett 1997).

The scientific community suggests other environmental reforms:

- *Expansion of the farming of low trophic level fish with herbivorous diets.* More scientific research is needed on feed requirements of herbivores and omnivores

to lessen the impetus to add fish meal and fish oil to their feeds.

- *Reduction of fish meal and fish oil inputs in feed.* Feed is the largest production cost for commercial aquaculturists. Partial substitution of fish oil with cheaper vegetable oil is widely accepted within the industry.
- *Development of integrated farming systems.* An integrated farming system efficiently utilizes available food and water resources of the ecosystem, thereby reducing costs and increasing productivity.
- *Promotion of environmentally-sound aquaculture practices and resource management.* Unfortunately, there is a large difference between the technology that is on the shelf and what is being utilized in the field (Naylor et al. 2000).

Hopkins et al. (1997) and the *Murky Waters* report (Goldburg and Triplett 1997) argue that the National Marine Fisheries Service (NMFS) is very well suited to assume the lead role to be generally responsible for protecting the environment from impacts of open ocean aquaculture operations. These authors argue that NMFS should use its authority under the Magnuson Act to develop regulations requiring approval of open ocean aquaculture facilities by NMFS through a fishery management plan (FMP) using the same broad criteria as used in capture fishery FMPs. In these authors' view, NMFS has adequate authority to consider all potential environmental impacts of open ocean aquaculture facilities in determining whether to approve a facility, and in drafting specific FMP conditions on the siting, construction and operation of a particular facility.

## ► Public Trust and Conflicts Issues

### The public trust doctrine

Traditionally, the navigable waters of the United States have been free and open to all, and the land beneath navigable waters as well as the living resources inhabiting those waters have been owned by the state in trust for the benefit of the public. Under the public trust doctrine, a set of common law principles originating in Roman law and embodied in U.S. property law, “the public has the right to use and enjoy trust lands, water and resources for a variety of uses” (Marine Law Institute 1992, p.6). The most common uses of public water are navigation, commerce, and fishing, but the public trust doctrine is not necessarily limited to these uses.

The public trust doctrine has three basic principles:

(1) all tidelands and lands under navigable waters were owned by the original thirteen states at the time of the American Revolution, as successors in sovereignty to the English Crown, and each subsequent state was endowed with similar ownership rights at the time of its admission into the Union; (2) the states own these lands subject to a ‘public trust’ for the benefit of their citizens with respect to certain rights of usage, particularly uses related to maritime commerce, navigation, and fishing; and (3) all lawful grants of such lands by a state to private owners have been made subject to that trust and to the state’s obligation to protect the public interest from any use that would substantially impair the trust. Moreover, any such conveyed lands must be used by their private owners so as to promote the public

interest and so as not to interfere unduly with the public’s several rights under the public trust doctrine (Archer 1994, p. 3-4).

In its legal review of the public trust doctrine with respect to aquaculture, the Marine Law Institute (1992) indicates the public trust doctrine would apply in two situations: when aquaculturists seek exclusive rights to use a publicly owned intertidal or submerged site for cultivation of finfish or shellfish, and when aquaculturists seek use of fishery resources from the public domain. They recommend that lease provisions for aquaculture be developed consistent with public trust responsibilities (Marine Law Institute 1992, p. 25-30). Aquaculture-specific leasing laws are preferable to generic leasing laws. The leasing law should allow other uses to the extent they do not unreasonably interfere with aquaculture operation, but ensure the aquaculturist maintains an exclusive right to the cultured organisms. It is appropriate to prohibit leasing on certain lands which should remain in the public domain.

With respect to legal mechanisms for conveying security of tenure to an aquaculturist, Rieser (1997) points out that the lease form conveys greater security than other alternatives, such as a license. However, “public property rights...prevent the conveyance of exclusive private use rights to submerged lands or water in perpetuity,” and the aquaculturist’s use remains “subject to public and private riparian rights and to government oversight” (Rieser 1997, p. 213). She includes in her list of elements in an improved government framework for aquaculture several measures to protect both the aquaculturist and the public interests, such as enforceable legal remedies to protect the aquaculturist’s investment and administrative procedures that balance the due process rights of

leaseholders with the public right of participation in decisions affecting public resources.

Application of the public trust doctrine does not preclude the government from granting the right to use public resources to a private individual or entity. It does, however, obligate the government to manage these public resources for the greatest benefit of all. Therefore, it implies an expectation that the private user of public land, water, or other resources provide some form of compensation to the public in return for this right. As noted by Barr (1997) and others, lease programs will have to be developed to guarantee the public fair reimbursement for the use of these common resources.

### **Conflicts with other users**

Given the location of marine aquaculture in traditionally public areas of the ocean, conflicts with other users are inevitable, and policy for marine aquaculture should include provisions

for minimizing and adequately addressing anticipated conflicts.

Leasing programs for submerged lands should include criteria to establish priorities among aquaculture applicants competing for the same site (Marine Law Institute 1992). Programs should also include criteria to establish priorities among non-aquaculture uses competing with aquaculture applicants for the same site (Marine Law Institute 1992). Along the same lines, a lease should identify other public or private uses that will potentially be affected by aquaculture activities (Rieser 1997). Hopkins et al. (1997) suggest that the National Marine Fisheries Service, through its regional fishery management councils, is uniquely positioned to address user conflicts associated with any proposal to set aside, for the exclusive use of one entity, a large area of the sea surface, water column, and possibly the seabed.

## CONCLUSION

The findings and recommendations from the studies examined in this chapter provide a wealth of information on which to base our current effort to develop a policy framework for offshore marine aquaculture in the 3-200 mile U.S. ocean zone. With these valuable insights,

we can move forward in taking a closer look at the experiences with offshore marine aquaculture in the United States, identifying and assessing policy options, and putting together a proposal for consideration by federal policy-makers.

## Chapter 3



# ANALYSIS OF PAST AND CURRENT EFFORTS TO ESTABLISH AND OPERATE MARINE AQUACULTURE FACILITIES IN THE UNITED STATES

## EXPERIENCES WITH OFFSHORE MARINE AQUACULTURE

A review of past efforts to conduct marine aquaculture in open waters in the United States provides examples of both the types of challenges involved in the efforts and various strategies for addressing these challenges (both successful and unsuccessful). This discussion includes projects in state waters that are located in open waters and therefore face the same types of challenges (both physical and regulatory) as those located in federal waters 3 or more miles offshore.

There has been an active interest in open ocean aquaculture in the United States for about 12 years. In retrospect, the first private sector project may be described as both bold and blind—bold in the sense that the project was large-scale and ambitious (proposing to occupy nearly 50 square miles of public waters in a

physically challenging location more than 25 miles offshore); blind in the sense that neither the project’s sponsors nor the federal regulatory agencies knew what to expect or demand in terms of applicable regulatory requirements and the regulatory review/approval process.

The projects that followed (both private, public, and in combination) proceeded more cautiously, taking a more research-oriented approach with a focus on species selection, production methods and processes, and demonstration of commercial feasibility. In doing so, they continued to raise important questions about the regulatory framework that should be applied to their endeavors and prodded the responsible government agencies for action. Today, there are three federally funded open ocean aquaculture demonstration projects



underway to demonstrate the biological, technological, economic, and social feasibility of offshore marine aquaculture; each of these projects, in the process of obtaining all of the necessary state and federal permits, is addressing the regulatory challenges as well and providing additional details on specific aspects of the regulatory framework.

Four major types of projects are examined here:

1. A large-scale, private sector salmon project (American Norwegian Fish Farm, Inc.)
2. A federally funded experimental sea scallop project (SeaStead)
3. A seafood/oil industry venture based on an offshore platform in the Gulf of Mexico (SeaFish Mariculture)
4. Federally sponsored demonstration projects in open waters off New

Hampshire, Hawaii, and in the Gulf of Mexico (open ocean demonstration projects)

These projects are summarized in Table 3.1 and discussed in greater detail in the rest of this chapter.

### ► American Norwegian Fish Farm, Inc.

On November 25, 1988, American Norwegian Fish Farm, Inc., a private company, filed an application with the Army Corps of Engineers (Corps) for a Section 10 permit under the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) to locate a 47 square mile aquaculture facility in federal waters 27 miles due east of Cape Ann, Massachusetts. The proposed facility would consist of 90 floating salmon pens (each measuring 90 feet in diameter and 90 feet deep) attached to 9 moored barges (10 per barge), in

**Table 3.1. Summary of Offshore Aquaculture Projects in the United States**

Project	Sponsor	Location	Timing	Technology	Species	Status
Am. Norwegian	Private company	27 m. east of Cape Ann (MA)	1988-1994	Net pens	Salmon	Project abandoned
SeaStead	University/private (federally funded)	12 m. SW of Martha's Vineyard (MA)	1994-	Bottom culture and suspended nets	Scallops	Active
Open Ocean Demo (NH)	NOAA	1.3 m s. of Isles of Shoals (6 m. from mainland)	1997-	Submersible cages and rafts	Flounder Mussels	Active
SeaFish	Joint venture with Shell Oil	34 m. offshore Texas	1998-1999	Net pens attached to gas platform	Red drum	Ended 1999
Open Ocean Demo (HI)	Oceanic Institute/NOAA	2 m. off Ewa Beach	1999-	Submerged cage	Pacific threadfin (moi)	Active
Gulf of Mexico consortium	NOAA	22 m. s. of Pascagoula, MS	2000-	Submersible cage	Red snapper or cobia	Active

Source: Prepared by Susan Bunsick, Center for the Study of Marine Policy, University of Delaware, 2000

which the company planned to raise 46.8 million pounds/year of Atlantic salmon (see Figure 3.1). On February 8, 1989, the Corps gave notice of public hearing.

A permit (#198803500-R-90) was issued on December 14, 1990. On the same date, the Corps issued an Environmental Assessment\* under Section 102 (2) (C) of the National Environmental Policy Act (42 U.S.C. § 4332 (2) (C)), which found “no significant impact on the environment.” However, because the site originally proposed was considered to be a very productive fishing area, the permit relocated the site further offshore (37 miles due east of Cape Ann, in 600-800 feet of water).

Thus, the first permit for an offshore marine aquaculture facility in federal waters was issued about 2 years after application, following an environmental assessment by the Corps of Engineers. However, it was withdrawn 9 months later, after the Navy raised concerns about submarines in the area and an environmental group took the Corps to court over the issuance of the permit.

On February 5, 1991, the Conservation Law Foundation of New England filed suit in United States District Court for the District of Massachusetts (*Conservation Law Foundation of New England v. United States Corps of Engineers*, No. 91-10488-WD) charging that, in issuing the permit, the Corps 1) violated the National Environmental Protection Act, Council on Environmental Quality regulations, and

Section 706 of the Administrative Procedures Act; 2) violated the public trust obligations of the United States; and 3) violated the Administrative Procedures Act by issuing a permit in the absence of regulations, an action considered to be “arbitrary, capricious, and an abuse of discretion.” A key concern expressed by the Conservation Law Foundation was the Corps’ failure to prepare an Environmental Impact Statement (EIS). The Corps did not consider the granting of the permit to be a major Federal action significantly affecting the human environment. The suit summarized the reservations and concerns expressed by environmental groups and the commercial fishing industry (see Table 3.2), as well as written comments by federal agencies involved in the review of the permit application.

Before filing its suit against the Corps, the Conservation Law Foundation had provided written comments as part of the review process for the permit application (CLF, 4/14/89). In these comments, CLF cited the need for comprehensive regulations or a programmatic EIS that would:

- 1) Consider legal and policy implications of closing off or restricting public use of large areas of public waters for the benefit of a single private user without compensation to the U.S.
- 2) Explore the cumulative long range impacts of multiple facilities of this nature and scale on both the natural environment and on existing users of offshore waters; and

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\* An Environmental Assessment is less detailed than an Environmental Impact Statement (EIS). An EA provides evidence and analysis for determining whether to prepare an EIS or to issue a finding of no significant impact. An EA includes a brief discussion of the need for the proposal, alternatives to the proposal, environmental impacts of the proposal and alternatives considered, and a listing of agencies and persons consulted. An EIS means a detailed written statement as required by section 102(2)(C) of the National Environmental Policy Act (NEPA).

Figure 3.1. Example of a netpen/berge configuration



3) Consider in depth the criteria for siting any such facilities in public waters.

In its lawsuit filed after the permit was issued, the Conservation Law Foundation summarized the comments filed with the Corps by various federal agencies, including:

- *Coast Guard* - “It is not in the public interest to exclude the mariner from such a large area” and to “effectively reserve 49 square miles of navigable waters to the exclusive use of one commercial operation” (First Coast Guard District, 2/24/89).
- *Fish and Wildlife Service* - Expressed concerns about the potential environmental impacts, and recommended the phased-in establishment of the Facility, combined with a monitoring program (New England office, FWS, 5/10/89).
- *National Marine Fisheries Service* - Suggested reducing the project size or preparing a programmatic EIS; developing monitoring programs to determine adverse environmental impacts and the extent of hardship on the fishing industry; a moratorium on the acceptance of further applications pending the evaluation of the results of the monitoring programs (NE Regional Office, NMFS, 6/1/89 and 1/25/90).
- *New England Fishery Management Council* - Expressed concern over consideration of the application in the absence of any federal statutory framework to govern siting, user conflicts and environmental impacts; exclusion of fishermen from traditional offshore fishing areas; and privatization of public waters without a thorough review of the broader

**Table 3.2****Issues Raised by the Conservation Law Foundation in a Suit Against the American Norwegian Fish Farm, Inc. Permit**Public trust

“The Permit does not require ANFF to pay any compensation to the United States for the right to occupation, for an indefinite period, of a major area of public navigable waters.”

Nature of project

“The proposed facility is unprecedented in United States waters in terms of its size, its production capacity and its offshore location in federal waters outside of state jurisdiction.”

Legal/regulatory uncertainty

“At the federal level, there is no specific statutory framework for regulating aquaculture in general or the raising of finfish in particular. There are no regulations governing the licensing of aquacultural projects by the Corps or any other federal agency. Based on information and belief, neither the Corps nor any other federal agency has ever prepared a programmatic environmental impact statement with respect to aquaculture.”

Public participation

“Based on information and belief, the Corps, in issuing the Permit, has relied solely on internal ‘guidelines’ that seek to ensure the submission of data that the Corps deems adequate for evaluating a specific project on a case-by-case basis. These guidelines were developed in consultation with certain agencies selected by the Corps, with minimal opportunity for input from the public.”

Environmental concerns

“The Corps made an inadequate evaluation of the environmental impacts of the Facility and made no attempt to address the cumulative impacts of other similar facilities that can be reasonably anticipated. Indeed, the Corps in effect rejected the need to consider cumulative impacts by asserting that each permit application will be considered on the basis of ‘case by case review of project specific data.’”

Harm to community

CLF members, who live in the Cape Ann region, “will be directly harmed by the Corps’ failure to prepare an EIS by being denied the opportunity to fully scrutinize the plans for the Facility, to examine and contest the supporting environmental analyses and studies, to examine and comment on ANFF’s alternatives to the Facility and mitigation analyses, and to comment knowledgeably about the full range of actual and potential impacts

Harm to commercial fishermen

Interests of owners and crews of commercial fishing boats that operate in the Gulf of Maine and other New England waters, together with their families...will be directly affected by the adverse impacts of the Facility, and of similar facilities that can reasonably be anticipated following the precedent of the Permit, upon the exercise of their traditional public rights of navigation and fishing in the public offshore waters of the United States.”

*Source: Conservation Law Foundation of New England v. United States Army Corps of Engineers (United States District Court for the District of Massachusetts, 91-10488WD, filed February 5, 1991)*

implications of such a decision. Recommended a programmatic EIS or a significant reduction in the scope of the project and the development of a regulatory framework (New England Fishery Management Council, 5/19/89).

- *Environmental Protection Agency* – Recommended an EIS to address the potential impacts, including the effects on the commercial fishing industry and on marine mammals (EPA, Region 1, 7/18/89).

In 1994, American Norwegian Fish Farm, Inc. submitted an application for a prototype version of its original project, consisting of only one barge with 10 pens attached in an area even further offshore (47 nautical miles ENE of Cape Ann). The company's plan was to eventually expand the facility to the originally proposed 90 pens if environmental, structural, and conflict-of-use concerns were satisfied by the prototype. The Corps issued a public notice about the application on April 26, 1994. No permit for this scaled-down facility was ever issued, however, due to the Corps' reservations about the structural integrity of the mooring system. The Corps was concerned about the potential navigational hazard if the system were set adrift during a storm, and required the applicant to develop a mooring system that could survive the hazards associated with the offshore environment. The project's sponsors have apparently abandoned their efforts.

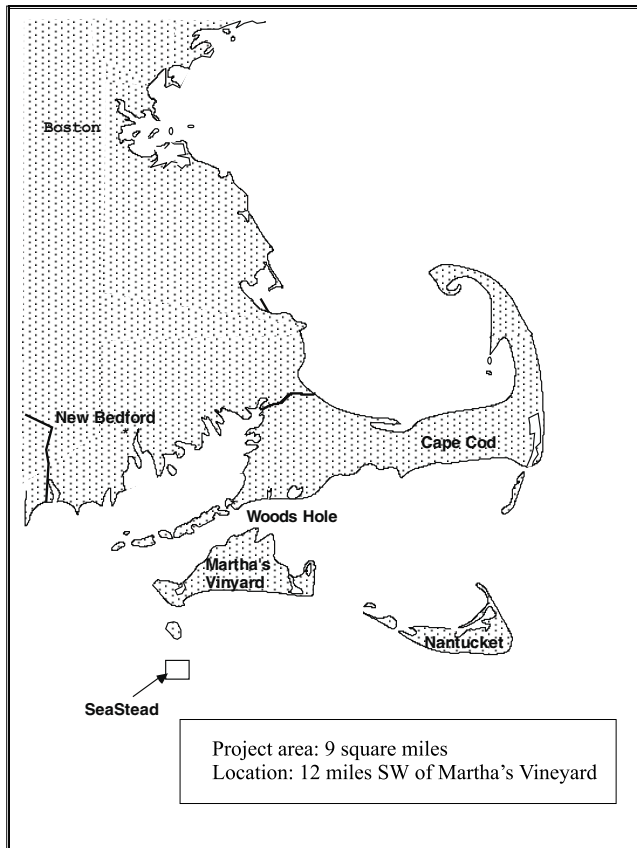
The American Norwegian Fish Farm, Inc. proposal was the first attempt to establish a major offshore aquaculture project in the United States. Neither the project planners nor the government agencies involved appear to have been ready to deal with the range of concerns that needed to be addressed given the project's

large size, remote location, and exposure to harsh physical conditions. As a result, the application for a Section 10 permit triggered an after-the-fact effort by federal agencies to determine powers and responsibilities (see, for example, Brennan 1995). For a variety of reasons, including both physical and regulatory challenges, the project was never built.

## ► **SeaStead Project**

In September 1994, representatives of the SeaStead project (a federally funded, 18-month experimental sea scallop project under NOAA's Saltonstall Kennedy grant program) applied to the Corps for a permit to locate their operation in a 9 square mile area 12 miles southwest of Martha's Vineyard, Massachusetts (see Figure 3.2). The facility would consist of bottom culture growout plus a growout array of nets suspended from buoys, in waters averaging about 100 feet deep. The purpose of the project, a collaborative effort between scientists and the sea scallop fishing industry, was to develop and demonstrate the technology to enhance sea scallop production, on a sustainable and environmentally sound basis, using the existing New England fishing industry and infrastructure.

The Corps' permit was issued in January 1995, following: 1) a finding by the Corps that the project would not unduly interfere with navigation and that the gear placed in the water would not fail and become a risk to navigation and 2) a review by the National Marine Fisheries Service (on biological and marine mammal issues), the U.S. Fish and Wildlife Service (on biological impacts), the U.S. Environmental Protection Agency (on water quality/NPDES), the U.S. Coast Guard (on aids to navigation), the Department of Defense (on naval activities), the

**Figure 3.2. Location of SeaStead Project**

Source: Goudey and Smolowitz (undated)

Department of State (on international treaties), and the Department of the Interior (on minerals management). The relative ease with which the permit was obtained is largely attributed to the use of a native, filter-feeding species (Smolowitz and Goudey undated). This eliminated several major concerns expressed in considering finfish aquaculture projects, such as the American Norwegian Fish Farm, Inc. project discussed above—namely, the environmental impacts from the accumulation of feed and waste and the potential genetic consequences of escaped fish.

This project, however, faced another major hurdle due to its location in an active fishing area of the ocean and the production of a species regulated under an existing fishery management plan. The Corps' permit only authorized the

placement of structures in public waters; it did not guarantee the holders of the permit would have exclusive use of the 9 square mile area. Even before filing the Corps' permit application, the project team had approached the New England Fisheries Management Council about the need to protect the seeded bottom (August 1994). Although the Council did not raise serious objections to this request, it had no experience in regulating aquaculture, and there were no relevant examples to follow from other regions. However, the Council felt that a simple "relaxing" of existing fishery regulations and the granting of an experimental fishing permit would not be adequate. Instead, based on guidance from NOAA's General Counsel, the Council required an amendment to the Atlantic Sea Scallop Fishery Management Plan. The purpose of this amendment was to prohibit trawling, gillnetting, and non-project dredging within the site's boundaries. The Council asked the project team to draft the amendment.

The approval process took over 2 years (see Table 3.3), with the delays attributed to the complex process the Council followed under the Fishery Conservation and Management Act (now the Sustainable Fisheries Act) as well as the competing demands on the Council's time and resources for conducting its primary responsibilities related to the management of commercial fishing in the region. In addition, the amendment approved by the New England Fishery Management Council had to be approved by the National Marine Fisheries Service and published in the *Federal Register* for comment prior to the publication of a final rule. Thus, the project could not begin until the final rule was implemented in February 1997.

One noteworthy outcome of the review process, however, was the identification of a trawling "hot spot" in the middle of the proposed site, based on track plotter sheets from commercial draggers. In addition, lobstermen in the area feared the sea scallop experiment would

**Table 3.3**  
**Events Associated with the Permitting Process for the SeaStead Project**

**1994**

August	Apply to New England Regional Fishery Management Council (Council) for area closure
September	Apply to Army Corps of Engineers for Section 10 permit Presentation to Council
October	Presentation to Council's Scallop Committee
November	Presentation to Council's Interspecies Committee
December	Council vote

**1995**

January	Receive Section 10 permit (Army Corps of Engineers)
February	Submit Amendment 6 Draft to Council
June	Presentation to Council's Aquaculture Committee
December	Council vote on Amendment 6

**1996**

January	Council public hearing, Woods Hole, MA
February	Council vote
April	Industry meeting, Martha's Vineyard, MA Industry meeting, New Bedford, MA Council vote on site relocation
May	Second public hearing, Wareham, MA Presentation to Council's Scallop Committee
June	Council vote on site relocation Amendment submitted to NMFS
November	Review complete, publish proposed rule
December	<i>Federal Register</i> comment period closed

**1997**

January	Publish final rule in <i>Federal Register</i>
February	Implementation date (begin project)

*Source: Smolowitz, Ronald and Clifford Goudey, "Obstacles to Offshore Sea Scallop Culture in New England Waters," undated.*

attract fish, which in turn would attract fishermen using dredges—creating potential gear conflicts with the lobstering activities. The importance of the proposed site to the commercial fishery was not revealed in NMFS data (which is aggregated to blocks of 10 minute latitude by 10 minute longitude, or over 75 square miles). Through meetings with fishermen on Martha's Vineyard and in New

Bedford, a consensus was reached for moving the site 5 miles to the west of the original proposal. Because the Corps' permit had been based on the original site, it was necessary to hold a second public hearing. Although no objections were raised, the project was set back 2 months.

The 30-month process required for approval of an experiment designed to be conducted over a much shorter, 18-month period, appears disproportionate. But when one considers the novelty of the process and the plethora of issues that needed to be addressed, the lengthy process is not so surprising.

Project sponsors have since completed the 18-month experiment at the site, which was marked by large lighted yellow buoys. This was the first site to involve floating containment systems designed for full exposure to the rigors of the Northwest Atlantic Ocean, which included large waves and strong currents. In addition to their scientific accomplishments (which are beyond the scope of this discussion), the project report highlights the project's regulatory and social accomplishments:

The biggest obstacles the project has overcome, and with great success, were regulatory and social. The project was in part responsible for (a) the formation of the Sea Scallop Working Group in Massachusetts, (b) the formation of an Aquaculture Committee within the New England Fishery Management Council, (c) developing scallop industry awareness of enhancement/area management strategies, and (d) establishing the first working aquaculture site in federal waters. (Smolowitz et al. 1998, p. 2).

The SeaStead project has been awarded follow-up funding for the continuation of research at the site under the Sea Grant Technology Program. The project team is seeking a long-term designation for the site and anticipating another amendment to the Sea Scallop Management plan in January 2001 (Goudey and Smolowitz 2000).

## ► SeaFish Mariculture

In 1998, the first aquaculture facility associated with an offshore oil industry platform in the Gulf of Mexico began operations off the Texas coast (Lutz 1999). The facility, entirely a private investment in a commercial operation, grew red drum in cages attached to an unused natural gas production platform owned by Shell Oil, 34 miles offshore (Kaiser and Achnee 2000). The permitting challenges for this project were significantly less than for the two New England projects described above, owing largely to the association with an existing structure—the addition of cages to the platform did not significantly increase threats to navigation or interference with fishing or other uses. The platform was staffed in rotation by two, 2-person teams who lived on the platform and were transported to and from the platform via helicopter service supplied by Shell Oil.

The biggest challenge for this project was the frequency of hurricanes in the Gulf of Mexico. The staff would be evacuated along with Shell's oil personnel during storms for their personal safety, but the cages and fish were lost or damaged. The arrangement ended when Shell decided to develop a nearby natural gas well, and needed the platform once again for its main business. However, this project provides a good example of the potential association of aquaculture with the offshore oil and gas industry. In this case, the facility provided an interim use of a platform and delayed the need for the oil company to make a decision on abandonment. Additional possibilities may arise from use of platforms slated for abandonment by the oil companies, provided agreement could be reached on the liability question.



## ► Open Ocean Demonstration Projects

The National Oceanic and Atmospheric Administration is currently supporting open ocean aquaculture demonstration projects off New Hampshire and Hawaii and in the Gulf of Mexico. The New Hampshire and Hawaii projects have obtained all of the necessary permits, and have already stocked submersible cages. The Gulf of Mexico project just got underway in early 2000; it has obtained permits for the site, but has not yet obtained all of the permits to stock fish.

### University of New Hampshire open ocean aquaculture demonstration project

This 5-year project, which started up in 1997, is the first pen culture in the open ocean of the United States. It is a cooperative university/industry effort, involving the University of New Hampshire, Great Bay Aquafarms, and the Portsmouth Fishermen's

Cooperative. The project's goal is "to demonstrate the biological, technological, engineering and economic feasibility of culturing fish and shellfish in unprotected, oceanic environments" and "to do so in an environmentally responsible manner" (University of New Hampshire 2000b). A key objective is to establish a fully permitted, pilot-scale demonstration site (see Table 3.4 for site selection criteria). The project has obtained federal and state permits for a commercial operation in open waters off the Isles of Shoals, 6 miles from the mainland (see Figure 3.3).

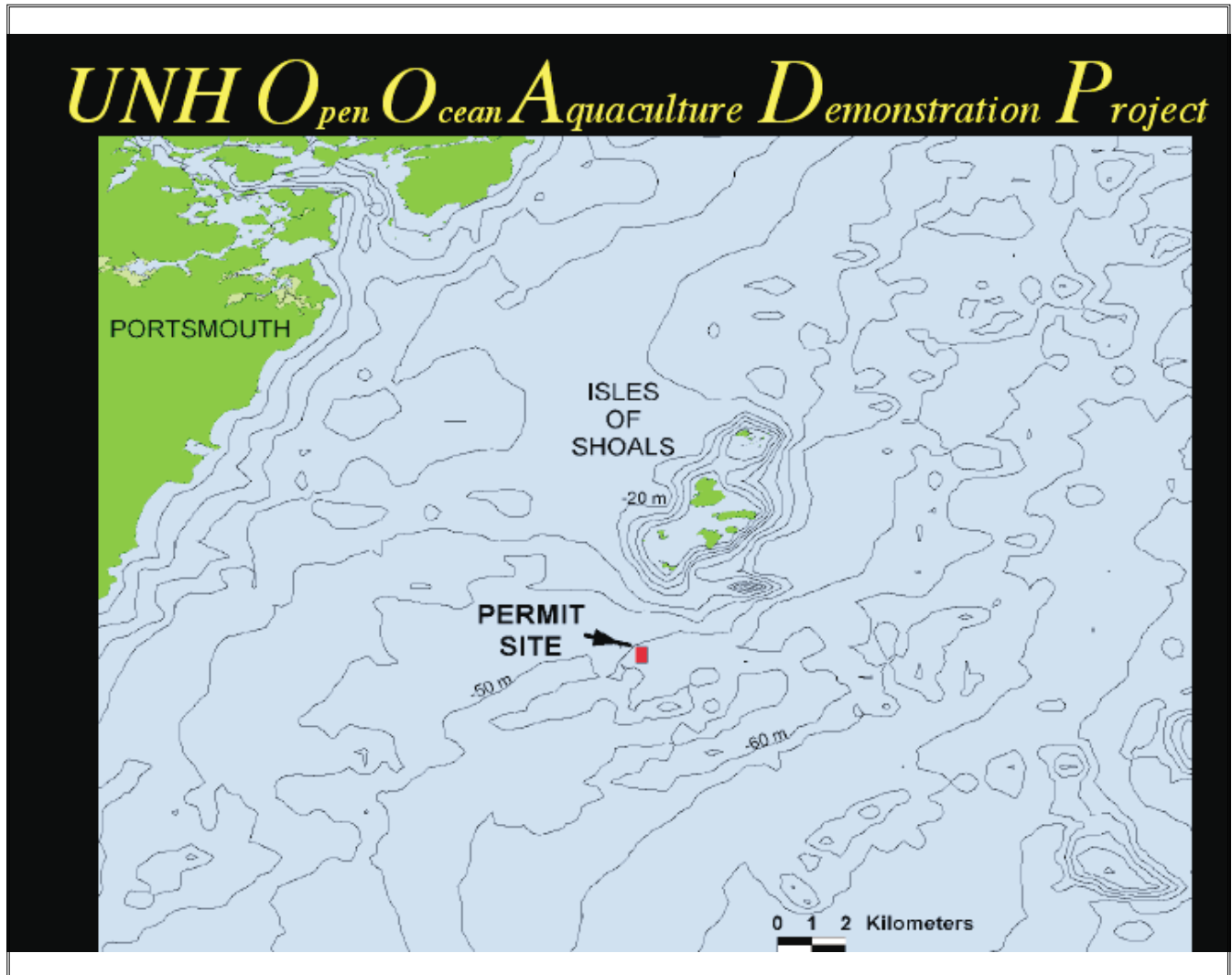
Species of interest to date include both summer flounder and blue mussels, so separate finfish and shellfish permits were necessary. Although the finfish and shellfish growout activities are both physically within the bounds of the project site, they are being developed as separate operations. According to a project team member, it took an estimated 200 hours to complete the necessary applications, plus additional hours spent meeting with relevant officials. The process (see Table 3.5) extended over a 2-year period—1 year of preparation and

**Table 3.4**  
**Site Selection Criteria for New Hampshire Open Ocean Aquaculture Demonstration Project**

- Representative of open ocean site in the Gulf of Maine (fully exposed, deep water)
- Sufficient water movement
- Well-mixed water column
- Sufficient primary productivity
- Proper bottom substrate (not too firm, not too soft)
- Relatively easy access from port
- Minimal multiple use conflicts (navigation, fishing)
- No insurmountable environmental issues

*Source: University of New Hampshire, "Open Ocean Aquaculture Project Overview," 2000.*

Figure 3.3. Location of University of New Hampshire Project



**Source:** University of New Hampshire Open Ocean Aquaculture Demonstration Project home page:  
<http://www.ekman.sr.unh.edu/AQUACULTURE/PRESENTATIONS/OVERVIEW/sld10.htm>

another year between application and approval. Numerous surveys were performed in collecting data for the applications, at an estimated cost of more than \$100,000 (Langen 2000b).

Permits obtained were:

- U.S. Army Corps of Engineers: Section 10 permit (plus biological assessment, requested by the National Marine Fisheries Service, emphasizing marine mammal entanglement)
- New Hampshire Fish and Game Department: Marine aquaculture license (\$750/acre x 30 acres = \$22,500/year) (Tuohy 1999).
- New Hampshire Department of Environmental Services: Wetlands permit
- U.S. Coast Guard: Private aids to navigation permit

**Table 3.5**  
**Permitting Process for New Hampshire Project**

**Steps Taken**

- Initiated one year prior to submitting applications
- Met with regulatory agencies prior to submitting applications
- Met with stakeholders
- Synthesized all data on the site, and on proposed activities
- Wrote and submitted required permits
- Responded to comments and inquiries
- Public hearings

**Issues Raised**

- Entanglement of endangered whales and turtles
- Potential impacts of biodeposition of fish waste and uneaten food on seafloor
- Potential increase in dissolved nutrients
- Seal attraction and predation
- Escapement of fish from cages
- Vessel navigation
- Commercial and recreational fishing

*Source: University of New Hampshire, “Open Ocean Aquaculture Project Overview,” 2000.*

- New Hampshire Coastal Program:  
Federal consistency review

Agencies consulted in the permit process included:

- U.S. Environmental Protection Agency
- U.S. National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- U.S. Coast Guard
- New Hampshire Governor’s Office

- New Hampshire Office of State Planning
- New Hampshire Port Authority
- New Hampshire Department of Environmental Services/Water Supply and Pollution Control Division
- Atlantic States Marine Fisheries Commission
- New England Fishery Management Council
- Executive Councilor, Portsmouth, New Hampshire

In obtaining the permits, the project team argued that:

- Moorings and cages do not represent any known entanglement threat to whales and sea turtles
- Environmental impacts are minimal (e.g., there is good waste dispersion and predator mitigation; cage is stocked with first generation offspring of wild species)
- The area is mostly barren of commercial species.

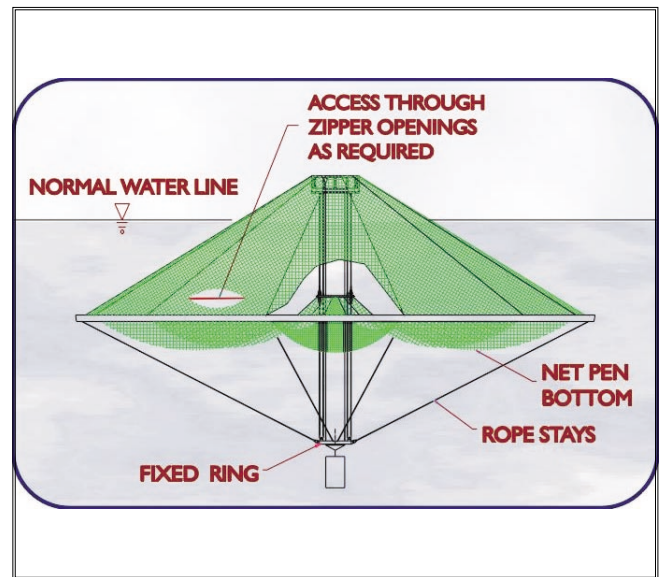
In reflecting on the permitting process, the director of the Jackson Estuarine Laboratory at the University of New Hampshire listed the following needs (Langen 2000b):

- One central regulatory contact point that coordinates with all agencies
- An information package that identifies all the issues and required information
- One application that is shared with and satisfies all agencies
- An aquaculture advocate on the staff of the lead permitting agency.

The 30-acre site, which is located 6 miles off the mainland (1.3 miles south of White Island, Isles of Shoals), is marked by yellow buoys, including a flashing navigational buoy. It also includes an environmental monitoring buoy powered by photovoltaic panels. In the summer of 1999, two Ocean Spar Sea Stations (submersible cages) were deployed in waters averaging 178 feet deep and stocked with summer flounder (see Figure 3.4).

To date, the shellfish component of this project (mussels) has been more successful in terms of production than the finfish effort

**Figure 3.4 Ocean Spar Sea Station**



**Source:** Ocean Spar web page:  
<http://www.oceanspar.com>

(flounder), which experienced problems with feeding, fish mortality, and slow growth rates. The first finfish were harvested in December 1999, and the first shellfish in spring 2000. The project is considering additional species for future years, including cod, haddock, winter flounder, sea scallops, and European oysters.

## Hawaii

This project, a collaboration between the Hawaii Sea Grant College Program and the Oceanic Institute, is Hawaii's first experiment in open-ocean aquaculture. The project site is 2 miles off Ewa Beach (in the state waters of Hawaii). An Ocean Spar SeaStation 3000 (50 x 80 foot biconical sea cage, fully submerged to depth of 40 feet with no navigational markers) was deployed in April 1999 in 100 feet of water and stocked with 70,000 indigenous Pacific threadfin (*Polydactylus sexfilis*, locally known as moi). Because the cage is fully submerged, a feeding tube is used to deliver food to the cage. The tube, which is attached to the cage, must be

brought to the surface by divers for each feeding (Figure 3.5).

The permitting process for this project took 4 months from a complete application to approval of all agencies. This relatively quick approval is related to the nature of the project: short-term government research using a native species, and therefore determined not to require an Environmental Assessment. The process was facilitated through scoping meetings, agency input into the experimental design, and agency decisions to issue administrative approvals (the easiest form of approval available). The high level of agency interest in learning about open ocean aquaculture from the project contributed to the decision-making process (Corbin 2000).

The project is reporting good results in terms of system operation and fish production. The

first fish were harvested after 4 months ( $\frac{3}{4}$ -1½ pounds each) and marketed outside Hawaii, so as not to compete with local small-scale aquaculture ventures. Based on these results, the project is considered to be feasible and economically viable, without adverse environmental impacts to the water column, sea floor, or nearby reefs (Hawaii Sea Grant undated). Phase II of the cage research resulted in additional fish harvests in 2000.

### Gulf of Mexico

This university/industry project, funded by Sea Grant and involving input from federal and state agencies, is in its first year. The project plans to deploy two cages offshore Mississippi: one in “deep” federal waters off Horn Island

**Figure 3.5. Tube Used in Stocking Sea Cage in Hawaii (similar tube used in feeding)**



**Source:** Hawaii Sea Grant home page ([http://www.soest.hawaii.edu/SEAGRANT/special\\_projects.html](http://www.soest.hawaii.edu/SEAGRANT/special_projects.html))

(50-100 feet deep) and another in “shallow” state waters off the Gulf Coast Research Laboratory in Ocean Springs (<50 feet deep). Its approach is to address engineering and environmental issues before moving on to a study of fish production methods for offshore waters in the Gulf of Mexico. Its goal is to use the best available technology—defined as socially and environmentally acceptable and economically feasible. Target species include red snapper or other warm water species.

A key concern is the survivability of cages in the shallow, hurricane-prone waters of the Gulf. For this reason, the project may delay stocking fish for production until preliminary engineering tests are completed. The project assumes that it would be impossible for fish in cages to survive a Class 5 hurricane; therefore, its engineering goal is to minimize hardware losses and risks to others by designing a way to preserve the cage and net and prevent the movement of the cage/mooring system.

As part of the project, the Mississippi-Alabama Sea Grant Legal Program is compiling existing applicable federal and state regulations, and surveying agencies for information on policies and protocols. The project plans to produce a regional guide to permitting offshore aquaculture. It will also work towards the establishment of offshore aquaculture zones in the Gulf of Mexico and a “one stop shopping” leasing process.

In February 2000, the consortium held a workshop of regional and national experts and natural resource stakeholders to further define problems and opportunities associated with offshore aquaculture.

The project has obtained the necessary permits to place an offshore cage (a 30x49 foot SeaStation cage manufactured by Ocean Spar) adjacent to a Chevron natural gas platform approximately 22 miles due south of Pascagoula, Mississippi (the cage will not be attached to the platform) (Bridger 2000).

## LESSONS LEARNED

### ► **Army Corps of Engineers Permitting**

Worth noting in each of the cases for which permitting information was available is that the specific purpose of the Section 10 permit (to avoid interference with navigation and potential navigational hazards) is straightforward. The administrative and regulatory challenge has to do with the extension of the review process to incorporate a review by other federal agencies with a host of much broader concerns (environmental, economic, etc.). For example,

the SeaStead project, if located at the site originally proposed, was not considered by the Corps to be a navigational hazard; nevertheless, in the process of receiving approval from the New England Fishery Management Council, it was found to interfere with commercial fishing operations in the area and eventually relocated following two public meetings. The much broader concerns raised in the Conservation Law Foundation’s lawsuit against the Corps after it issued a permit to American Norwegian Fish Farm, Inc., however, would take more than a few public meetings to resolve. Past experience,

therefore, does not indicate a serious problem with the Corps' process for determining whether an aquaculture project would interfere with or create a hazard to navigation; it does, however, suggest that the Corps may not be the appropriate agency for decision-making on the broader issues of concern (at least not as currently formulated).

### ► Fishery Management Council Approval

The detailed information provided by the participants in the SeaStead project documents the difficulties of continuing the ad hoc approach to regulating offshore aquaculture. To get approval for an 18-month experiment, participants had to prod the regional Council, push the limits of its authority, and take an active part in creating an ad hoc regulatory mechanism to provide the scientists with exclusive use of the area for which they had already obtained a Corps Section 10 permit. While the New England Fishery Management Council may be lauded for breaking new ground—it created an Aquaculture Committee, supported the project's efforts to amend the scallop fishery management plan, and spearheaded an effort to coordinate the application process for future projects seeking a Corps Section 10 permit—the process was lengthy and at times unwieldy. In addition, the Council's authority is less clear with respect to species for which there is no Fishery Management Plan (Smolowitz and Goudey undated).

Clearly, there is a need for national level guidance to all of the regional fishery management councils in dealing with future proposals for aquaculture facilities in federal waters. The SeaStead project, as a government-funded research effort, was able to

delay its start-up until the appropriate approvals had been obtained. For a private firm seeking financing for a commercial project, however, a 30-month application process makes it difficult or impossible to proceed in a way that preserves the prospects for obtaining a loan or commitments from potential investors.

### ► Integration with Other Uses: Research

The SeaStead project and the three federal demonstration projects now underway incorporate a host of data collection efforts, on environmental, economic, and social impacts as well as on engineering and production techniques directly related to the aquaculture operation itself. Collection of this type of data—whether by an agency of the federal government, university or other researchers, a private firm, or the aquaculture operator—should be a component of future projects as well. Such information will serve to reduce the scientific uncertainties that underlie many of the current conflicts over whether development of an offshore aquaculture industry is in the public interest.

### ► Integration with Other Uses: Commercial Fishing

The SeaStead project and the more recent demonstration projects in New Hampshire and Hawaii directly involve the commercial fishing industry. The approach appears to be successful in terms of identifying potential conflicts, relocating a site if necessary, and providing alternative employment for commercial fishermen, boats, and gear. It provides a positive foundation to build a new industry on the existing resource base of a region traditionally dependent on commercial fishing.

In an attempt to gauge the potential support for aquaculture from the commercial fishing sector in northern New England, a survey of fishermen conducted by the University of New Hampshire identified the following concerns: 1) who has the right to open ocean leases; 2) restrictions in traditional fishing methods, places, and times; 3) the possible dominance of large corporations over the individual entrepreneur; and 4) regulations on the industry. While many commercial fishermen were willing to consider potential opportunities in marine aquaculture, they felt they would be left out if the industry were dominated by large industries. Nearly 9 out of 10 fishermen wanted to keep doing what they were doing (Robertson et al. 2000).

### ► Synergy with Other Uses: Offshore Oil and Gas Production

The SeaFish Mariculture project provides several lessons: First, the benefits in terms of ease of site approval from associating an aquaculture project with an existing use of ocean space; second, an alternative to oil platform abandonment—either permanent or temporary; third, the remaining engineering challenges of maintaining aquaculture facilities in areas frequently prone to storm damage. While the structure on which the aquaculture operation was based survived some storms, the cages and fish were lost on several occasions in a relatively short time span. This raises concerns over escaped fish as well as hazards from the cages set adrift by a storm.

### ► Moving Ahead: Federal Open Ocean Demonstration Projects

Current efforts are building on past experience and seeking to address the range of

concerns identified in early projects. Each of these projects obtained, or plans to obtain, all of the necessary permits under existing laws and regulations. The New Hampshire project has documented its efforts, the Hawaii project is compiling state and federal regulations, and the Gulf of Mexico consortium includes a legal/regulatory guide as one of its planned work products. The amount of time and effort put into this activity by professional researchers consumes a large share of project resources. Based on this experience, the burden placed on a private business under the current regime appears excessive. Even with well-prepared and documented guides, such as that underway for the Gulf of Mexico region, the process will remain complex and costly for potential investors.

### ► The Big Gaps: Addressing the Security of Tenure, Public Trust, and Environmental Issues

None of the federal agencies involved in the past efforts to approve offshore aquaculture in federal waters has the authority to address the public trust issue beyond the ability to advise against a particular project. As a result, projects have been issued permits to operate at designated offshore sites, but no leases. Even the “closed fishing area” designation for the SeaStead project did not exclude transit over the area or fishing with special permits issued after taking account of the potential for interference with the experimental sea scallop project underway at the site. Although there are no purely commercial offshore projects in operation today, successful completion of the various research and demonstration projects underway could produce significant interest in future projects. Before this occurs, the federal government needs to decide 1) how future



projects should be granted security of tenure (i.e., private property rights) and 2) how these projects should compensate the public for the exclusive right to operation in an area of the ocean previously open to all users. The various components of such a system (lead agency; lease/rent/royalty payments; designation of areas open to aquaculture; conditions on operations, such as insurance, bonds, environmental monitoring requirements) are examined in detail elsewhere in this report.

The other major gap relates to how environmental impacts are addressed. These are not dealt with systematically under the current framework.

### ► **The Bottom Line: No Active Commercial Projects in the 3-200 Mile Ocean Zone**

More than 12 years after the first permit application by American Norwegian Fish Farm, Inc., there are no fully commercial aquaculture facilities operating in open waters of the EEZ under federal government control. The American Norwegian proposal raised concerns and prompted government responses, which are only now beginning to coalesce in a coordinated effort to devise a system for governing this new ocean industry.

# Chapter 4



## THE FEDERAL FRAMEWORK FOR ADMINISTRATION OF OFFSHORE MARINE AQUACULTURE

### INTRODUCTION

As interest in establishing an offshore marine aquaculture industry in the United States has developed, federal agencies have increasingly assumed regulatory and promotional roles based on existing authorities. These authorities pre-date any aquaculture industry in open ocean waters, and do not explicitly address the particular types of aquaculture facilities and operations that are of concern in this study. In the absence of more specific legal guidance, federal agencies have attempted—with varying degrees of success—to apply their existing regulatory authorities to various aspects of open ocean aquaculture facilities and operations (in state waters as well

as in federal waters beyond the limits of state jurisdiction). On the promotional side, they have made a variety of research, extension, financing, and other programs open to offshore aquaculture interests.

In this chapter, we first provide an overview of federal legislation and activities to stimulate the development of the aquaculture industry (freshwater and marine). We then address more specifically federal roles and legislative authorities related to the management of offshore aquaculture.

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## THE FEDERAL GOVERNMENT AND AQUACULTURE\*

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### ► The National Aquaculture Act and the Joint Subcommittee on Aquaculture

The major piece of legislation for the U.S. aquaculture industry is the National Aquaculture Act of 1980 (PL 96-362), as amended (16 U.S.C. 2801 *et seq.*), which promotes private development in aquaculture due to its potential for reducing the trade deficit, augmenting commercial and recreational fisheries, and meeting future food needs. Although the law does not explicitly address marine aquaculture, it is an important initiative because: 1) it established that the development of a U.S. aquaculture industry is “in the national interest” and 2) it provided a mechanism for making aquaculture development part of the national policy, through the establishment of the Joint Subcommittee on Aquaculture (JSA) as a coordination group for federal government activities relating to aquaculture (see Table 4.1). The JSA’s mission is “to increase the overall effectiveness and productivity of Federal aquaculture research, technology transfer, and assistance programs” (see the JSA’s worldwide web site: <http://ag.ansc.purdue.edu/aquanic/jsa/>).

The JSA is part of the National Science and Technology Council (NSTC) within the Office of Science and Technology Policy in the Office of the Science Advisor to the President. It reports to the NSTC’s Committee on Science, one of five research and development (R&D) committees that prepare coordinated R&D strategies and budget recommendations for

accomplishing national goals. The Secretaries of the three departments with the most aquaculture-related responsibilities (i.e., Agriculture, Commerce, and Interior) make up the JSA’s Executive Committee. Initially, these agencies rotated responsibility for chairing the JSA, but the National Aquaculture Improvement Act of 1985 established the Secretary of Agriculture as the JSA’s permanent chair.

The primary task for the JSA was to develop a National Aquaculture Development Plan covering about 30 programs in 12 federal agencies, which was completed in 1983. Its major innovation was the creation, within the Department of Agriculture, of a National Aquatic Information Center and a network of Regional Aquaculture Centers. The plan also identified the major problems facing the industry: inadequate credit, diffused legal jurisdiction, lack of management information, lack of supportive government policies, and lack of reliable supplies of feed stocks. To date, inadequate resources have been directed towards addressing these issues, and they remain concerns for the industry today.

A revised National Aquaculture Development Plan was drafted in 1996, with stakeholder (including industry) input, but has not yet been formally adopted. The draft Plan seeks to develop a framework dealing with 12 major issues, including the federal regulatory framework (Table 4.2). Its vision is:

To develop a highly competitive, sustainable aquaculture industry in the United States to meet consumer demand for cultivated

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\* *This section is adapted from Bunsick 1998.*

**Table 4.1 Joint Subcommittee on Aquaculture**

**Executive Committee**  
 Secretary of Agriculture (permanent chair)  
 Secretary of Commerce  
 Secretary of Interior

**Members**  
 Secretary of Energy  
 Secretary of Health and Human Services  
 Administrator, Environmental Protection Agency  
 Chief of Engineers  
 Administrator, Small Business Administration  
 Administrator, Agency for International Development  
 Chair, Tennessee Valley Authority  
 Director, National Science Foundation  
 Governor, Farm Credit Administration  
 Heads of other Federal Agencies, as appropriate

**Task Forces and Working Groups**  
 Aquaculture Information & Technology Transfer Task Force  
 Aquatic Animal Health Task Force  
 Bird Depredation Task Force  
 Shrimp Virus Task Force  
 Working Group on Aquacultural Statistics and Economics  
 Working Group on Quality Assurance in Aquaculture Production  
 Aquaculture Effluents Task Force

*Source: JSA Web site (<http://www.ag.ansc.purdue.edu/aquanic/jsa/>), accessed 6/13/00)*

aquatic foods and products that are of high quality, safe, competitively priced, and nutritious and are produced in an environmentally responsible manner with maximum opportunity for profitability in all sectors of the industry (Joint Subcommittee on Aquaculture 1996).

The plan leaves principal responsibility for future development to the private sector, and identifies actions the federal government could take over the next 3-5 years to support development of the industry. The principal goal is to improve international competitiveness and sustainability of the U.S. aquaculture industry.

**► Current Programs**

Most federal funding of aquaculture today supports two main program areas: research and the operation of fish hatcheries. Of particular interest to marine aquaculture are the National Oceanic and Atmospheric Administration’s Sea Grant Program and the Department of Agriculture’s Cooperative State Research, Education, and Extension Service.

The National Sea Grant College Program funds research on aquaculture production and

**Table 4.2 Major Issues Addressed in the National Aquaculture Development Plan**

Research and technology development	Product quality, safety, and variety
Technology transfer	Federal regulatory framework
Education, extension, and training	Marketing and international trade
Information systems	Statistics and economics
Sustainability and environmental compatibility	Financial services and incentives
Aquatic animal health	Coordination and partnership

*Source: JSA, National Aquaculture Development Plan (1996 draft)*

species, including policy studies such as this one, aimed at meeting the present needs of the aquaculture industry. Sea Grant aquaculture research is conducted in many areas: genetics, biotechnology, endocrinology, physiology, pathology, engineering, nutrition, policy, economics, and others. The Sea Grant Extension Service utilizes a corps of area agents and specialists to provide public education, technology transfer, and demonstration projects in aquaculture. The Program develops information generated by Sea Grant and other research, for use by groups in the private sector to develop marine aquaculture.

The Department of Agriculture's Cooperative State Research, Education, and Extension Service operates similar types of programs aimed at all types of aquaculture, including marine aquaculture. Research efforts emphasize aquaculture systems; integrated aquatic animal health; reproduction, growth, and nutrition; genetics; product quality; marketing economics; and other areas. In addition, the agency operates five Regional Aquaculture Centers and coordinates all federal research programs in aquaculture.

A summary of fiscal year 1998 appropriations and the fiscal year 1999 budget request for the three major agencies (Agriculture, Commerce, and Interior) is provided in Table 4.3. A more complete list of

aquaculture activities is provided in Table 4.4, which summarizes information compiled by the Joint Subcommittee on Aquaculture in the *Guide to Federal Aquaculture Programs and Services* (see JSA worldwide web site: [http://ag.ansc.purdue.edu/aquanic/jsa/federal\\_guide/Federal%20Guide.htm](http://ag.ansc.purdue.edu/aquanic/jsa/federal_guide/Federal%20Guide.htm)). The JSA's guide is a good start toward identifying the wide range of aquaculture-related activities in which the federal government is involved, and it demonstrates the extent to which program responsibilities and activities are scattered across various government agencies. In addition, the absence from the list of the Army Corps of Engineers (which serves on the JSA and has become involved in the issuance of permits for offshore aquaculture facilities) and the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (which deals with aquaculture in the context of state coastal management plans) indicates the list is far from exhaustive.

Although a full discussion of each of these programs is beyond the scope of this report, three features are worth noting: 1) several agencies play major roles in particular areas, such as research and hatchery programs; 2) no single agency has the lead responsibility for the overall direction of aquaculture programs and policies; and 3) regulatory programs are not aimed specifically at aquaculture, but at broader environmental, health, and safety concerns.

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## **THE FEDERAL GOVERNMENT AND THE MANAGEMENT OF OFFSHORE MARINE AQUACULTURE**

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Issues related to the management of offshore aquaculture—the need for clarification of agency roles, coordination of the regulatory

process, and additional regulatory authority to fill in the gaps—were common themes in the critiques of early attempts by federal agencies to

**Table 4.3. Federal Funding for Aquaculture, Selected Agencies**

Department/Agency	Program/Activity	FY1998 Appropriation	FY1999 Request
<b>Agriculture:</b>			
<i>Cooperative State Research, Education, and Extension Service (CREES)</i>	<i>Regional aquaculture centers</i>	<i>\$4.0 million</i>	<i>\$3.9 million</i>
	<i>North Carolina mariculture</i>	<i>\$150,000</i>	—
	<i>Gulf Coast shrimp aquaculture</i>	<i>\$3.4 million</i>	—
<i>National Agricultural Statistics Service</i>	<i>Census of aquaculture</i>	—	<i>\$0.5 million</i>
<i>Agricultural Research Service (ARS)</i>	<i>Research funding</i>	<i>\$11.7 million</i>	<i>\$9.6 million</i>
<i>Animal and Plant Health Inspection Service</i>	<i>Pest and disease management</i>	<i>\$568,000</i>	<i>\$583,000</i>
<b>Commerce:</b>			
<i>National Oceanic and Atmospheric Administration/OAR</i>	<i>Regional Open Ocean Aquaculture (New England)</i>	<i>\$1.7 million</i>	—
	<i>Mariculture initiative</i>	—	<i>\$1.6 million</i>
<i>National Marine Fisheries Service (NMFS)</i>	<i>Colombia River Hatcheries</i>	<i>\$11.1 million</i>	<i>\$10.3 million</i>
<b>Interior:</b>			
<i>Fish and Wildlife Service</i>	<i>National Fish Hatchery System</i>	<i>\$38.4 million</i>	<i>\$39.5 million</i>
	<i>Snake River Hatchery (reimbursed by Bonneville Power Administration)</i>	<i>\$11.6 million</i>	<i>\$11.6 million</i>
<p><i>Note: According to recent estimates, CSREES funding totaled \$17.5 million in FY 1998 and \$20.2 million in FY99, of which about 50 percent is invested in marine species. ARS funding is about \$19.5 million (Broussard 2000). NMFS provides additional support for marine aquaculture under the Saltonstall-Kennedy Act, the Fisheries Finance Program, and work at its research laboratories (Rhodes 2000).</i></p>			

Source: Worldwide web site: <http://www.cnie.org/nle/mar-19.htm>.

regulate offshore aquaculture, as discussed in Chapter 2. As illustrated in Chapter 3, the efforts of federal agencies to regulate offshore aquaculture have been, by necessity, ad hoc in nature. As the different agencies interpreted and exerted their authorities with respect to offshore marine aquaculture, several concerns soon

arose: 1) regulatory requirements often overlapped; 2) agency roles were sometimes conflicting; and 3) regulatory gaps became apparent.

In this section, we discuss the current framework for offshore marine aquaculture.

**Table 4.4. Aquaculture-Related Programs in the Federal Government**

Department	Agency or Program	Activities
<b>Department of Agriculture</b>	<i>Agricultural Research Service</i>	<i>National Agricultural Library. Includes Alternative Farming Systems Info. Center and Water Quality Info. Center. National aquaculture centers (Stonevill, MS; Stuttgart, AR; Leetown, WV) for intramural research.</i>
	<i>Cooperative State Research, Education, and Extension Service</i>	<i>Coordinates all Federal research programs in aquaculture; includes 5 Regional Aquaculture Centers. Extramural research, extension, education, including technology transfer.</i>
	<i>Farm Service Agency</i>	<i>Loans for facilities and operations</i>
	<i>Agricultural Marketing Service</i>	<i>Marketing, financial, technical support</i>
	<i>National Agricultural Statistics Service</i>	<i>Industry surveys; Aquaculture Situation and Outlook Report</i>
	<i>Foreign Agricultural Service</i>	<i>Export opportunities and trade</i>
	<i>Animal and Plant Health Inspection Service</i>	<i>Animal and plant health protection</i>
	<i>Federal Crop Insurance Information</i>	<i>Insurance, loans, disaster assistance</i>
<b>Department of Commerce</b>	<i>National Marine Fisheries Service</i>	<i>Research laboratories, resource management, financial assistance for research and structures, Fishery Management Councils</i>
	<i>Office of Oceanic &amp; Atmospheric Research: National Sea Grant College Program; National Undersea Research Program</i>	<i>Research grants, extension services, education</i>
	<i>National Ocean Service: Office of Ocean and Coastal Resource Management</i>	<i>Technical products, coastal resource management, state grants</i>
	<i>Economic Development Administration</i>	<i>Community planning, technical assistance, economic assistance to distressed areas</i>
	<i>Technology Administration: National Institute of Standards and Technology - Advanced Technology Program</i>	<i>Assist industry in development of technology to improve product quality, reliability, modernize, commercialize</i>
	<i>Minority Business Development Agency</i>	<i>Support for creation, growth and expansion of minority-owned businesses</i>
	<i>International Trade Administration</i>	<i>Encourage exports, fair competition, equal access to foreign markets</i>
<b>Department of Interior</b>	<i>Fish and Wildlife Service</i>	<i>Hatcheries, technical/scientific advice</i>
	<i>Geological Survey</i>	<i>Data on ground and surface water</i>
<b>Department of Health and Human Services</b>	<i>Food and Drug Administration</i>	<i>Animal drugs, feeds (Center for Veterinary Medicine) and seafood safety (Center for Food Safety and Applied Nutrition)</i>
<b>Other</b>	<i>Environmental Protection Agency</i>	<i>Water quality programs, effluent discharge standards and permits, waste/nutrients, wetlands protection, pesticide registration</i>
	<i>Agency for International Development</i>	<i>R&amp;D projects in developing countries</i>
	<i>National Research Support Project No. 7</i>	<i>Shortage of minor use animal drugs</i>

Source: JSA, *Guide to Federal Programs*; updated (based on Mieremet 2000 and Broussard 2000).

([http://ag.ansc.purdue.edu/aquanic/jsa/federal\\_guide/Federal%20.html](http://ag.ansc.purdue.edu/aquanic/jsa/federal_guide/Federal%20.html))

Table 4.5. Agencies with a Role in Offshore Marine Aquaculture

	Federal										Regional			State			
	JSA	Agriculture	Commerce			Interior		DOD	DOT	EPA	FDA	Other	Fishery Management Councils	Interstate Fishery Management Commissions	Coastal agency	Environmental agency	Other agencies
<b>Regulation</b>																	
<i>Siting/permitting</i>							X	X	X	X		X	X	X	X		
<i>Operations</i>												X					
<i>Environmental impacts</i>										X						X	
<i>User conflicts</i>									X				X	X			
<i>Species</i>		X							X								
<i>Food safety</i>		X											X				X
<b>Monitoring/surveillance</b>		X											X				
<b>Industry Assistance</b>	X																X
<b>Research</b>																	X
<b>Advisory role</b>																X	
<b>Inter-agency coordination</b>	X																

Source: Compiled by Susan Bunsick, Center for the Study of Marine Policy, University of Delaware, 2000.



This is important because it will allow us, in later sections, to assess the components of current policy in order to identify which features should be preserved, which should be modified, and what needs to be added or reorganized in order to create a fair and effective governing framework for a sustainable aquaculture industry in federal waters out to the 200 mile limit of the Exclusive Economic Zone. This discussion has benefited from work done at the University of Mississippi in conjunction with the Gulf of Mexico Consortium project discussed in Chapter 3 (see Fletcher and Weston 2000).

### ► Overview of Federal Agency Roles

Table 4.5 lists the range of responsibilities that constitute the federal role in the management of offshore marine aquaculture, and the agencies we have identified in our study as currently involved in fulfilling each responsibility. The federal role goes beyond the regulatory role, which was the primary focus of the studies reviewed in Chapter 2 of this report, to include additional roles such as monitoring and surveillance, industry assistance, research support, advisory roles in the regulatory process, and interagency coordination.

#### Regulatory role

The regulatory role is by far the most important one to the aquaculture industry as well as to environmentalists, commercial fishermen, the shipping industry, recreational ocean users, consumers, state and local officials, and anyone else with an interest in what goes on in public waters. This is because federal agencies have the authority to delimit the location of an aquaculture facility, the types of operations and practices allowed at that location, and the species that may be grown there. An important

element within this role is the ability to address the environmental impacts of aquaculture operations and to resolve conflicts between aquaculture and other users of federal waters. The federal government also plays an important role in ensuring that the fish and shellfish produced from an aquaculture operation meet food safety standards.

As many as 11 federal agencies are directly involved, and another 10 agencies are indirectly involved, in regulating aquaculture under 120 statutory programs; about half of these programs require direct compliance (DeVoe 1999). Of course, the actual number of statutes affecting a particular aquaculture operation depends on its size, location, species cultivated, and other factors. For offshore aquaculture, the regulatory role encompasses:

- Siting and permitting of facilities
- Operation of facilities (including use of feeds and drugs)
- Environmental impacts (including water quality and broader impacts on ecological systems)
- Resolution of conflicts with other users
- Approval and monitoring of species (including non-native, hybrid, and transgenic species)
- Animal health (including the import and export of live species)
- Food safety approval

Seven federal agencies, which are discussed later in this chapter, have regulatory programs that directly affect the marine aquaculture industry:

- Army Corps of Engineers
- Environmental Protection Agency
- Fish and Wildlife Service
- Food and Drug Administration
- Department of Agriculture
- National Marine Fisheries Service
- Coast Guard

### **Monitoring/surveillance role**

This role is highly related to the regulatory role described above. It encompasses a broader range of concerns, however, in that it addresses the cumulative impacts of aquaculture development and the interaction with other uses—for example, monitoring water quality and fish habitat in or near areas of aquaculture development or observing changes in commercial fishing activity and navigation in response to the location of an aquaculture facility.

### **Industry assistance role**

This role relates to government efforts aimed at fostering the development of an aquaculture industry in offshore marine waters. It is clearly distinct from the regulatory role. Although the type of aquaculture supported by federal agencies should be one that complies with all regulatory requirements for the industry, the main concern for a mission oriented towards industry assistance is providing incentives aimed at establishing the offshore aquaculture industry. Incentives could be offered to investors, employers, businesses, state and local

government, and consumers in a variety of forms—grants, loans, in-kind support, training programs, extension and outreach programs, fish health services, marketing campaigns, trade promotions, tax breaks, etc.

### **Research role**

The federal government role with respect to aquaculture is probably the best established in the area of research support. In fact, the catfish aquaculture industry (the largest single sector in the U.S. aquaculture industry) owes its existence largely to research support received through agricultural research and extension programs (Tiddens 1990).

### **Advisory role**

A number of federal agencies without direct regulatory authority or programs directly targeted at the offshore marine aquaculture industry do have an interest in activities that take place in the waters of the United States. As such, they are (or can be) consulted before making regulatory decisions or funding major research projects or industry promotion activities.

### **Inter-agency coordination role**

Given the range of activities that come under the U.S. offshore marine aquaculture policy umbrella, interagency coordination is a critical element for effective policy planning and implementation. Although this project seeks to clarify agency roles and streamline regulatory processes, we must start from the realistic assumption that it may be neither feasible nor desirable to consolidate all of the roles into a single federal agency. For example, combining regulatory and industry assistance roles in a single agency could create internal conflicts

**Table 4.6. Statutory Authorities\* for the Regulation of Offshore Marine Aquaculture, by Agency**

Agency	Statute	Citation	Description
Animal and Plant Health Inspection Service (APHIS)		21 U.S.C. 111 <i>et seq.</i>	Enforces regulations on the spread of contagious, infectious, or communicable disease of animals from a foreign country or between U.S. states.
Army Corps of Engineers (ACOE)	Clean Water Act	33 U.S.C. 1251 <i>et seq.</i>	Requires a permit for the discharge of dredged or fill material in waters of the United States (ACOE has joint authority with EPA under Section 404)
	Marine Protection, Research and Sanctuaries Act	16 U.S.C. 1431 <i>et seq.</i>	Requires a permit for the transportation of dredged materials for purposes of dumping it into ocean waters (Section 103)
	National Environmental Policy Act	42 U.S.C. 4332	Requires a determination on environmental impacts prior to issuance of permit
	Rivers and Harbors Act	33 U.S.C. 403	Requires a permit for activities in or affecting the navigable waters of the United States, including installations and other devices permanently or temporarily attached to the seabed, erected for the purpose of exploring for, developing or producing resources from the outer continental shelf (Section 10)
Coast Guard (USCG)	Merchant Marine Act	14 U.S.C. 83 <i>et seq.</i> 46 U.S.C. 12101 <i>et seq.</i>	Requires aquaculture-related structures located in navigable waters to be marked with lights and signals Requires certification for vessels (including barges) of 5 or more net tons
Environmental Protection Agency (EPA)	Clean Water Act	33 U.S.C. 1251 <i>et seq.</i>	Requires a National Pollutant Discharge Elimination System (NPDES) permit prior to certain discharges (Section 402) - EPA has determined that it has authority to set ocean disposal criteria and review environmental effects of aquaculture projects under Section 403(c) - National effluent limitation guidelines and standards for aquaculture are being developed (draft in June 2002) - Authority to issue permit may be delegated to state environmental agency Requires a permit for the discharge of dredged or fill material in waters of the United States (EPA has joint authority with ACOE under Section 404) State environmental agency must certify federal discharge permits
	Marine Protection, Research and Sanctuaries Act	33 U.S.C. 1401-1445	May require an Ocean Discharge Permit
	National Environmental Policy Act	42 U.S.C. 4332	Requires a determination on environmental impacts prior to issuance of permit
Fish and Wildlife Service (FWS)	Endangered Species Act	16 U.S.C. 1531 <i>et seq.</i>	Consultations and review of aquaculture siting permits to assure that no conflicts arise with any ongoing species recovery programs under ESA
	Lacey Act	16 U.S.C. 3371-3378	Prohibits commerce in wildlife taken in violation of state, tribal, federal, or foreign government law Prohibits the introduction of injurious species of wildlife into the United States
Food and Drug Administration (FDA)	Federal Food, Drug, and Cosmetics Act	21 U.S.C. 301 <i>et seq.</i>	Ensures that seafood shipped or received in interstate commerce is "safe, wholesome, and not misbranded or deceptively packaged." Approval of animal drugs and feeds. GMOs
	Public Health Service Act	42 U.S.C. 262, 294 <i>et seq.</i>	Control the spread of communicable diseases from one State, territory, or possession to another
Minerals Management Service (MMS)	Outer Continental Shelf Lands Act	43 U.S.C. 1331-1356	Leasing program for the exploration, development, and production of mineral resources on the Outer Continental Shelf. Covers collection of royalties and oversight of environmental/health impacts, including abandonment /removal of platforms.
National Marine Fisheries Service (NMFS)	Endangered Species Act	16 U.S.C. 1531 <i>et seq.</i>	Consultations and review of aquaculture siting permits to assure that no conflicts arise with any ongoing species recovery programs under ESA
	Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1801-1882	Management of commercial fishing operations Protection of essential fish habitat Requires compliance with fishery management plans developed by regional fishery management councils (plans may be amended to accommodate aquaculture activities)
	Marine Mammal Protection Act	16 U.S.C. 1361-1421	Review and approve any facility whose operation may endanger critical habitat of marine mammals or migratory paths for whales, or otherwise result in the taking of protected marine mammals
Office of Ocean and Coastal Resource Management (OCRM)	Coastal Zone Management Act	16 U.S.C. 1451-1464	Issues guidelines and assists states with aquaculture components of state coastal zone management plans. Requires consistency certification with application for the federal permits State coastal zone management agency must certify that federal permits are consistent with state coastal zone management plan

\* Includes both explicit statutory authority and agency interpretation of general statutory authority; authorities cited may not necessarily apply to offshore marine aquaculture.  
Source: Prepared by Susan Bunsick, Center for the Study of Marine Policy, University of Delaware, 2000.

making it difficult to fulfill either role effectively.

### ► The Key Agencies Currently Involved in Marine Aquaculture

The following two sections discuss the role of each of the agencies identified in Table 4.5. First, we will look at agencies whose role is primarily regulatory in nature. Then, we will look at agencies that play a mixed role in offshore marine—i.e., they regulate the industry as well as provide industry assistance.

Table 4.6 summarizes the major laws that federal agencies have cited as their authority for governing offshore marine aquaculture. These are discussed below in the context of each of the federal agencies that have regulatory authority under the statute.

In reviewing this section, it is important to keep in mind that each agency is basing its involvement in aquaculture, for the most part, on legal authorities that were not “written or established with aquaculture in mind, and considerable uncertainty exists as to whether the agencies’ assertions of jurisdiction over open ocean aquaculture under these statutes, principles and protocols will withstand legal challenge” (Hopkins et al. 1997).

### ► Regulatory Agencies

#### U.S. Army Corps of Engineers

The Corps of Engineers has a major regulatory role under the current policy framework for offshore marine aquaculture, by virtue of its authority over the navigable waters of the United States. Given that offshore

aquaculture is by definition located in open areas of the ocean, all offshore projects are subject to review and approval by the Corps.

*Section 10 permits.* The primary authority for the Corps’ regulatory role is Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403), as extended to the outer continental shelf under the Outer Continental Lands Act (43 U.S.C. §§ 1331-1356, see especially § 1333(e)). A Section 10 permit is required for activities in or affecting the navigable waters of the United States, including installations and other devices permanently or temporarily attached to the seabed, erected for the purpose of exploring for, developing or producing resources from the outer continental shelf.

In response to an application for a Section 10 permit, the Corps considers a broad range of potential environmental and other impacts, in consultation with other federal, state, and local agencies. These include:

- Effects and cumulative impacts upon water quality
- Effects of the facility or structure on recreation, fish, and other wildlife
- Pollution
- Economic factors
- Safety
- Aesthetics
- Protection of navigational integrity
- Accurate charting of any structures

The process includes a “public interest review” (33 C.F.R. § 320.4(a)(1)), which seeks to balance all reasonably expected benefits and detriments to the public interest, including environmental, economic, aesthetic, navigation, property rights, and international interests (Rieser 1997).

The Corps has authority to issue general permits rather than individual permits, in certain cases (33 C.F.R. §325.5(c)). General permits may be issued for a class of regulated activities that are substantially similar in nature and cause only minimal individual and cumulative impacts (33 C.F.R. § 322.2(f)). There are three types of general permits: regional (33 C.F.R. § 325.2(c)(2)), nationwide (33 C.F.R. § 330.1), and programmatic, including State Programmatic General Permits (61 Fed. Reg. 18,575 (1996)). Where a general permit is available, a letter of permission from the Corps serves as the permit for an individual project.

Any permit issued is conditioned on compliance with Coast Guard regulations requiring the marking of all structures. Pilings and anchoring devices constitute “permanent anchorage” and are subject to Corps and Coast Guard regulations for marking (see below).

If a structure does not interfere with navigation, a permit may not be required; instead, a letter of permission may be granted. Scientific research may be conducted under existing nationwide permits and general permits.

**Other permits.** Depending on the particular activities involved in a specific project, offshore aquaculture facilities may need to obtain additional permits from the Corps of Engineers. These include:

- A permit for the discharge of dredged or fill material in waters of the United States,

under Section 404 of the Clean Water Act (33 U.S.C. § 1344).

- A permit for the transportation of dredged materials for purposes of dumping it into ocean waters, under Title I and II of the Marine Protection, Research and Sanctuaries Act (16 U.S.C. 1401 *et seq.*).

**NEPA responsibilities.** As the lead agency for issuing the permits listed above, the Corps issues a determination on environmental impacts, under the National Environmental Policy Act (42 U.S.C. § 4332(2)(C)). As part of its review process, the Corps decides whether a full environmental impact statement is required for a particular project, or whether a less extensive environmental assessment is sufficient. This decision would depend on whether the project is considered to be significant and controversial.

A permit application requiring preparation of an EIS requires public notice at several key steps in the review process: 1) a notice of intent to prepare an EIS, which solicits input during the scoping process by which substantive issues are identified; 2) a notice of the availability of a draft EIS, which solicits public comments on the NEPA document and on the proposal itself; 3) a notice of public hearing, which may be requested by the public or initiated by the Corps decision-maker; 4) a notice of availability of the final EIS; 5) a notice of the availability of any EIS supplement; and 6) a notice of the availability of the decision-maker’s record of decision (see Corps’ web site: <http://www.usace.mil/inet/functions/cs/cccwo/reg/oceover.htm>).

### **Environmental Protection Agency**

The Environmental Protection Agency has an important regulatory role by virtue of its

authority to protect the natural resources of the United States.

***NPDES permit.*** EPA has statutory authority to require point source pollution permits for discharges into navigable waters of the United States, under the Clean Water Act (33 U.S.C. § 1342). The purpose of these permits is to ensure that point source discharges do not impair the nation's water quality. EPA may apply this authority to offshore aquaculture facilities to the extent they are considered concentrated animal feeding operations (i.e., point sources of pollution) requiring a National Pollutant Discharge Elimination System (NPDES) permit, under Section 402 of the Federal Water Pollution Control Act (40 C.F.R. § 122.28).

EPA has asserted its authority over open ocean aquaculture, but it is not clear whether the Clean Water Act mandates these permits (Hopkins et al. 1997). In the early 1990s, for example, EPA did not require permits for salmon farms in Maine because the permits issued by the Army Corps of Engineers and the state Department of Marine Resources were considered adequate; however, EPA is now reconsidering its position (Hewitt 2000). In April 2000, the U.S. Public Interest Research Group (PIRG) gave notice that it intended to file a lawsuit asking the United States District Court in Bangor to ensure legally enforceable limits are imposed on three salmon farms in Maine for discharging wastes without an EPA permit (National Environmental Law Center 2000).

EPA has the authority to issue general permits under the National Pollutant Discharge Elimination System (NPDES) permit program (40 C.F.R. § 122.28). These have not yet been developed, but EPA plans to issue effluent limitation guidelines for the aquaculture industry. A draft rule is scheduled to be issued in June 2002, and a final rule in June 2004. The

guidelines will identify best available technologies and/or best management practices that are economically achievable. The guidelines are to be based on science, technology, economic achievability, and other factors as identified under Section 304 of the Clean Water Act. The scope of these guidelines includes land-based and marine environment operations (EPA 2000).

***Section 404 permit.*** In conjunction with the Corps of Engineers, EPA implements the Clean Water Act Section 404 Wetlands Protection Program aimed at protecting natural wetlands from the impacts of dredging and filling. It has issued guidelines for reviewing of 404 permits by the Corps under 40 C.F.R. 230.10-80 and is also authorized to veto Corps permits and disposal sites under § 404(C) of the Clean Water Act.

***Ocean discharge permit.*** Depending on the type and amount of waste from an aquaculture facility, an Ocean Discharge Permit from the EPA may be required, under the Marine Protection, Research and Sanctuaries Act (33 U.S.C. §§ 1401-1445, see especially § 1412(a) regarding the selection of dumping sites). EPA is also authorized to promulgate criteria used by both EPA and the Corps in evaluating whether particular dumping proposals “unreasonably degrade” the environment.

***Pesticide registration.*** Chemicals and other materials to be used in aquaculture are subject to pesticide registration by EPA prior to marketing to the user.

***Environmental monitoring.*** EPA is concerned with the proper management of effluents and residual wastes of aquaculture systems in assuring the protection of the environment. EPA sets water quality criteria

and monitors shellfish waters and effluent discharge standards for assuring the protection of the nation's waterways and water supplies. EPA has determined that it has authority to set ocean disposal criteria and review environmental effects of aquaculture projects under Section 403(c) of the Clean Water Act (Brennan 1999).

### Coast Guard

The Coast Guard has a role in offshore aquaculture by virtue of its authority to ensure the safety of vessels and their navigation. Because offshore facilities will be located in areas that have traditionally been open to recreational and commercial navigation, the appropriate marking of structures and equipment is essential.

**Private aid to navigation permits.** The Coast Guard requires aquaculture-related structures located in navigable waters to be marked with lights and signals to ensure safe passage of vessels. The Coast Guard has oversight authority to ensure that an aquaculture facility complies with requirements for the installation and maintenance of these markings, which may be included as stipulations for permits issued by the Corps of Engineers or the Environmental Protection Agency.

**Vessel documentation.** U.S. vessels, including barges, that support aquaculture facilities and measure 5 net tons or larger must obtain Coast Guard documentation.

### Minerals Management Service

The Minerals Management Service has authority over mineral lease sites on the outer continental shelf, under the Outer Continental

Shelf Lands Act. Although this authority does not extend to aquaculture leasing, MMS will need to be consulted for projects near or attached to an oil or gas platform. In addition, MMS requires a permit for platform removal or transfer of ownership.

### Food and Drug Administration

FDA has primary Federal responsibility for the assurance of seafood safety and regulates aquaculture drugs, feeds, and veterinary medical devices.

**Seafood safety.** The Center for Food Safety and Applied Nutrition (CFSAN) is the primary Federal office with the responsibility for the assurance of seafood safety. The Center houses a wide range of programs devoted to the research and management of seafood, including aquaculture products. The FDA derives its authority for such programs primarily through two statutes: 1) the Federal Food, Drug, and Cosmetics Act (FFDCA: 21 U.S.C. 301 *et seq.*), and 2) the Public Health Service Act (PHSA:42 U.S.C. 262, 294 *et seq.*). Under the FFDCA, the FDA is assigned responsibility to ensure that seafood shipped or received in interstate commerce is "safe, wholesome, and not misbranded or deceptively packaged." Under PHSA, FDA is empowered to control the spread of communicable diseases from one State, territory, or possession to another.

**Animal drugs and feeds.** The Center for Veterinary Medicine (CVM) is responsible for the regulation of animal drugs, animal feeds, and veterinary medical devices. CVM's involvement in aquaculture is concentrated in four main areas:

- Approval of animal drugs and feeds under the Federal Food, Drug and Cosmetic Act, including support for the development of new animal drugs for minor species and minor uses (including aquacultural).

- Surveillance and compliance programs relating to the distribution and use of animal drugs, animal feeds, and other veterinary medical matters
- Biological and chemical research to support the food safety of new animal drugs and feeds
- Initiatives with the industry to develop quality assurance programs and educational materials to assist producers in using drugs and chemicals safely in animal production systems

### State Agencies

***Federal consistency certification.*** State coastal zone management agencies have the authority to review any federal license or permit for activities affecting any land or water use or natural resources of the coastal zone, under the Coastal Zone Management Act (16 U.S.C. §§ 1451-1464, see especially state consistency review at 16 U.S.C. § 1456(c)(3)(A)). The state may reject an offshore aquaculture facility's consistency certification (required to be filed with its application for the federal permits discussed above) if the proposed activity conflicts with an enforceable law or policy included within the state's approved coastal zone management program. To take full advantage of this authority, several states have indicated they plan to assert consistency review over offshore aquaculture proposals—for example, Massachusetts (Rieser 1997).

***Water quality certification.*** State environmental protection agencies have the authority to certify that the discharge from federal or federally permitted activities into navigable waters complies with state water quality standards under § 401 of the Clean Water Act (33 U.S.C. § 1341(a)).

## ► Agencies with Mixed Roles

### National Oceanic and Atmospheric Administration (NOAA)

The National Oceanic and Atmospheric Administration has an important role in offshore marine aquaculture by virtue of its responsibilities relating to the conservation, management, and wise use of the nation's living marine resources, including the utilization of fish as food. Two agencies within NOAA have responsibilities that are of particular relevance for offshore marine aquaculture. The National Marine Fisheries Service (NMFS) has management and regulatory authority by virtue of its authority to conserve, restore, and protect the fishery resources of the United States and to protect marine mammals and endangered species. The Office of Ocean and Coastal Resource Management (OCRM) has the authority to coordinate activities in federal waters with state officials, by virtue of its role in managing the coastal zone management program.

***Aquaculture policy.*** In 1998, NOAA adopted an agency-wide aquaculture policy designed to provide a context for agency activities over the next 10-20 years. Its purpose is to help foster sustainable economic development and environmentally friendly technologies, create employment opportunities, reduce the trade deficit in fish products, reduce fishing pressure on living marine resources, and rebuild depleted stocks. The policy points out NOAA's strong statutory basis for the promotion and regulation of marine aquaculture by NMFS, the National Ocean Service, and the Sea Grant Program. The policy addresses the dual public need for aquaculture development and environmental protection. It provides that a successful NOAA program will focus on : research, development,



and technology transfer; financial assistance to businesses; environmental safeguards, including regulatory and permit procedures; and coordination.

The Department of Commerce, NOAA's parent agency, has also adopted a department-wide aquaculture policy promoting: 1) the development of a code of conduct for responsible aquaculture; 2) increasing exports of U.S. aquaculture goods and services; 3) national and regional meetings with aquaculture constituents to inventory resources, identify issues, and set priorities; 4) an efficient and transparent permitting process for aquaculture; and 5) an information clearinghouse and dissemination system. Its vision for U.S. aquaculture is:

To assist in the development of a highly competitive, sustainable industry in the United States that will meet growing consumer demand for aquatic foods and products that are of high quality, safe, competitively priced and are produced in an environmentally responsible manner with maximum opportunity for profitability in all sectors of the industry (Department of Commerce 1999a).

***Fishery management.*** NMFS has regulatory authority to manage commercial fishing operations under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801-1882), as amended by the Sustainable Fisheries Act (Public Law 104-297, 110 Stat. 3559). NOAA has interpreted the Act's broad definition of "fishing" as the harvesting of fish or activities likely to result in the harvesting of fish, thereby extending this authority to aquaculture (50 C.F.R. § 229.2). NOAA's Office of General Counsel, in a memorandum relating to the American

Norwegian Fish Farm, Inc. project (see Chapter 3), concluded that the proposed farm constituted "fishing" under the Magnuson Act because it involved the harvesting of fish from the EEZ by U.S. vessels (Rieser 1997).

Based on NOAA's interpretation of current law, the eight Regional Fishery Management Councils established under the Magnuson-Stevens Act have the authority to manage aquaculture in the EEZ and, under the current framework, need to amend fishery management plans to accommodate aquaculture. Although permits may not be necessary, at least two regional councils (New England and the Gulf of Mexico) have developed aquaculture policies. The Councils comment on proposed facilities, especially in relation to potential impacts on Essential Fish Habitat and the possible need to amend fishery management plans. For example, in 1997, the New England Fishery Management Council closed an area to some commercial fishing to prevent conflicts between commercial fishermen and a sea scallop aquaculture research project (SeaStead, see Chapter 3).

NMFS includes a growing, environmentally sound marine aquaculture industry as one of its three long-term goals of its plan for implementing the U.N. Food and Agriculture Organization's Code of Conduct for Responsible Fisheries (see Chapter 6). With respect to aquaculture, the agency plans to: 1) promote the commercial rearing of seven new species; 2) reduce the time and cost of permitting environmentally sound marine aquaculture ventures; 3) provide financial assistance; 4) identify suitable areas in the EEZ for aquaculture; and 5) develop and implement environmentally sound marine aquaculture technologies and practices.

**Marine mammal protection.** NMFS has statutory authority to administer the Marine Mammal Protection Act (16 U.S.C. §§ 1361-1421h). As such, it has the authority to review and approve any facility whose operation may endanger critical habitat of marine mammals or migratory paths for whales, or otherwise result in the taking of protected marine mammals. Marine mammals are known predators of the fish and shellfish being raised in aquaculture facilities, and would be attracted to the aquaculture operation by the concentration of prey.

**Endangered species protection.** The National Marine Fisheries Service shares responsibility with the U.S. Fish and Wildlife Service in administering the Endangered Species Act (16 U.S.C. 1531 *et seq.*). As part of its responsibilities under this Act, NMFS may hold consultations and review aquaculture permits to assure that such activities do not jeopardize threatened and endangered species or recovery programs under ESA.

**Permit reviews.** NMFS acts as a review agency under Section 10 of the Rivers and Harbors Act, the Fish and Wildlife Coordination Act, and the National Environmental Policy Act. As such, the agency may review and comment on Corps or EPA permits (33 C.F.R. §§ 320.4(c), 325.3(d); 40 C.F.R. § 124.59(b))

**Federal consistency review.** The Office Ocean and Coastal Resource Management requires a consistency determination with approved state coastal zone management programs for federally permitted activities that affect land, water, or natural resources of the coastal zone, under the Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*). Although the affected state makes the initial determination, the Secretary of Commerce has

the authority to reverse the state decision (15 C.F.R. pt. 930) (Rieser 1997).

**Industry research and assistance.** As noted earlier in this chapter, NMFS operates salmon hatcheries, funds research on the cultivation of marine species, and provides international marketing assistance for U.S. aquaculture products.

**Fisheries finance.** NMFS operates the Fisheries Finance Program, which provides direct loans to finance aquacultural facilities construction, reconstruction, reconditioning, and acquisition. For fiscal year 2000, marine aquaculture was identified as a priority lending purpose to compete for a share of the \$23.7 million loan ceiling available under Title XI of the Merchant Marine Act of 1936, as amended.

## Department of Agriculture

The Department of Agriculture has an important coordination and research role, by virtue of its designation as the permanent chair of the interagency Joint Subcommittee on Aquaculture and its long history of agricultural research and extension services. It also has regulatory responsibilities relating to animal health.

**Federal coordination.** As noted earlier in this chapter, the Department of Agriculture is the coordinating federal agency for aquaculture and the Secretary of Agriculture is the permanent administrative chair of the Joint Subcommittee on Aquaculture, under the National Aquaculture Act of 1980, as amended (16 U.S.C. §§ 2801-2810). This role encompasses the coordination of Federal interagency programs and policies, dissemination of national aquaculture information, encouraging and coordinating efforts for the aquaculture industry,

and continually monitoring and assessing the industry.

**Research, information and extension activities.** The Department of Agriculture provides research support and a variety of services, including:

- Regional aquaculture centers, which provide technology transfer and extension education on behalf of aquaculture producers
- Animal and plant health
- Export promotion and assistance
- Credit
- Marketing and economic analysis
- Disaster assistance
- Information and statistics, including the Aquaculture Information Center of the National Agricultural Library and a census of aquaculture
- Purchase and distribution of surplus commodities (7 U.S.C. 612)

**Animal health.** The Animal and Plant Health Inspection Service (APHIS) establishes import requirements for aquatic plants to prevent the importation and dissemination of plant pests and diseases and noxious aquatic weeds (Plant Protection and Quarantine Program), and assists producers with facility damage and depredation by migratory birds and other animals. APHIS licenses veterinary biologics (vaccines, diagnostic kits, etc.) for prevention, diagnosis, and/or treatment of diseases of animals,

including aquatic animals; several fish vaccines are presently licensed by APHIS through their Center for Veterinary Biologics. An increasingly important role relates to international fish health regulations and negotiations related to imports and exports.

#### **Fish and Wildlife Service (Department of Interior)**

FWS has responsibilities for restoring depleted fish populations, preserving endangered species, mitigating the impacts of Federal water development on fish populations, and managing fish resources on Federal lands.

**Species introductions.** The Fish and Wildlife Service has the authority to regulate the introduction of exotic species into the United States, under the Lacey Act Amendments of 1981 (16 U.S.C. §§ 3371-3378). Thus, any aquaculture facility interested in raising non-native species would require permission from the FWS.

**Review and approval.** FWS may also review and comment on Corps or EPA permits (33 C.F.R. §§ 320.4(c), 325.3(d); 40 C.F.R. § 124.59(b)) under:

- Fish and Wildlife Coordination Act (16 U.S.C. § 661-666) (general to all species, including plants)
- Endangered Species Act
- Marine Mammal Protection Act

**Research and other industry support.** FWS operates hatcheries, fish health centers, fish technology centers, and fishery research centers.

**Table 4.7. Explicit References to Aquaculture in Current U.S. Statutes**

<i>National Aquaculture Act of 1980, as amended</i>	<ul style="list-style-type: none"> <li>• This law is the only law specifically directed at aquaculture. However, it is a promotional rather than regulatory statute—focusing primarily on planning and interagency coordination. Its applicability to the regulation of the industry is limited to calls for a Regulatory Constraints Study and preparation of a plan “to remove unnecessarily burdensome regulatory barriers to the initiation and operation of commercial aquaculture ventures” (16 U.S.C. 2808).</li> <li>• Statutes governing agricultural research, extension, and teaching include a separate subchapter dealing with aquaculture (7 U.S.C. §§ 3321-3324).</li> </ul>
<i>Federal Crop Insurance Act of 1980, as amended</i>	“Agricultural commodity” has been explicitly defined to include aquacultural species (7 U.S.C. §1518), and the inclusion of aquaculture is explicit in statutes governing many USDA farm and commodity programs, including emergency loans.
<i>Clean Water Act of 1977, as amended</i>	<i>EPA had explicit authority “to permit the discharge of a specific pollutant or pollutants under controlled conditions associated with an approved aquaculture project under Federal or State supervision” (33 U.S.C. § 1328).</i>
<i>Coastal Zone Management Act of 1972, as amended</i>	<p><i>NOAA has explicit statutory authority to assist states in coastal zone management activities relating to aquaculture, by providing:</i></p> <ul style="list-style-type: none"> <li>• Assistance to support comprehensive planning, conservation, and management for living marine resources, including “planning for the siting of ... aquaculture facilities within the coastal zone” (16 U.S.C. 1452).</li> <li>• Resource management improvement grants for “the development of a coordinated process among State agencies to regulate and issue permits for aquaculture facilities in the coastal zone” (16 U.S.C. 1455a).</li> <li>• Coastal zone enhancement grants for the “adoption of procedures and policies to evaluate and facilitate the siting of public and private aquaculture facilities in the coastal zone, which will enable States to formulate, administer, and implement strategic plans for marine aquaculture” (16 U.S.C. 1456b).</li> </ul>
<i>Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended</i>	<p><i>Aquaculture is included under aquatic nuisance prevention and control statutes, both as an activity to be protected and as a potential source of non-indigenous species:</i></p> <ul style="list-style-type: none"> <li>• “Aquatic nuisance species” means a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters”(16 U.S.C. 4702).</li> <li>• “Unintentional introduction” means an introduction of nonindigenous species that occurs as the result of activities other than the purposeful or intentional introduction of the species involved, such as the transport of nonindigenous species in ballast or in water used to transport fish, mollusks or crustaceans for aquaculture or other purposes” (16 U.S.C. 4702)</li> </ul>
<i>Coast Guard Authorization Act of 1993, as amended</i>	<i>Laws governing Atlantic coastal fisheries cooperative management exclude aquaculture from the definition of “fishing” (16 U.S.C. 5102). The Secretary of Commerce may exempt “fish which have been produced in an aquaculture operation” from bans on possession and use during a moratorium on fishing (16 U.S.C. 5106).</i>

*Note: Based on search for the word “aquaculture” in each Title of the U.S. Code maintained online by the Legal Information Institute, Cornell Law School (<http://www4.law.cornell.edu/uscode/>, accessed 6/14/2000)*

*Source: Prepared by Susan Bunsick, Center for the Study of Marine Policy, University of Delaware, 2000.*

## CONCLUSIONS: PROBLEMS AND GAPS THAT NEED TO BE ADDRESSED

### ► **Limitations of Existing Statutory Authorities: Few Explicit References to Aquaculture**

Of the statutory authorities cited above, only a few are based on explicit references to aquaculture, and none address the specific issues associated with offshore marine aquaculture. Table 4.7 shows the instances in which the word “aquaculture” is found in a search of each Title of the U.S. Code. With few exceptions, federal agency statutory authority over offshore marine aquaculture is based on agency interpretation of statutory authority over particular aspects of an aquaculture operation.

In some cases, such as the Army Corps of Engineers Section 10 permitting authority with respect to the placement of aquaculture structures in navigable waters, the application of general laws to aquaculture is fairly straightforward and generally accepted as an appropriate exercise of the agency’s statutory authority.

In other cases, such as NMFS’ assertion of authority over aquaculture under the Magnuson-Stevens Act, the extension of general regulatory authority to the regulation of the aquaculture industry is less clear. Although NOAA’s General Counsel found that aquaculture falls within the definition of “harvesting” for purposes of the Act, the law governing the Atlantic States Fisheries Commission specifically excludes aquaculture from its definition of “fishing” (16 U.S.C. 5102).

Finally, the authority of the one agency with extensive experience in managing resources on

the Outer Continental Shelf, MMS, is largely confined to mineral resources only.

The absence of explicit statutory authority is not uncommon for new activities, such as offshore marine aquaculture, that could not have been foreseen at the time existing law was enacted. Although beyond the scope of this analysis, transgenic organisms present similar challenges for government regulation. The Food and Drug Administration has asserted authority over genetically modified organisms (GMOs) by treating GMOs as a new drug subject to its statutory authority under existing law.

The absence of explicit statutory authority can have important implications for the credibility and effectiveness of agency actions with respect to the management of offshore marine aquaculture, as suggested by the following examples:

- An agency’s interpretation of its statutory authority may be challenged in the courts. Environmental groups have challenged the public review process for Army Corps of Engineers permits for a range of projects, and questioned the appropriateness of its role as the lead agency for assessing environmental impacts of aquaculture and other projects (e.g., see Chapter 3).
- An agency may have insufficient resources or expertise to fulfill responsibilities they assume based on the application of general statutes to aquaculture. For example, EPA has only recently begun to acquire agency expertise in various types of aquaculture operations and associated impacts in order to develop draft standards for the industry.

Similarly, the Coast Guard often does not have sufficient resources to police restricted areas. The FDA's capability to assess potential environmental impacts of GMOs has been questioned by some groups. According to a senior scientist at the Union of Concerned Scientists, "the F.D.A. is not qualified to evaluate the ecological risks of engineered fish...We should be concerned that the environment will be at risk" (Yoon 2000). In an editorial several days later, *The New York Times* added: "Unfortunately, the F.D.A. is ill-equipped to deal with environmental questions. Its scientists are not trained in that field and its interests do not lie in that direction" (*The New York Times*, May 14, 2000).

## ► Conflicts

### Industry assistance v. regulation in agencies with mixed roles

The three Departments that make up the executive committee of the Joint Subcommittee on Aquaculture (USDA, Commerce, and Interior) include both regulatory agencies and agencies that assist with the development of the aquaculture industry, which could result in internal conflicts within the organization. Critics of the current framework also point out that "federal policies...may even differ among divisions within the same agency" (DeVoe 1999, p. 88). Within NOAA, for example, organizations supporting development of an offshore marine aquaculture industry face inevitable conflicts with other parts of the organization representing the interests of uses that may be in conflict with aquaculture development (marine mammal protection, commercial fishing, etc.). While the

representation of these different perspectives within a single organization may be beneficial in terms of keeping other policy priorities in mind in the process of promoting the development of a new ocean industry, internal organizational conflicts could frustrate the ability of any single part of the organization to fulfill its mission in an efficient way.

### Conflicts between different regulatory agencies

Without a lead agency for offshore marine aquaculture, conflicts between different regulatory agencies are inevitable. For example, the National Environmental Policy Act requires the lead federal agency to assess the environmental impacts of federally approved projects and determine the need for the preparation of an Environmental Impact Statement. It is conceivable, therefore, that the Army Corps of Engineers might determine that a less in-depth environmental assessment is sufficient for a particular aquaculture project, based on an analysis of the potential for interference with navigation and recreational use, while the Environmental Protection Agency might conclude that the project's level of nutrient waste discharges requires that it be subject to a full EIS review process.

### Conflicts between regulatory agencies and agencies assisting the industry

Under the current framework, no single department has a role that is purely oriented towards assisting the industry; however, individual agencies within departments may focus on industry development quasi-independently of the regulatory agencies within their department. For example, research, extension, and training programs within the Department of Agriculture are organizationally

distinct from the Department’s regulatory agencies such as the Animal and Plant Health Inspection Service.

## ► Major Gaps

### **No statutory authority to issue aquaculture leases in federal water**

Current statutory authority is limited to the issuance of permits for the siting and operation of aquaculture facilities in federal waters. The closest thing to a lease is the designation of “closed areas” by a regional fishery management council, which may be used to restrict access to an area of the ocean.

The lack of a mechanism for issuing leases shortchanges both the industry and the public. The industry suffers because operations and financing are more difficult without the ability to acquire the right to exclusive use of an area of the ocean. The public is also deprived of a potential source of revenue from industry payment (of fees, royalties, etc.) in return for the right to exclusive use of ocean space.

### **Some types of aquaculture may avoid regulation under current authorities**

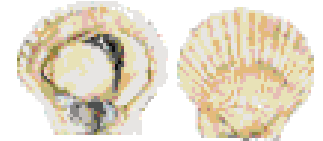
The aquaculture industry is examining a range of new technologies and practices that may “fall

through the cracks” under a governing framework based on statutory authorities that have already been stretched to include aquaculture at all. For example, future practices may include mobile operations not tethered to the bottom in a single location. Such an operation may not be deemed a potential threat to navigation, and therefore may not require a Section 10 permit from the Army Corps of Engineers.

### **No lead agency**

As noted above, the National Environmental Policy Act requires an environmental assessment be performed by the lead agency prior to the issuance of a permit by a federal agency. However, for offshore marine aquaculture, there are currently at least two “lead” permitting agencies—the Corps and the EPA—in addition to the “lead” coordinating agency under the National Aquaculture Act (USDA). The lack of a single lead agency for offshore marine aquaculture has implications for the overall effectiveness of federal agency programs aimed at industry promotion, monitoring, research, etc. With each agency paying attention to different aspects of offshore marine aquaculture, it is difficult to gain an overall understanding of the impacts (both positive and negative) of industry activities.

# Chapter 5



## RELEVANT EXPERIENCES FROM THE U.S. COASTAL STATES

### INTRODUCTION

Although there has been little practical experience with offshore marine aquaculture in federal waters of the United States, several U.S. coastal states support active marine finfish and shellfish aquaculture industries within their state jurisdictional waters (e.g., salmon netpens and oyster production in New England and the Pacific Northwest). This chapter reviews relevant policy experiences in U.S. coastal states to identify features that may be desirable to incorporate in an overall policy framework for the U.S. EEZ. Of particular interest are policies directly addressing the issue of leasing in open ocean waters, streamlining the permitting process, handling environmental/biological impacts, and integrating aquaculture into coastal zone management.

A number of U.S. coastal states have been engaged in commercial-scale marine aquaculture development in state waters for a number of years. Maine and Washington are the most important states in the production of salmon, the primary food fish produced by the

U.S. marine aquaculture industry. The main shellfish species for the U.S. aquaculture industry are oysters, clams, shrimp, and mussels. Shrimp are grown mainly in the south (Texas, South Carolina, Florida). Mollusks (clams, oysters, mussels) are produced in the northeast, Pacific Northwest, and the South, with Connecticut, Florida, and Washington among the largest producers.

State aquaculture operations have, in a number of instances, proven very controversial, and significant conflicts between aquaculture operations, environmental groups, fishing groups, and coastal property owners have taken place. For example:

- There has been opposition to ocean ranching of Pacific salmon since it began in the 1970s, both because of its unknown ecological effects across state and international boundaries, as well as anticipated socioeconomic impacts. Although there is an established



ocean-ranching industry in Oregon, opposition by conservationists, commercial fishermen, and others has kept the industry from expanding into other states. In 1979, for example, California's legislature defeated a bill that would have allowed a large corporation (Weyerhaeuser) to establish a commercial salmon-ranching operation in Humboldt Bay (Berg 1981).

- In Washington, where salmon are grown in netpens, property owners have opposed expansion of the industry on aesthetic as well as environmental grounds.
- Concerns over the impacts of fish escapes on wild stocks and the overall ecological balance have been raised by recent studies indicating that the farmed fish may have a greater ability to survive in the wild, compete with wild stocks for food, and reproduce than originally estimated.
- In Washington, this concern is heightened because some of the fish that have escaped

are non-native Atlantic salmon, and many stocks of the native Pacific salmon have been listed as threatened or endangered.

- In Maine, the issue has taken on greater significance since 1999, when NMFS and FWS recommended that Atlantic salmon populations from several rivers be listed as endangered.

In response to such problems and in efforts to provide an appropriate policy framework for marine aquaculture, several states have made extensive efforts to develop policies and regulations for the conduct of marine aquaculture operations. For example, Maine has established a Salmon Aquaculture Advisory Council, and is reviewing its leasing system. Some states have made improvements through better coordination or consolidation of state programs, or by incorporating aquaculture in their coastal zone management plans. Useful lessons can be learned from these experiences with potential application to the federal level.

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## SUMMARY OVERVIEW OF STATE AQUACULTURE POLICIES

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For this project, we sent a brief questionnaire to aquaculture coordinators in each of the coastal states asking about the current status of the industry and government policy toward marine aquaculture in their state (see Appendix 2). Questions focused specifically on the leasing/permitting requirements and the overall framework governing marine aquaculture in the state (i.e., designation of a lead agency; existing laws, regulations, and policies). We were particularly interested in what state aquaculture coordinators considered the best features of their state's approach, what they thought could be done to improve the policy, and their views on federal policy for

aquaculture in the EEZ beyond state jurisdiction. The survey was conducted in the period May to June 2000. Twenty-three out of twenty-five questionnaires were returned (a 92% response rate).

Table 5.1 summarizes the overall status of aquaculture policy in each coastal state. It indicates whether or not there is a marine aquaculture policy in place, where the policy is found, when it was implemented and which agencies play a lead role. It also indicates any pending proposals for new or revised policy measures. Note that only seven states (Maine,

**Table 5.1. Summary of Marine Aquaculture Policies in Coastal States**

State	Location of Offshore Projects	Marine aquaculture policy in place?	Where found?			Date Implemented	Lead Agency	Pending Proposals
			CZMP	Aquaculture Plan	Other Policy or Plan			
Maine	1/4-3/4 miles	Yes		X		1989	Dept. of Marine Resources	None
New Hampshire	7 miles	No						Yes
Massachusetts	> 3 miles	Shellfish only			General laws	1960	Div. of Marine Fisheries/ Dept. of Food & Agriculture	Developing marine finfish regulations
Rhode Island	None	Yes	X	X	Fisheries/Economic devp.	1980	Coastal Resources Mgmt. Council	None
Connecticut	0-15 miles	Yes	X	X	State laws	1986	Dept. of Agriculture	None
New York	None	No					None	None
New Jersey	None	No					Dept. of Environmental Protection	Ag/Env. agencies
Delaware	None	Oysters only					Div. of Fish & Wildlife	None
Maryland	None	Yes		X	Legislative direction	1988	Dept. of Agriculture/Dept. of Natural Resources	Revision underway
Virginia	None	Yes	X	X	Economic Develop. Plan	1950	Marine Resource Commission	None
*North Carolina								
South Carolina	None	Yes	X	X	Fisheries		None	None
Georgia	None	Yes	X	X		1996	None	None
Florida	None	Yes			Fla. Aquaculture Policy Act	1984	Dept. of Agriculture & Consumer Services	None
Alabama	None	No					Dept. of Conservation & Natural Resources, Marine Resources Div.	None
Mississippi	None	Yes	X			1992	Dept. of Marine Resources	None
Louisiana	None	Yes			Statutes		Dept. of Wildlife & Fisheries	None
Texas	10 miles**	No					None	None
California	None	No					Dept. of Fish & Game	None
Oregon	None	No					Dept. of Fish & Wildlife/ Dept. of Agriculture	None
*Washington								
Alaska	100-200 ft.	Yes	X	X	Economic Develop. Plan, statutes, regulations		Dept. of Natural Resources leads multiagency program	None
Hawaii	1 mile	Yes		X	Economic Develop. Plan	1979	Dept. of Agriculture	None
Puerto Rico	None	Yes	X				Dept. of Agriculture	None
Virgin Islands	None	No					Dept. of Planning & Natural Res.	None

\*Did not respond to survey \*\*Inactive project  
Source: University of Delaware survey of state aquaculture coordinators, 2000.

New Hampshire, Massachusetts, Connecticut, Texas, Hawaii, and Alaska) indicated any experience with open ocean aquaculture in waters under their jurisdiction.

### ► Designation of a Lead Agency for Marine Aquaculture

States have followed several different strategies in terms of the designation of a lead agency for aquaculture. The lead agency may be a state coastal/marine agency (Maine, Rhode Island, Virginia, Mississippi), a state department of agriculture (Massachusetts, Connecticut, Maryland, Florida, Hawaii, Puerto Rico), a state fish and wildlife agency (Delaware, Louisiana, California), a natural resources agency (Alabama, Alaska, Virgin Islands), or an environmental agency (New Jersey). In one state (Oregon), the Department of Fish and Wildlife and the Department of Agriculture share the lead role. Only four states (New York, South Carolina, Georgia, and Texas) indicated there is no lead agency for aquaculture.

Several states delegate the leadership for particular aspects of the aquaculture industry. For example, in Maryland, where the Department of Agriculture has the overall lead for aquaculture, the Department of Natural Resources is in charge of permitting and regulation. Alaska, where the Department of Natural Resources is the lead agency, has a multi-agency program involving two other state agencies (Fish & Game, and Conservation). In some states, marine-related responsibilities (including aquaculture) are found within departments with broader responsibilities. For example, Massachusetts has a division of marine resources within its Department of Food and Agriculture; Alabama has a marine resources division within its Department of Conservation and Natural Resources.

### ► Current Leasing Policy

Twenty of the states responding to the survey offered some type of marine aquaculture lease (the exceptions are New Hampshire, Puerto Rico and the Virgin Islands). The most common type of lease is a bottom lease. Excluding the territories, all but three of the responding states offered bottom leasing, the only exceptions being Georgia (where shellfish harvesting is allowed under other mechanisms), New Hampshire (whose respondent cited the need for the state to provide long-term leasing options), and South Carolina (which offers water column leases). Twelve states offer water column leases. These results are summarized in Table 5.2.

### ► Administrative Requirements

Our survey asked state aquaculture coordinators about the permit/lease application process and the types of fees the state requires aquaculture operations to pay. The results are summarized in Table 5.3.

As indicated in Table 5.3, a public hearing and an environmental review for an aquaculture application are either required, or could be required, in most states. Only Connecticut and Delaware do not require any public hearing, and only Delaware and Alaska do not require an environmental review. Alaska does not currently offer leases for finfish, and the aquaculture operations found in both Delaware and Connecticut almost exclusively produce shellfish rather than finfish.

Annual fee payments varied between states and also within states, depending on the operation or location. Where a per-acre amount was indicated, these ranged from a low of \$1.50 per acre per year in Virginia to a high of \$500 per

**Table 5.2. Types of marine aquaculture leases offered in state waters**

	Bottom lease	Water column lease
Maine	X	X
New Hampshire	1-year permits	1-year permits
Massachusetts	X	
Rhode Island	X	X
Connecticut	X	
New York	X	
New Jersey	X	X
Delaware	X	
Maryland	X	X
Virginia	X	X
*North Carolina		
South Carolina		X
Georgia	Shellfish harvesting lease only	
Florida	X	X
Alabama	X	
Mississippi	X	X
Louisiana	X	
Texas	X	
California	X	X
Oregon	X	X
*Washington		
Alaska	X	X
Hawaii	X	X
Puerto Rico		
Virgin Islands		

\* Did not respond to survey

Source: University of Delaware survey of state aquaculture coordinators, 2000

acre for shellfish and \$700 per acre for finfish in New Hampshire. Texas charges a fixed fee of \$10,000 per year. Royalties are only required in four of the responding states (ME, MA, MS, and PR) and may be required in three other states

(NY, CA, and OR). Bonds are more common in state policy—they are mandatory in 6 states (ME, SC, TX, AK, HI, and PR) and may be required in 7 others (MA, RI, NY, MD, MS, CA, and OR). Performance bonds provide a form of insurance against damages for which the aquaculture operation may be liable in the future. In Maine, administrative requirements may be relaxed for small-scale or low impact projects.

### ► States’ Critiques of Current Policy Framework

*Best features of current policy at the state level.* Asked about the best features of the current approach to marine aquaculture in their state, aquaculture coordinators mentioned:

- Flexibility (RI, MA); unwritten policy is easy on shellfish aquaculture development in productive areas (SC)
- Consolidation
  - One lead agency (CT, FL)
  - A single application for four agencies: Fish & Game, Environmental Conservation, Coastal Management Program, and Natural Resources lease (AK)
  - Good agency coordination (OR)
- Industry involvement
  - Encouraging industry involvement in policy development (CT)
  - Stimulates voluntary industry compliance and cooperative research efforts (ME)
  - Responsive to industry needs (OR)
- Raising traditional products that complement traditional product name and resources (VA)
- Consideration of a range of concerns in the approval process
  - Economic impacts, conflicting interests among users, and environmental

**Table 5.3. State permitting/leasing requirements for marine aquaculture**

	<b>Public hearing</b>	<b>Environmental review</b>	<b>Bonds</b>	<b>Royalties</b>	<b>Annual fees</b>
Maine	Mandatory	Mandatory	Mandatory	Mandatory	Mandatory
New Hampshire	Mandatory	Mandatory	Not required	Not required	Mandatory
Massachusetts	Mandatory	May be required	May be required	Mandatory	Mandatory
Rhode Island	May be required	May be required	May be required	Not required	May be required
Connecticut	Not required	May be required	Not required	Not required	Mandatory
New York	May be required	Mandatory	May be required	May be required	May be required
New Jersey	Don't know	Don't know	Don't know	Don't know	Don't know
Delaware	Not required	Not required	Not required	Not required	Mandatory
Maryland	Mandatory	Mandatory	May be required		Mandatory
Virginia	May be required	May be required	Not required	Not required	Mandatory
*North Carolina					
South Carolina	May be required	Mandatory	Mandatory	--	Mandatory
Georgia	May be required	May be required	Not required	Not required	Don't know
Florida	May be required	Mandatory	Not required	Not required	Mandatory
Alabama	May be required	May be required	Not required	Not required	Mandatory
Mississippi	Mandatory	Mandatory	May be required	Mandatory	Mandatory
Louisiana	Don't know	Mandatory (finfish)	Don't know	Don't know	Mandatory
Texas	Mandatory	Mandatory	Mandatory	Don't know	Mandatory
California	Mandatory	May be required	May be required	May be required	May be required
Oregon	May be required	Mandatory	May be required	May be required	Mandatory
*Washington					
Alaska	May be required	Not required	Mandatory	Not required	Mandatory
Hawaii	Mandatory	Mandatory	Mandatory		Mandatory
Puerto Rico	May be required	Mandatory	Mandatory	Mandatory	Don't know
Virgin Islands	May be required	Mandatory	Don't know	Don't know	Don't know

\* *Did not respond to survey*

Source: *University of Delaware survey of state aquaculture coordinators, 2000*

protection and enhancement (MS)  
 - Protection of wild fisheries resources as well as operating shellfish farm (MA)  
 - Slow, deliberative program weighs the interests of applicants, non-coastal residents, other users, environment (ME)

- Aquaculture products considered farm products (CA)

- Marine aquaculture encouraged as a beneficial activity (CA)
- Water column activity restricted to private waters (LA)

- Pre-determining existing use profiles; negotiated exclusivity concept; economic unit concept (HI)
- Balances environmental stewardship with sustainable utilization of renewable marine resources (ME)

***How current state policy may be improved.***

Areas which state aquaculture coordinators felt needed improvements included:

- Increase financing/funding/staffing or incentives; provide proactive state assistance (ME, NH, RI, NJ, FL, MS, TX, PR)
- Streamline, simplify, or coordinate permitting process (CT, MD, SC, CA, LA)
- Develop NPDES requirements/environmental BMPs for aquaculture (NY)
- Complete new regulations to authorize/revitalize small-scale shellfish leasing (NY)
- Develop or improve state plan or framework for aquaculture (GA, AL, TX)
- Eliminate unreasonable conditions or regulations (MD, VA, NJ)
- Designate zones for aquaculture ( MA, SC, HI)
- Provide long-term leasing options with realistic permit/lease fees (NH)
- Increase industry involvement (CT)
- Reduce sediment in water column (DE)
- Establish disease diagnostic research capacity (NY)
- Increase activity at local level (MA)
- Provide more general information on website (AK)
- Promote more aquaculture for coast (PR)
- Use marine culture to improve stocks of fish and shellfish (PR)
- Require an informational community meeting prior to adjudicatory public hearing (ME)
- Allow explanations and rebuttals at public hearings (ME)

***What features should be included in federal policy framework.*** Suggestions for what to include in a national policy for offshore marine aquaculture in federal waters spanned a range of concerns, summarized in Table 5.4. Three states did not agree on the need for a federal policy on offshore aquaculture, because current policies (EPA, Corps, MMS, FWS, NMFS) seem adequate (TX), or offshore marine aquaculture is not expected to be an issue (DE, OR).

**Table 5.4. Suggestions for Federal Offshore Marine Aquaculture Policy****Address organizational concerns**

- Clearly define multi-agency interests and designate a lead agency (CT)
- Keep it simple; one shop for issuing leases (NH)
- Need a “national champion,” i.e., a proactive agency (NH)
- Need a single agency contact (FL)
- Remove “kingdom” mentality of federal agencies (MD)
- One-stop permitting (ME, HI)
- Policies should be favorable and not unduly burdensome (VI)
- Direct, reasonable, stable leasing/regulatory program (ME)

**Apply laws and regulations suited to the aquaculture industry**

- Don’t govern by fisheries laws devised to protect wild stocks (MA)
- Voluntary compliance, cooperative research (ME)

**Involve the states**

- Cooperation/consultation with relevant states (MA, NY, HI)

**Learn from international and state experience**

- Look to Norway, Japan, Greece, Spain, etc. for guidance (MD)
- Use Maine as a model (ME)

**Address fishery-related concerns**

- Protect wild ocean stocks (GA)
- Native present species only (HI)
- Restrict use of non-indigenous species (LA)
- No non-indigenous species/genetic strains (NY)
- Study impacts on local fisheries (HI)

**Address environmental and ecological concerns**

- Support sustainable marine aquaculture that is economically and ecologically responsible (GA)
- Water quality standards and discharge regulations no less protective than the states (NY)
- Environmental protection (MS)
- Monitor impacts on water quality and benthic habitats (LA)
- Determine carrying capacity for area (HI)

**Address concerns about use of public waters by private entities**

- Private entities using federal waters should pay a fair lease value (GA)
- Pay attention to competing uses (SC, MS, AL)
- Zoning (SC, HI)
- Bonds for removal (SC)

**Consider economic aspects**

- Economic enhancement (MS)
- Recognize aquaculture as a beneficial activity if no significant environmental impacts are demonstrated (CA)

**No policy needed**

- Not an issue (DE)
- Pacific Ocean is too rough, too cold, very high risk (OR)
- Current policy adequate; problems in state waters, not federal (TX)

*Source: University of Delaware survey of state aquaculture coordinators, 2000*

## LEARNING FROM THE STATES: EXAMPLES OF GOOD PRACTICES IN U.S. COASTAL STATES

### ► State Policy for Aquaculture Leases/Permits in Open Waters

In reviewing U.S. coastal state experience, we were particularly interested in state initiatives directly addressing the issue of aquaculture leases or permits in open waters (as opposed to traditional shellfish leases that typically cover areas down to the low tide line).

**Hawaii.** Hawaii has had a marine aquaculture policy in place since 1979, and an ocean leasing policy since 1986 (Ocean and Submerged Lands Leasing Act, Chapter 190D, HRS). Commercial ocean leasing, however, only became possible with the amendment of state law in 1999. The state awards bottom leases, water column leases, and non-exclusive easements. The leasing process involves a mandatory public hearing, environmental review, the posting of a bond, and an annual rental payment. Several features of the state's approach, as described by the state aquaculture coordinator and discussed in a December 1999 report to the Hawaii state legislature (Hawaii Department of Land and Natural Resources and Department of Agriculture 1999) are worth noting here:

1. *Pre-determining existing use profile* - The applicant for a lease is required to study existing uses thoroughly and provide information to decision-makers.
2. *Negotiated exclusivity concept* - The degree of exclusivity and public access to a site will be determined during the permitting/leasing process by those who

participate in the process. The negotiated exclusivity will take into account the needs of the aquaculture business and the needs of the public. The law also mentions establishing clear property boundaries and lanes so boats can pass without interfering with lessee operations. The final degree of exclusivity will be subject to the approval of the Board of Land and Natural Resources (BLNR). Of particular concern are native Hawaiian gathering rights.

3. *Economic unit concept* - State law defines the water surface, water column and submerged lands beneath them as one economic unit, which is used in calculating the lease rent (essentially, a 3-dimensional rather than the traditional 2-dimensional approach).

4. *Public input in siting* - Obtaining a lease involves a two-step process: 1) a Conservation District Use Permit (CDUP) and 2) a lease disposition from the BLNR. Each step requires public notice and a public meeting. The CDUP also requires a public hearing.

5. *Environmental concerns* - An environmental assessment is required for each project/site. Lessees must be bonded, and there are strict penalties for violations of lease terms and conditions.

**Rhode Island.** Rhode Island Coastal Resources Management Program regulations (Section 300.11) include requirements that are relevant to the siting of open ocean aquaculture facilities. Applicants must:



1. Describe the location and size of the area proposed
2. Identify the species to be managed or cultivated within the permitted area and the organisms over which the applicant shall have exclusive right
3. Describe the method or manner of management or cultivation to be utilized, including whether the activities proposed are experimental, commercial, or for personal use
4. Provide such other information as may be necessary for the Council to determine:
  - The compatibility of the proposal with other existing and potential uses of the area and areas contiguous to it, including navigation, recreation, and fisheries
  - The degree of exclusivity required for aquacultural activities on the proposed site
  - The safety and security of equipment, including appropriate marking of the equipment and/or lease area
  - The projected per unit area yield of harvestable product
  - The cumulative impact of a particular aquaculture proposal in an area, in addition to other aquaculture operations already in place
  - The capability of the applicant to carry out the proposed activities
  - The impact of the proposed activities on the scenic qualities of the area.

The regulations require the aquaculturist to restore the area to pre-existing conditions within 90 days of the revocation, termination, or expiration of a permit or lease. To encourage the development and testing of new gear or techniques, a 2-year experimental permit is available for up to 3 sites (per applicant) not to exceed a total area of 1,000 square feet. Fines

and penalties are provided for anyone who willfully destroys, vandalizes, or disrupts aquaculture operations.

**Florida.** Florida statutes specifically address the leasing of submerged land and the water column for the conduct of aquaculture activities and granting exclusive use of the bottom and water column to the extent required for aquaculture activities. The statutes cover both commercial and experimental aquaculture. The leasing program is administered by the Division of Aquaculture's Bureau of Aquaculture Development within the Florida Department of Agriculture and Consumer Services.

The application process involves four steps:

1. Applicant identifies a lease site, describes the proposed activity, and develops a business plan.
2. Comprehensive review (4-6 weeks), including site inspection (additional field surveys and site inspections may be necessary to modify initial site boundaries).
3. Notice to local entities
  - County may file objection within 30 days of the first publication of notice
  - The county objection is based on a majority vote of its county commission
  - A county may object to an aquaculture project located in a proposed lease area that would lie within the county if its boundaries "were extended to the extent of interest of the state."
4. Approval of lease by the Governor and Cabinet in their role as the Board of Trustees of the Internal Improvement Trust Fund

**Alaska.** Alaska offers leases for shellfish and aquatic plants, but not for finfish. A lease application period is scheduled at least every other year from January 1 – April 30, with a public review and comment period on the preliminary best interest finding in the subsequent fall. There is a multi-agency application form that includes an Alaska Coastal Management Program certification form. The applicant’s site plan and installation schedule are considered a development plan, which must result in commercial use of the site beginning no later than the fifth year and continuing through the rest of the lease term. “Commercial” is defined as annual sales of aquatic products of at least \$3,000 per acre, or \$15,000 per farm (whichever is less). The development plan must be approved before the lease is issued.

State law requires regulations for:

1. Establishing criteria for approval or denial of leases
2. Limiting the number of sites in an area in order to protect the environment and natural resources.
3. Considering upland management policies
4. Considering whether the proposed use of a site is compatible with the traditional and existing uses of the area

Criteria that may be considered in making a “best interest finding” include: compatibility with land management policies applicable to the farmsite and nearby upland; conflicts with existing or pending uses; ensuring public access to and along public waters; protection of interests served by the public trust doctrine; the need for special lease provisions or other measures to mitigate conflict; and other significant social, economic, and environmental effects.

The regulations specify certain provisions that must be included in the lease. For example: “A lessee shall operate so as to cause no significant damage to land, public trust resources, and public uses of public trust resources.”

**Maine.** Leases awarded in Maine must meet a set of conditions specified in state law (12 M.R.S. § 6072). These are:

1. Will not unreasonably interfere with the ingress and egress of riparian owners.
2. Will not unreasonably interfere with navigation.
3. Will not unreasonably interfere with fishing or other uses of the area taking into consideration the number and density of aquaculture leases in an area.
4. Will not reasonably interfere with the ability of the lease site and surrounding areas to support existing ecologically significant flora and fauna.
5. The applicant has demonstrated that there is an available source of organisms to be cultured for the lease site.
6. The lease does not unreasonably interfere with public use or enjoyment within 1,000 feet of municipally owned, state owned or federally owned beaches and parks or municipally owned, state owned or federally owned docking facilities.

The state’s site evaluation requirements include baseline fieldwork to collect information on temperature, dissolved oxygen, salinity, pH, and depth profiles, as well as a SCUBA diver survey to observe/videotape the bottom

topography and composition of flora and fauna within the boundaries of the proposed site.

State law also includes a set of conditions governing the use of the leased area and limitations on the aquaculture activities, in order to:

- Encourage the greatest multiple, compatible uses of the leased area
- Address the ability of the lease site and surrounding area to support ecologically significant flora and fauna
- Preserve the exclusive rights of the lessee to the extent necessary to carry out the lease purpose.

Leases may be granted on a conditional basis until all necessary federal, state and local permits have been acquired. Leases require certification from the Department of Environmental Protection that the project will not violate the standards ascribed to the receiving waters classification.

The lessee must record the lease, publish a notice, mark the lease site, and submit an annual report of seeding and harvesting in the preceding year and plans for the coming year.

Marine organisms cultivated on the leased area are exempt from any minimum/maximum size or length requirements (12 M.R.S. § 6073). A special license is available that exempts aquaculture from marine resource laws as to the time, place, length, condition, amount and manner of taking or possessing a marine organism (12 M.R.S. § 6074).

Leases are monitored annually, and may be revoked if no research or aquaculture has been conducted within the preceding year or if it has

been conducted “in a manner substantially injurious to marine organisms” or violated any lease conditions.

Two types of leases are available: a standard lease covering up to 150 acres for a 10-year period and an experimental lease for up to 2 acres for a 3-year period. In addition, emergency leases may be issued to allow relocation of an aquaculture operation when there is a threat to shellfish health and safety.

### ► State Efforts to Coordinate/Streamline Aquaculture Permitting Process

*Florida.* The Department of Agriculture and Consumer Services is the lead agency for aquaculture in Florida. In 1999, a new Division of Aquaculture was created within the Department as a “one-stop” office for both saltwater and freshwater aquaculture. The Division of Aquaculture merged the regulatory activities of the Bureau of Marine Resource Regulation and Development (previously in the Department of Environmental Protection) and the Aquaculture Certificate of Registration Program.

Florida’s Aquaculture Certification Program identifies aquaculture producers and aquacultural products and entitles the aquafarmer to the same benefits as other agricultural producers. It also exempts the aquafarmer from certain requirements of wild-harvested species, offers tax advantages, and reduces the number of permits required from other regulatory agencies. In signing the annual certification, the aquafarmer agrees to abide by Best Management Practices for Aquaculture (BMPs), under a program created by the legislature in 1998. The Department of

Agriculture and Consumer Services is currently developing BMPs, in concert with each segment of the aquaculture industry, and plans site visits at each certified facility. Certified aquaculturists who comply with BMPs will be presumed to be in compliance with state groundwater and surface water standards as well as regulations for the culture of non-native species. The BMPs are designed to eliminate cumbersome, duplicative and confusing environmental permitting and licensing, thereby allowing the aquafarmer to concentrate finances and time on producing a marketable product.

**Maine.** Maine has adopted one-stop permitting for leasing and environmental review. The one-stop permit process includes the application and review process for the Section 10 Army Corps of Engineers permit.

The state has also established an aquaculture policy/ombudsman position within the Department of Marine Resources to: 1) coordinate state policy on the culture of all aquatic species, 2) respond to inquiries on a timely basis from aquaculturists and interested parties, 3) coordinate the Interagency Committee on Aquaculture and staff an Aquaculture Advisory Committee, 4) collect, maintain and distribute data on the State's aquaculture-related activities, 5) develop a proactive aquaculture development program that pulls together and focuses the various resources that exist at the state and federal level for which aquaculture businesses might be eligible, and 6) advocate the State's interests to regional and national aquaculture agencies.

**Mississippi.** The Mississippi Aquaculture Act of 1988, as amended, specifies a one-stop permitting procedure. The Mississippi Department of Agriculture and Commerce coordinates requests for Cultivation/Marketing

Permits with all state and federal agencies that have related regulatory responsibilities. The aquaculturist submits a single form ("Mississippi Aquaculture Activities Application for Aquaculture Permits"), and the Department of Agriculture and Commerce conducts a coordinated review with all applicable state and federal agencies. The Commissioner of Agriculture and Commerce makes the decision on the issuance of the permit.

### ► Institutional Bodies Created to Address Aquaculture Issues

**Maine.** Maine has a 4-member Salmon Aquaculture Advisory Council, consisting of the state marine resources commissioner and 3 industry members. The Council makes recommendations on expenditures from the state's Salmon Aquaculture Monitoring, Research and Development Fund.

**Florida.** Florida has established an Aquaculture Interagency Coordinating Council to serve as a forum for the discussion and study of governmental regulation relating to aquaculture. The council consists of an aquaculture coordinator from five departments (Agriculture and Consumer Services, Commerce, Community Affairs, and Environmental Protection), the Fish and Wildlife Conservation Commission, the statewide consortium of universities under the Florida Institute of Oceanography, Florida Agricultural and Mechanical University, the Institute of Food and Agricultural Sciences at the University of Florida, the Florida Sea Grant Program, and each water management district. The chair of the Council serves on the Aquaculture Review Council, which also includes the chair of the State Agricultural Advisory Council and seven members

representing industry. State law requires representation by an alligator farmer, a food fish farmer, a shellfish farmer, a tropical fish farmer, an aquatic plant farmer, a representative of the commercial fishing industry, and a representative of the aquaculture industry at large.

### ► State Policies to Address Environmental/Biological Risks

*New Hampshire.* State permitting policy includes criteria for “unacceptable risk,” and for reporting of an “unusual event.” In determining whether a particular risk is acceptable or not, the following criteria are considered:

- the proposed species (life cycle, life history, reproductive habits, habitat requirements)
- genetics of the individual wildlife
- interaction with competing species
- food/habitat competition with indigenous species
- other factors relating to the proposed operation, such as types of system (closed or controlled) and screened outlets or other enclosures.

An unusual event is any event related to the aquaculture operation that might have a negative impact on the environment.

No aquaculture license is granted if any portion of the aquaculture operation would adversely impact the state’s aquatic or marine resources or would impose unacceptable disease, ecological, environmental, health, safety or welfare risks to persons, the environment, or aquatic or marine species.

*Maine.* Maine has an aquaculture monitoring program for establishing and maintaining a comprehensive information base pertaining to all aspects of the siting, development and operation of finfish aquaculture facilities (12 M.R.S. § 6077). At a minimum, information is collected on the following site-specific categories:

- Geophysical site characteristics, including currents and bathymetry
- Benthic habitat characteristics and effects, including changes in community structure and function
- Water column effects, including water chemistry and plankton
- Feeding and production data sufficient to estimate effluent loading
- Smolt and broodstock introduction and transfer data
- Disease incidence and use of chemical therapeutics
- Other ancillary information, as deemed necessary.

The state has a Salmon Aquaculture Monitoring, Research and Development Fund, (12 M.R.S. § 6078) financed by the collection of a fee of one cent per pound of whole fish harvested. This fund is used to develop effective and cost-efficient water quality licensing and monitoring criteria, analyze and evaluate monitoring data and process lease applications (12 M.R.S. § 6079).

Growers are required to give advance notice of the application of any antibiotic, including information on the dosage, timing, and duration of the treatment

*Mississippi.* Mississippi prohibits cage culture of exotic species and organisms that are

genetically modified by means other than breeding and crossbreeding. Endangered, threatened and protected species can be cultured with an approved Cultivation/Marketing Permit. Natural stocks from other states can also be cultured in Mississippi provided they are also native to Mississippi and they are not known to be a different genetic sub-population.

### ► Incorporating Aquaculture in State Legislation and Regulation

**South Carolina.** South Carolina provides an example of the magnitude of the effort required to incorporate aquaculture within existing legal and regulatory frameworks, and the shortcomings of such a policy strategy.

Since aquaculture began to emerge as a viable industry in South Carolina in the early 1980s, the state legislature has been responsive to the need to amend state statutes in order to facilitate the development of marine aquaculture operations. In 1985, the South Carolina General Assembly, using language similar to that in the National Aquaculture Act of 1980, declared it was in the state's interest to encourage the development of aquaculture (Title 2, Chapter 22, Amendments, S.C. Code of Law). Subsequently, the state legislature enacted a series of initiatives to facilitate aquaculture development. As noted in an earlier study (see Devoe 1997), the General Assembly:

- provided exemptions from seasonal and minimum size regulations to the hard clam aquaculture industry (1986 and 1989)
- legalized the culture of hybrid striped bass (passed in 1988 after 4 years of very difficult negotiations)
- declared that all fish, shellfish, crustaceans and plants grown in bona fide aquaculture

operations remain the private property of the culturist until sold or traded (1989)

- provided for significant penalties (including fines and imprisonment) for anyone convicted of causing damage to aquaculture facilities or stealing cultured fish and shellfish (1989)
- developed an importation policy for the use of non-native *penaeid* shrimp species in culture operations (1990)
- began considering coastal zone regulations that allow for the use of the state's waters and tidal bottoms for aquaculture near population centers (proposed in 1996)

Despite the inclusion of aquaculture on the state's legislative agenda over a 10-year period, the state still lacks an overall framework for addressing aquacultural issues. As noted by DeVoe:

South Carolina has obviously demonstrated a willingness to deal with constraints to aquaculture development through legislative and regulatory reform, but it has done so in a reactive, crisis-management mode. This becomes extremely clear when examining the State Code of Laws—statutes directly affecting aquaculture are spread throughout the Code Book. As a result, there is no overall state framework for aquaculture in South Carolina (Devoe 1997, p. 14).

**Washington.** Washington provides an example of state agency and industry collaboration to call for greater regulation of aquaculture. So far, they have not been successful.

Over the past several years, there have been a number of large fish escapes from salmon netpens, at the same time that serious environmental concerns were being raised about the impact of such escapes. The state's aquaculture policy designated the state department of agriculture as the lead agency for aquaculture, but—according to the industry and the state Department of Fish and Wildlife—regulations and programs for preventing and responding to fish escapes are inadequate. The Department of Fish and Wildlife is advocating the development of a comprehensive code of scientific salmon aquaculture practices, coordination of aquaculture policy with industry and neighboring British Columbia, use of non-reproducing Atlantic salmon, adequate funding for management of the salmon industry, and re-establishment of its authority (or another agency's) to regulate aquaculture. Regulatory authority would encompass which species could be raised, inspections of aquaculture operations, educational opportunities for aquaculturists, and an Atlantic Salmon Watch program as a focal point for gathering data (Washington Department of Fish and Wildlife 1999). The salmon industry in Washington is supporting legislation that would put a moratorium on salmon farm expansion and improve methods of preventing escapement of farmed salmon into the wild, and is considering independent action to catch escaped fish and establish a Salmon Watch program. However, some of the industry's proposed responses, such as using commercial fishing gear to catch escaped fish, also require changes in state regulations. (IntraFish.com 2000).

## ► Integration of Marine Aquaculture in State Coastal Zone Management

As an important, or potentially important, use of state coastal waters, marine aquaculture is being addressed in some state coastal zone management plans. NOAA's Office of Ocean and Coastal Resource Management (OCRM) provides assistance to state coastal planning processes (see chapter 4). Table 5.5 summarizes the results of a survey on state aquaculture plans, which identified 13 coastal states that have an aquaculture plan. (Nelson et al. 1999). Seven of these coastal states have also included an aquaculture component in their state coastal zone management (CZM) plans, and an additional three states (which have no aquaculture plan) address aquaculture in their CZM plans. For example:

- Connecticut's CZM laws recognize aquaculture as a "water dependent" priority.
- Massachusetts' Ocean Resource Policy includes support for "the development of environmentally sustainable aquaculture, both for commercial and enhancement purposes."
- Rhode Island's CZM plan addresses regulations and permitting of aquaculture operations.

The study notes that several states (Connecticut, Maine, and South Carolina) reference aquaculture as a special enhancement area, eligible to receive federal funds under Section 309 of the federal Coastal Zone Management Act. The authors note the results of a recent assessment by NOAA's Office of Ocean and Coastal Resource Management

**Table 5.5. Relationship of aquaculture to state coastal zone management plans**

	States with aquaculture component in CZMP	States with aquaculture plan	Contents of state aquaculture plans			
			Agency jurisdictions	Legislative strategies	Education, R&D	Marketing & promotion
Maine	X	X	n.d.	n.d.	n.d.	n.d.
New Hampshire	*	*	*	*	*	*
Massachusetts	X	X	X	X	X	X
Rhode Island	X	X	X	X	—	—
Connecticut	X	X	n.d.	n.d.	n.d.	n.d.
New York	*	*	*	*	*	*
New Jersey		X		X		
Delaware	*	*	*	*	*	*
Maryland		X	X	X	X	X
Virginia		X		X	X	X
North Carolina		X		X		
South Carolina	X	X	X	X	X	X
Georgia		X	X		X	X
Florida	X	X			X	X
Alabama		X	X	X	X	X
Mississippi						
Louisiana	X					
Texas	*	*	*	*	*	*
California	X					
Oregon	*	*	*	*	*	*
Washington*	*	*	*	*	*	*
Alaska	X					
Hawaii	X	X			X	X
Puerto Rico	*	*	*	*	*	*
Virgin Islands	*	*	*	*	*	*

\* Did not respond to survey

Source: Adapted from Nelson et al. 1999, tables 2, 6 and 9.

indicating three states have identified aquaculture as a high priority in their CZM program.

- Rhode Island would use federal funding to develop a management plan.

- Maine and Virginia (which has not yet incorporated aquaculture in its state CZM plan) would use federal funding to improve state leasing regulations and address water quality issues.



In Massachusetts, the state coastal zone management agency played a lead role in developing a strategic plan for aquaculture. The agency is also funding development of the

Massachusetts Ocean Resources Information System, which will be used to identify existing and screen for potential aquaculture sites along the Massachusetts coast.

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## APPLICABLE LESSONS FROM COASTAL STATE EXPERIENCES

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Based on our survey and other sources of information on the experience in U.S. coastal states, several elements emerge as likely candidates for inclusion in a federal policy for offshore marine aquaculture in the 3-200 mile U.S. ocean zone.

### ► Planning

- A lead agency helps promote the industry and reduces regulatory burdens, but care should be taken so as not to sacrifice regulatory enforceability in the process.
- Designation of aquaculture zones should be considered as a way of dealing with siting concerns.
- Public and industry input are critical.
- Designation of lease conditions and criteria for reviewing applications for leases should be included in legislation.
- New institutional authorities may need to be created.

### ► Permitting/Leasing

- Regulatory flexibility, consolidation of programs, and streamlined application

processes are desirable features for a federal policy.

- Public reviews and environmental assessments are common elements in the siting of aquaculture in state waters, so should be included in federal policy as a matter of standard practice.
- Performance bonds are commonly required for aquaculture operations in state waters, so industry is not likely to oppose bond requirements in federal policy, provided the amounts were considered reasonable.
- The degree of exclusivity for an aquaculture project may be negotiable.
- Experimental and research leases with shorter terms and smaller areas than commercial leases should be considered.

### ► Operations

- The aquaculture industry in the United States is not used to paying royalties when operating in state waters, so some resistance to such payments in federal waters should be anticipated.
- Monitoring and incident reporting requirements should be included in the powers of the leasing authority.

- Best Management Practices (BMPs) should be considered as a regulatory approach.
- Different standards may be needed for different types of species (shellfish v. finfish; native v. non-native v. hybrid v. transgenic organisms).

## ► Termination

- Performance bonds should be required in an amount sufficient to cover the costs for removing structures and cleaning up the site should the operator abandon the facility.

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## CONCLUSION

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In general, based on state experience, comprehensive legislation targeted at regulating and managing marine aquaculture offers the best promise of success, both in terms of environmental protection and industry

assistance. Achievement of this goal will typically require extensive coordination among competing agencies, industry and the public, as well as legislative action.



# Chapter 6



## POLICY DEVELOPMENT ON OFFSHORE AQUACULTURE: LESSONS FROM THE INTERNATIONAL ARENA

As is well known, marine aquaculture has developed more rapidly in a number of other nations than in the United States. Hence, in this chapter we review the experiences in other nations with industries and policy/regulatory frameworks that could help inform the U.S. policymaking process regarding offshore aquaculture in the U. S. EEZ.

While no nations appear to have yet developed an explicit regulatory policy framework for their EEZs, several have had considerable experience with the management of aquaculture operations located in nearshore coastal waters or in other cases some distance from shore. A majority of these have world leading or expanding marine aquaculture industries producing Atlantic salmon and related

species. Most also have shellfish industries that are either well established or have significant potential for future development. Short summaries of the current policy and regulatory situations in eight coastal nations with substantial marine aquaculture activities are discussed in this chapter: The experiences of Norway, United Kingdom, Ireland, Canada, Chile, Australia, New Zealand, and Japan.

Important guidance on carrying out aquaculture operations in a sustainable development manner may also be drawn from the work of various international organizations such as the UN Food and Agriculture Organization (FAO) and the International Council for the Exploration of the Seas (ICES). The second part of this chapter reviews the nature and implications of this work.

## THE EXPERIENCES OF OTHER NATIONS WITH OFFSHORE MARINE AQUACULTURE

### ► Norway

Farmed salmon is Norway's leading seafood product. Norway is the world's largest producer and exporter of Atlantic salmon with production exceeding more than 390,000 tons valued at NOK 10 billion (US\$667 million) in 1998 (Norwegian Institute of Marine Research 2000). During 1999, farmed salmon and trout represented more than 30 percent of seafood exports valued at NOK 29.9 billion (US\$3.4 billion) to leading markets in Japan, Denmark, France and Germany (IntraFish 2000).

With its highly indented shoreline, sheltered fjords, and rich deep coastal waters, Norway is well suited for aquaculture. Most of its marine aquaculture is done in net pens in the relatively sheltered waters of fjords and embayments. No evidence could be found that Norwegian fish farms are yet sited more than 12 nautical miles from the shoreline—that is in the Norwegian EEZ, nor could we find policies or regulations that apply explicitly in their EEZ. Nonetheless, some of the experience gained in Norway as marine aquaculture has developed over the last 30-40 years, is, we believe, relevant to our study.

This is especially true on the intergovernmental/institutional side but it is also of interest to see what kinds of siting, environmental, and biological issues (carrying capacity, diseases, etc.) have dominated Norwegian policy-making activities. First, on the intergovernmental/institutional side, even in the nearshore coastal waters, Norwegian federal ministries have jurisdiction. Thus, the Ministry of Fisheries, the Ministry of Environment, the

Ministry of Agriculture, and the Ministry of Local Government and Labor are all involved in the regulation of marine aquaculture. This multi-jurisdictional situation parallels, of course, what we have in the U. S. EEZ, where at least five agencies may have some form of jurisdiction (Corps of Engineers, Environmental Protection Agency, NOAA/NMFS, regional fishery councils, U. S. Coast Guard, etc.). Hence, the way the Norwegians have arranged their regulatory review process will be of interest. Also, the extent to which one agency, the Ministry of Fisheries, plays the lead agency/coordinating role is relevant.

The regulatory framework governing marine aquaculture in Norway is largely based on national legislation entitled the *Act Relating to the Breeding of Fish, Shellfish, Etc.* together with the regulations issued to implement this legislation. A thorough discussion of the regulatory framework for salmon farms is also summarized in *The Salmon Aquaculture Review Final Report, Volume IV - Part C, II. Norway.* developed by the British Columbia Environmental Assessment Office (1998a). Participating government ministries/agencies and their respective role(s) in the regulatory framework discussed below are derived from this publication.

The Directorate of Fisheries (of the Ministry of Fisheries) issues the licenses for fish farms after consultation with the Ministry of the Environment, the Ministry of Agriculture, and the Ministry of Local Government and Labor, to take account of the views of interested local governments. The Act states that a license will not be issued if the proposed facility:

- will cause the risk of the spread of disease among fish or shellfish,
- will raise the risk of pollution,
- will cause conflicts with other activities in the surrounding environment, lawful traffic, and other exploitation in the area.

The Pollution Control Authority (of the Ministry of the Environment) issues permits required for waste discharges including those associated with marine aquaculture operations. This authority operates under the terms of the Pollution Control Act and the regulations issued in connection with that legislation. Regulations Relating to the Establishment and Operation of Fish Farms have explicit rules regarding the cleaning of fish, the storage and handling of dead fish, and many other aspects of the aquaculture operation. The Waste Treatment Regulations issued by the Ministry of Agriculture under the Internal Fish Diseases Act contain approved methods for the destruction of dead fish and wastes and the treatment of effluents from fish farms to prevent the spread of an infection. Ministry of Agriculture regulations also require that fish farms keep records for at least five years of:

- all incoming and outgoing live aquatic organisms,
- slaughter and loss of aquatic organisms through escape or mortality,
- health certificates accompanying live organisms entering the fish farm.

It is the responsibility of the fish farmer to demonstrate that a farm will not cause unacceptable pollution effects and that there is

an adequate plan for handling wastes, such as fish mortalities, prior to establishing or expanding a fish farm. If it is unclear to government authorities that the receiving waters will be suitable (to adequately assimilate the discharge), the government authorities will require that a monitoring program be undertaken prior to the leasing of the proposed operation or the expansion of that operation.

Given the rapid growth of the industry, the siting of fish farms has attracted substantial attention in Norway. In 1987-90, a national assessment of the suitability of the Norwegian coastal zone and rivers for aquaculture (LENKA) was established. Its aim was to develop an overview of the potential for aquaculture along the coast and to provide a basis for the systematic development of the industry. This was a joint undertaking of the Ministry of Fisheries, the Ministry of the Environment, and the Ministry of Local Government and Labor. The following siting selection criteria are used:

- the expansion of fish farming is permitted only in salt water with good water exchange and where there are no problems or tendencies toward eutrophication, reduced oxygen concentration, or the accumulation of sediments under the culture systems;
- the expansion of fish farming in fresh water is not permitted; and
- fish farming close to rivers important to wild salmon populations is prohibited.

As a part of LENKA, a procedure was also established for estimating the gross available capacity for aquaculture production in LENKA zones. The main steps in the development of the capacity assessment are:

- an assessment of the maximum permissible organic loading of the waterbody of the marine area; and
- an assessment of the space available for aquaculture development arrived at by subtracting all unsuitable areas and all areas already occupied from the total area of the zone.

The Norwegian Planning and Building Act has been amended to include sea areas. Spacing requirements for salmon aquaculture farms include the following:

- the distance between each fish farm is to be at least one kilometer;
- the distance between a salmon grow-out farm in the sea and a broodstock farm is to be at least three kilometers.

Other issues which seem to have dominated the time of both the private farmers and the Norwegian government, noted in a recent Norwegian paper (Hjelt 2000), are listed below:

- Production and market crisis
- Freezing program
- Collapse and bankruptcy
- Restructuring and integration
- New organization of marketing
- Control of diseases
- Accusations of dumping

- Regulation by feeding quotas
- “Understanding” with the EU
- Economic crises in Russia/Asia

It can be seen that economic issues (such as production, marketing, etc.) dominate the list. Only two of the issues—control of diseases and regulation by feeding quotas are not in this category. Thus, the great preoccupations on the policy side of Norwegian offshore aquaculture in the last several decades appear to have been the questions of marketing, overproduction, and related economic concerns.

### ► United Kingdom (Scotland)

Marine finfish aquaculture in Scotland dates back to the 1960s with the introduction of net pen farming of Atlantic salmon in coastal waters. While growth of the salmon farming industry has been slow, the industry experienced a rapid expansion during the last decade. Production increased from 32,000 metric tons in 1990 to 110,000 metric tons in 1998, valued at £260 million. Other marine fin fish species with demonstrated commercial value or the potential of such include halibut, sea trout, turbot and cod.

Salmon farming is the most economically important sector of the marine fish farming industry and Scotland is the predominant locale for finfish aquaculture in the United Kingdom. Salmon farms are located throughout Scotland but the industry is most concentrated in relatively isolated, rural locations along the northern and western coasts. While these farms operate in protected nearshore waters, there is interest among the industry to develop offshore sites largely due to advances in gear and production technology and environmental

considerations. These include the relative lack of new inshore sites, concerns about carrying capacity and eutrophication, and losses to Infectious Salmon Anemia (ISA) disease. The Scottish government is supportive of industry expansion into open ocean sites. However, downward trends in European market prices, international competition from Norway and the relatively higher capital and operating costs for offshore operations have limited the addition of new offshore fish farms.

Shellfish farming in Scottish coastal waters, valued at approximately £2 million, principally involves four species of bivalve molluscs: mussels, native oysters, Pacific oysters, and king and queen scallops. Shellfish farms, utilizing protected nearshore or intertidal waters, are also located in largely rural areas. Future increases in Scottish shellfish production are expected to be moderate but steady and no offshore or open ocean shellfish farms are currently in operation.

The development of the marine aquaculture industry, particularly during the last 10 years, has had important social and economic implications for rural Scottish coastal communities. The Scottish government estimates that 330 salmon farms and supporting industries provide approximately 6,500 jobs to rural communities and that the shellfish industry employs 350 people, mostly on a part-time basis.

The Scottish Executive publication *Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters* (1999) provides a detailed description of the current regulatory framework for marine fish farms in Scotland. Participating government ministries/agencies and their respective role(s) in the regulatory framework discussed below are derived from this publication. The Scottish regulatory framework for salmon farms is also

summarized in *The Salmon Aquaculture Review Final Report, Volume IV - Part C, III. Scotland* developed by the British Columbia Environmental Assessment Office (1998b).

### **The Crown Estate (CEC)**

The CEC is responsible for the management of the territorial seabed and most of the foreshore between the high and low water mark. Anyone wishing to establish a marine fish farm must apply to the CEC for a lease of the seabed (and foreshore where appropriate) within which the marine fish farm will operate. The CEC monitors marine fish farm operations to ensure compliance with lease conditions. It also maintains a register of marine fish farm leases and is able to supply non-commercial information on request.

### **The Scottish Executive Development Department (SEDD)**

Following devolution SEDD has assumed responsibility for ensuring that works in tidal waters do not constitute a hazard to navigation (previously administered by the Department for the Environment, Transport and the Regions). Under the Coast Protection Act 1949, consent for the installation of marine fish farming equipment in sea areas must be obtained from SEDD.

### **Scottish Environment Protection Agency (SEPA)**

SEPA has a duty to promote the cleanliness of Scotland's tidal waters and to conserve so far as practicable, its water resources. SEPA is also required to promote the conservation of flora and fauna dependent on the aquatic environment. This includes the safeguarding of water quality and the condition of the sea bed in the vicinity of



fish farms. Under the Control of Pollution Act 1974, consent is required for the discharge of effluent from marine fish farms to coastal waters from SEPA. An application for discharge consent is advertised by SEPA in the appropriate local newspaper and the Edinburgh Gazette. SEPA consults other regulatory authorities and is a relevant and competent authority under the Conservation (natural habitats and conservation) Regulations 1994. If SEPA agrees to the discharge, it will inform any objector who can then have 21 days within which to request the Secretary of State to call-in the application for his own determination. Conditions designed to minimize adverse environmental effects may be attached to discharge consents. SEPA is responsible for ensuring that appropriate monitoring of the aquatic environment is undertaken and this is achieved by applying specific consent conditions and by its own audit monitoring. Consents may be subject to a review after a period of 4 years or sooner with the agreement of the discharger.

### **The Scottish Executive Rural Affairs Department (SERAD)**

SERAD is responsible for statutory measures under the Diseases of Fish Acts 1937 and 1983 and related EC Fish Health legislation to prevent the introduction and spread of serious pests and diseases of fish and shellfish which may affect farmed and wild stocks. All marine fish farms must be registered with the Department for disease control purposes. Certain diseases must be notified to the Department and there are procedures laid down for the treatment and disposal of infected stock. SERAD's Marine Laboratories carry out a wide range of basic marine fish farm research and offer advice on production methods and equipment. The Department also has wider

responsibilities in relation to the protection of fish, fisheries and the marine environment. It advises the Crown Estate on the implications for disease control, existing fishing interests and the inshore marine environment of applications for marine fish farm leases, and is consulted by SEPA on discharge consent applications.

### **Local Authorities**

Local authorities have the lead role in advising the Crown Estate on marine fish farm proposals under the interim arrangements pending the transfer of control to them under proposed changes to land use planning legislation. Local authorities, however, control fish farm developments above the low water mark. Thus, for freshwater fish farms, all development requires planning consent, as do any onshore facilities associated with marine fish farming.

### **Harbour Authorities**

Harbour authorities, in designated harbour areas, issue licences for the operation of marine fish farms. Applications for works licences must be advertised and are subject to consultation procedures. Applicants consult their local harbour authority on the particular procedures which apply.

### **The Health and Safety Executive (HSE)**

Under the terms of the Health and Safety at Work Act 1974, HSE inspects installations and facilities at marine fish farms. HSE has issued advice on minimum health and safety standards for the construction and use of floating fish farm installations used for fin fish in inshore waters.

## Shetland and Orkney Islands Councils

In Shetland, under the Zetland County Council Act 1974, the Council has powers to licence works in coastal waters which it exercises in conjunction with its powers as planning authority. Under these powers, the Council has developed policies for the development and regulation of salmon and shellfish farming. Anyone wishing to undertake marine fish farm development within the Shetland coastal waters must obtain a works licence from the Council. All applications for works licences must be advertised and the Council consults widely. Applicants and objectors enjoy the right of appeal to Scottish Ministers against the Council's decision. Under the Orkney County Council Act 1974, the Council exercises works licensing powers within certain designated harbour areas. In the event a Works licence is granted the applicant must also apply to the Crown Estate for a lease in the usual manner.

Shetland Islands salmon farmers are managing their operations in accordance with a recently developed Code of Best Practice. The Code contains guidelines or best management practices designed to mitigate a range of environmental concerns related to stocking densities, husbandry, fish health and waste management. Provisions of the Code are being incorporated into the works license administered by the Shetland Islands Council. Regulatory compliance is monitored and managed by the Shetland Marine Aquaculture Consultation Agency (SMACA), a new organization established by the Council that will also provide technical assistance to industry (Holmes 2000)

## Scottish Natural Heritage (SNH)

Scottish Natural Heritage is responsible for securing the conservation and enhancement of the natural heritage—wildlife, habitats and landscapes—and for promoting its understanding and enjoyment by the public. In addition the Natural Heritage (Scotland) Act 1991 states that SNH “shall have regard to the desirability of ensuring that anything done, whether by SNH or any other person in relation to the natural heritage of Scotland is undertaken in a manner which is sustainable.” When consulted on aquaculture applications, SNH takes into account the proximity to and potential impact on wildlife, habitats and landscape. The factors considered, in no order of priority, include :

- areas designated for natural heritage purposes;
- species protected by legislation, including the Wildlife and Countryside Act 1981 and Habitats and Species Directive (Annexes II, IV and V);
- impact on general environmental quality and biodiversity;
- impact on natural heritage interest of pharmaceutical and other compounds used in aquaculture;
- possible conflicts with potential predator species arising from proximity to seal haul-out areas, and otter and fish-eating bird populations;
- the risk of introducing alien species and the likely consequences for wild animal and plant communities;

- the risk of genetic contamination of native stocks, particularly of Atlantic salmon;
- visual and landscape implications; and
- the potential impact on remote or wild land qualities.

SNH would also point out the proximity of a proposed site to any Marine Consultation Areas. This is a non-statutory designation intended to highlight areas which have been identified as deserving of particular distinction in respect to the quality and sensitivity of their marine environment and where the scientific information available substantiates their nature conservation importance.

### **District Salmon Fishery Boards**

Salmon fisheries management in Scotland has been devolved to district salmon fishery boards under the terms of the Salmon Act of 1986. These boards may do such acts, execute such works and incur such expenses as may appear to them to be expedient for the protection or improvement of salmon fisheries, the increase of salmon and the stocking of the waters of the district with salmon. In order to fulfil their functions, they may appoint a clerk and water bailiffs. It is an offence for a person intentionally to introduce salmon or salmon eggs into inland waters in a salmon fishery district for which there is a board unless he has the written permission of the board or the waters constitute or are a fish farm within the meaning of the Diseases of Fish Act 1937, as amended.

### **West Coast Fisheries Trusts**

A number of Fishery Trusts, which are charitable organisations, have been set up to promote and undertake research to provide

scientific advice on the fisheries resources particularly in the west and north of Scotland. The Trustees are drawn from, among others, local owners of fishing rights and the fish farming industry. Support is provided by a number of organisations including SNH, SEPA and the Scottish Executive through the Freshwater Fisheries Laboratory, Pitlochry.

### **Ministry of Defence**

Fish farming is one of a number of activities which are excluded under bylaws from Ministry of Defence controlled areas which are used extensively by the UK, NATO and Allied nations for training purposes. The most significant of these areas include the Dockyard Ports of The Gareloch, Loch Long, Loch Goil, the Holy Loch and Rosyth. Similar prohibitions also exist at the British Underwater Test and Evaluation Centre (BUTEC) and the Rona Noise Range. Details of these prohibited areas can be found in the relevant sections of the West of Scotland Pilot and are normally indicated on the large scale Admiralty Charts. In addition Minelaying and Minehunting operations around military facilities on the west coast and the presence of submarine exercise areas militate against the provision of fish farm moorings in some areas. It is therefore important that MOD is consulted to ensure that fish farm developments do not constitute a hazard to navigation.

The Scottish regulatory framework places controls on marine fish farms with regard to siting, disease transmission, therapeutants, escapement, effluent discharges, marine mammal interactions, environmental monitoring and reporting. The Scottish Office coordinates industry regulation and has responsibility for incorporating relevant European Union legislation under Scottish law. Lease applications and reviews for marine fish farms

are coordinated by the Crown Estate, which consults with other government agencies having statutory jurisdiction (see agency descriptions), non-governmental organizations and the public for comment with regards to navigation, fishery conflicts, and a broad range of environmental considerations. The Crown Estate issues and administers fish farm leases and determines the lease fee based on the farm's production level. Under current Scottish law, a separate license is not required to operate the farm on an approved lease site. Lease applications not approved by the Crown Estate due to objections raised by statutory agencies involved in the review process are referred to a Fish Farming Advisory Committee (FFCA) established by the Secretary of State for resolution. Since its establishment in 1988 only three cases have been referred to the Committee.

The regulatory framework currently in place, however, is subject to significant revision by the Scottish government. With initial establishment of marine fish farms and the need to lease the seabed, the Crown Estate reluctantly assumed responsibility for coordinating statutory regulatory authority on an interim basis. Over time, significant concerns and objections to the Crown Estate's conflict of interest as owner of the seabed vs. its regulatory role in the development of marine fish farms plus the agency's own desire to be relieved of these regulatory responsibilities have prompted the Scottish Office to consider alternatives. One approach receiving widespread consideration involves transferring overall coordination duties to the Scottish Environmental Protection Agency (SEPA) and to increase the involvement and responsibility of local governments with regard to siting and operation of fish farms.

A November 1997 government publication *Marine Cage Fish Farming in Scotland: Regulation and Monitoring. A Compendium of Responses to SEPA's Consultation Paper*

(Scottish Environmental Protection Agency 1997) summarizes stakeholder responses to key regulatory and environmental/natural resource issues pertaining to sustainable industry development. These include proposed changes to the legislative framework to insure compliance with Environmental Quality Standards (EQSs) and the incorporation of Best Management Practices (BMPs); methods to improve the use, control and environmental monitoring of medicines and chemicals; avoidance of potential conflicts with shellfish farms; determination of allowable limits for nutrients, impact zones and organic wastes and management practices to reduce inputs; improved siting based on biomass and hydrographic and carrying capacity models; encouragement for siting new farms in open coastal sites with greater water exchange; avoidance of disease transmission and genetic mixing among wild and farmed stocks; and exclusion of fish farm development from environmentally sensitive, historically significant and/or other such designated waters.

While the report summarizes different views on issues it includes four points on which there was broad consensus:

- there is a rightful place for fish farming in the economy of the Highlands and Islands;
- industry has a direct interest in protecting the environment upon which it depends;
- there is a need to base the industry and its regulation upon sound science; and
- procedures for regulation and monitoring must be clear, fair and open.

The report goes on to conclude that "in marine cage fish farming, as in other sectors of the food industry, product image is important and may be enhanced by public perception of well regulated

and responsible operators. Industry could therefore be said to require regulation and monitoring to ensure and demonstrate environmental protection. There is no question...that the future of the Scottish fish farming industry is dependent on its being seen to be controllable, environmentally sensitive and economically and politically sustainable.”

## ► Ireland

The seafood industry is a major contributor to the coastal and national economy, and the heritage of the island nation of Ireland. During 1997, landings from commercial fisheries and aquaculture were valued at over IRL£300 million and provided employment estimated at 15,720 jobs in production and support services. Over the past 25 years, aquaculture production of marine fin fish and shellfish has gradually increased from approximately 5% of total seafood landings to 30% (IRL£58.5 million). Industry growth is largely attributed to the expansion of Atlantic salmon farms during the last decade and to a lesser extent, increased production of commercially important shellfish such as Pacific oysters and mussels. Farmed salmon production during 1998 was valued at IRL£38.8 million (14.9 tons). Total 1998 shellfish production (oysters, mussels, clams, scallops) of 23.2 tons was valued at IRL£13.3 million. Other species currently under commercial production or entering into production in Irish coastal waters include sea trout, halibut, and abalone.

As with marine aquaculture industries in other countries, conflicting use of the coastal zone, environmental degradation, uncertainty with regard to the biological impacts of fish farms on inshore fisheries and the health and diversity of local marine communities are issues of concern (MacDubhghaill 2000a). As a part of Ireland’s

commitment to sustainable management of its marine resources, the government is initiating a £21 million survey out to the 200 mile limit of the Irish EEZ. Information from mapping the seabed and its resources will help to determine the best use of coastal and offshore waters for a range of potentially conflicting activities such as fisheries, aquaculture, oil, natural gas and mineral resource exploration and commercial transport (MacDubhghaill 2000b). The salmon industry is evaluating the technical and economic feasibility of siting future operations at more exposed offshore sites. Ocean Spar submersible sea cages capable of producing 600 metric tons of fish are being tested at two deepwater sites on the west coast of Ireland. The first 20,000 cubic meter sea cage, installed during 1999, has successfully completed two production cycles and a second unit has been recently deployed for trial operations (Smith 1999; Sackton 2000).

The results of strategic planning by the Irish government on the future directions and opportunities for the Irish aquaculture industry are reviewed in a recently released report commissioned by The Department for the Marine entitled *Irish Aquaculture—the Future*. The report cites the aquaculture sector as having high growth potential in comparison to other segments of the Irish Sea fishing industry. Increased farm production and value added processing, and international exports are identified as areas for future government investment and development. The positive economic and social benefits of aquaculture development in coastal and island communities are also an important part of the development strategy. The report, which recommends that the government invest IRL£60 million over a 4 year period (2000-2004) to improve the industry support infrastructure, projects a production increase over the next 15 years of up to 160,000

tons per year valued at IRL£450 million. This level of industry expansion would support an additional 6,000 new jobs in the aquaculture industry and 3,000 jobs in support industries (Ireland Department of the Marine and Natural Resources 2000).

Administrative and regulatory control of commercial aquaculture in Ireland is centralized under the Department of the Marine. The Department's broad ranging and diverse regulatory responsibilities also include commercial shipping and port services, fisheries, forestry, marine coastal zone management, minerals and hydrocarbons exploration, marine tourism, emergency response, and research and technology development. Under the Fisheries Act, the Department has authority for development and implementation of policies and programs for management of commercial aquaculture in inland, coastal and offshore waters. Divisions within the Department having an aquaculture regulatory function are discussed below.

### **Inland Fisheries/Aquaculture Policy Division**

The duties of the Division applicable to marine aquaculture support development of sustainable Coastal Zone Management through new policies, plans and legislation. The Division is responsible for licensing (leasing) and controlling developments on foreshore (sea bottom) and reclaimed foreshore in accordance with the requirements of the 1933 and 1992 Foreshore Acts and the 1954 State Property Act. It also issues and administers licenses for the aquaculture industry based on environmental and technical standards in accordance with the provisions of the 1959 - 1997 Fisheries Acts.

## **Sea Fisheries Policy and Development**

### **Division**

The overall responsibility of Sea Fisheries Policy and Development Division is negotiation and implementation of European Union and national policy with regard to sea fisheries (including aquaculture). The Division also has responsibility for overseeing and monitoring the operations, activities and finances of the Irish Sea Fisheries Board (Bord Iascaigh Mhara or BIM).

### **The Irish Sea Fisheries Board (BIM)**

The BIM's mission rather than being regulatory, is "to promote the sustainable development of the Irish seafish and aquaculture industry both at sea and ashore and the diversification of the coastal economy so as to enhance the employment, income and welfare of coastal regions and their contribution to the national economy." The BIM aquaculture research and development program assists industry with business planning, modernization of facilities and equipment, new species, and development of cost effective production and waste treatment methods.

The Department of the Marine also oversees the activities of 7 Regional Fisheries Boards. Each Board has responsibility for enforcement of aquaculture licensing regulations and environmental protection at the local level. Legislation to protect and maintain the quality of the environment is implemented by local authorities such as the Regional Fisheries Boards and by the Environmental Protection Agency. The Agency promotes and implements standards for environmental protection and management.

## Licensing Requirements

Two licenses are required by the Department of the Marine to establish a fish farm in coastal waters: A foreshore license (or a lease) and an aquaculture or fish culture license. A foreshore license (or lease) gives permission to use and occupy a particular area of the State foreshore which is defined and delineated on a map. The license describes the specific details related to use of the site for moorings, fish cages, and other equipment related to fish or shellfish production. Foreshore licenses are generally issued for a 10 year period for a fee of IRL£50 per year for finfish irrespective of area and IRL£50 per year for up to 5 hectares for shellfish cultivation. The aquaculture license or fish culture license regulates fish husbandry and other operations on the site leased under the Foreshore Act 1933.

The Department of the Marine requires farms with annual production exceeding 100 tons to submit an environmental impact statement (EIS). The EIS calls for detailed technical information and assessment related to siting, standing stocks and feed input; operational practices and preventative measures with regard to disease treatment, escapement and waste discharges; environmental, water quality and biological monitoring; and record keeping, reporting and inspections pursuant to issuance of an operating license. A public disclosure and comment period is also part of the licensing requirement for larger farms.

### ► Canada

Commercial marine aquaculture in Canada dates back to the 1970s, with the development and gradual expansion of salmon farms in New Brunswick in the east, and British Columbia on

the west coast. Marine finfish and shellfish facilities operate on both coasts with significant or growing industries located in coastal waters of Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick, and British Columbia. British Columbia, rated as the world's 4th largest producer of farmed salmon, is the leading Canadian province with 1998 total production valued at CAN\$238 million or approximately 55% of the Canadian aquaculture industry output. Ranked second is Atlantic salmon production in New Brunswick. During 1998, farmed salmon was valued at CAN\$106 million and represented 93% of all aquaculture production in that province (Statistics Canada 1999; Canadian Aquaculture Industry Alliance, CAIA, 2000). Atlantic salmon accounted for 85% of farmed salmon production with west coast production of Coho and Chinook salmon representing the remaining 14%. Other marine finfish in commercial production or under consideration include black cod in British Columbia and Atlantic cod, flounder, haddock and halibut in the Maritime Provinces (CAIA 2000).

Commercially important marine shellfish and invertebrate species cultivated in coastal waters of the Maritime provinces and British Columbia include Pacific, American and European oysters, manila clams, sea scallops, geoduck clams, abalone, sea cucumbers and sea urchins. During 1998, shellfish production was valued at CAN\$48 million. Mussel culture, established in Atlantic Canada also during the 1970s, has emerged as Canada's largest shellfish industry. During 1998 mussel production was valued at CAN\$19 million with Prince Edward Island as the leading province. Over the last 30 years the aquaculture industry has grown in value (1998 value: CAN\$550 million) to become a significant contributor to the Canadian

economy and national seafood supply. As is the case in other countries, farms and employment opportunities are most often located in rural coastal areas. Estimates of direct employment within the aquaculture industry (production and supply/service sectors) range between 7,000-8,000 jobs (Department of Fisheries and Oceans, DFO, 2000b; CAIA 2000).

Between 1997 and 1998 a 19% annual increase in national commercial aquaculture production was primarily attributed to higher salmon harvests in British Columbia. The New Brunswick salmon industry experienced a significant production decrease due to losses from Infectious Salmon Anemia (ISA). International exports (primarily to U.S. markets) of value added (processed) products increased 24% and were valued at CAN\$425 million during 1998. Farmed salmon exports accounted for 93% of this total. In the near term, estimates of Canadian farm production and exports are expected to continue to increase but at a slower rate. This is attributed to the limited availability of additional protected inshore sites with suitable conditions to meet environmental safeguards and government limitations placed on establishment of new farms on both coasts. Uncertainty with regard to future investment capital, future ability to compete effectively in global markets, and inherent risks and higher operating costs for offshore farming operations are contributing factors. Accordingly, Canadian production is not expected to keep pace with expanding U.S. markets for processed salmon and other marine aquaculture products. In the longer term, the Canadian Aquaculture Industry Alliance (CAIA) predicts a doubling of finfish production and a quadrupling of shellfish production by the year 2005 (DFO 2000a).

The Canadian aquaculture industry is regulated at the federal and provincial government level. The scope of federal involvement includes 17 departments and

agencies that deliver programs and services to the industry. These programs address the fields of research, extension, education, planning and development, financing, regulatory frameworks, fish and shellfish health, and others geared toward achieving environmental quality and industry sustainability. The Department of Fisheries and Oceans (DFO), which has primary responsibility for Canada's fishery and ocean resources, is also the coordinating federal agency for aquaculture. In 1995, the DFO published a strategic planning document, *Federal Aquaculture Development Strategy*, describing the federal government's role to support industry growth and development:

- to provide a framework for integrated federal support for aquaculture development;
- to advance aquaculture in a manner that complements traditional, recreational and Native fisheries, and is consistent with federal responsibilities for public health and the environment;
- to help position the industry in a manner that supports the realization of sustainable competitive advantages while minimizing resource use conflicts

The Office of the Commissioner for Aquaculture Development (OCAD) was established in 1998 to implement the Federal Aquaculture Development Strategy. The Commissioner reports to the Minister of Fisheries and Oceans and is responsible for coordinating federal government resources with the provinces and the industry to institute regulatory reforms and advance industry development.

Under the Fisheries Act, the DFO has a long established precedent for delegating regulatory



responsibilities for commercial fisheries to the individual provinces. As aquaculture has developed as an industry, a similar arrangement is facilitated via Federal-Provincial Memoranda of Understanding (MOUs). The MOUs specify shared federal and provincial responsibilities based on the needs of the local aquaculture industry. The individual provinces have the primary responsibility for administration, licensing and regulation of aquaculture facilities within their jurisdictions.

Other federal programs relevant to marine aquaculture include Agriculture and Agri-Food Canada (AAFC); Canadian Environmental Assessment Agency (CEAA); Canadian Food Inspection Agency (CFIA); Canadian Heritage; Canadian International Development Agency (CIDA); Department of Finance Canada; Department of Foreign Affairs and International Trade (DFAIT); Environment Canada; Farm Credit Corporation (FCC); Health Canada [Bureau of Veterinary Drugs; Pest Management Regulatory Agency (PMRA)]; Human Resources Development Canada (HRDC); Indian and Northern Affairs Canada (INAC); Industry Canada (Atlantic Canada Opportunities Agency (ACOA)); Canada Economic Development for Quebec Regions; Federal Economic Development Initiative in Northern Ontario (FedNor); National Research Council Canada (NRC); Institute for Marine Biosciences; Western Economic Diversification Canada (WD)]; Natural Resources Canada (NRCan); and Statistics Canada (DFO 2000b).

The present regulatory framework used for aquaculture originated from policies applied to the management of fishery resources. Regulatory policies for aquaculture, administered via 17 federal programs and local provincial governments, are widely considered

to be ill suited for addressing current and emerging issues related to rapid expansion of salmon farming, particularly during the last decade. Dissatisfaction with the current regulatory system is attributed to several factors. These include the complexity of the system; broad distribution of regulatory authority; inability to keep pace with industry developments and to anticipate and effectively manage new problems; and controversy with policies, guidelines and procedures used for siting, environmental monitoring and operational issues such as waste discharges, wild/farmed fish interactions, therapeutants and other chemicals, and disease transmission (Conley 1999, CCG Consulting and PricewaterhouseCoopers 2000).

Widespread dissatisfaction among the industry and other stakeholders such as environmental groups, aquatic resource users (commercial and Native fisheries, tourism, etc), and federal and provincial government officials has led to an ongoing extensive review of the regulatory framework for aquaculture. The goal of this review is to develop a consensus among these stakeholder groups to achieve a comprehensive, modern day policy framework that will support sustainable growth of the industry while protecting and conserving environmental quality and coastal resources (Conley 1999).

## ► Chile

Ocean aquaculture has shown remarkable growth in Chile. In less than two decades (since 1986), the nation went from virtually no production of farmed salmon and trout to become the second largest producer in the world, after Norway. Chilean salmon varieties include Coho, Atlantic, and Chinook. Salmon exports

were valued at US\$625.0 million in 1999, a 19.5 percent increase over 1998. Chile supplied approximately 54.0 percent of the salmon sold in Japan and 40 percent of the fresh-farmed salmon products sold in the United States valued at US\$217.5 million in 1999 (Chilean Trade Commission 2000).

Conditions in Chile, especially the fjord-like regions along the central and southern coasts, offer many good sites for marine aquaculture although the limited infrastructure (roads, towns, utilities, etc.) along the remote parts of the southern Chilean coast will make development in this region expensive. However, with labor costs in Chile lower than those in competitive nations such as Norway, Canada, Ireland, and the UK, it can be expected that the growth of marine aquaculture activities will continue.

Several factors have contributed to this remarkable growth. They include:

- an extensive coastal area with very suitable environmental conditions for fish farming
- pollution- and virus-free coastal waters
- long hours of sunlight during the southern summer
- ready access to quality feeds such as fishmeal
- low labor costs

As of the 1990s, there were approximately 90 companies involved in salmon and trout farming in Chile. These companies possessed about 370 farming concessions (leases) authorized by the government. In addition, approximately 100 “resolutions” (applications) were pending but

not yet authorized. About 185 fish farms had been authorized (licensed) to operate, although only about 80 of them were actually operating. The area covered by operating farms was approximately 4,700 hectares (British Columbia Environmental Assessment Office 1997).

Aquaculture in Chile is regulated under the General Law of Fisheries and Aquaculture enacted in 1991. The regulatory framework created by the law involves the issuance of both leases and licenses. A lease (which is also called a “concession”) grants the use of a particular area of the coastal waters for aquaculture purposes and is applied for and granted first. A license (also called an authorization) is then required to develop an aquaculture facility. In approving a license, the government is approving an operating plan to culture a particular species on a specific site in a certain manner.

Agencies implementing this law are authorized to issue regulations to complement the general provisions in the law. Regulations issued so far deal with:

- granting concessions (leases) and authorizations (licenses)
- setting up a national registry of aquaculture operations
- establishing the number and size of cultivation structures
- outlining procedures for importing aquaculture species
- setting requirements for certifying that imported species are disease-free
- applying for importation of species for the first time

In Chile, marine aquaculture is regulated by three agencies—the Sub-Secretary for Marine Affairs of the Ministry of Defense, the Sub-Secretary for Fisheries in the Ministry of Economics, and the Secretariat General of the President’s National Environmental Commission (CONAMA). The role of each agency is briefly described below.

*1. Sub-Secretary for Marine Affairs of the Ministry of Defense*—This sub-secretary has control and enforcement powers over all of the Chilean coast and coastal waters. It has the exclusive power to issue permits for using coastal waters for any activity, including aquaculture. Hence, it is the Sub-Secretary for Marine Affairs that approves applications for aquaculture leases (concessions) after review by the Sub-Secretary for Fisheries. Leases are granted for an indefinite period and can be transferred, sub-leased, or sold.

*2. Sub-Secretary for Fisheries of the Ministry of Economics*—The Sub-Secretary for Fisheries is responsible for the management and preservation of the living marine resources of the rivers and the sea. It also manages aquaculture activities in Chile including the culture systems, the species under cultivation, and the introduction of non-indigenous species. Thus, in an area specified as “suitable for aquaculture” (see “siting of facilities” below) and for which a lease (concession) has been obtained, a fish farmer can apply for a license (authorization) from the Sub-Secretary for Fisheries to develop an aquaculture facility. When a farmer receives an aquaculture lease or license, he is required to register it with the National Aquaculture Register operated by the National Fisheries Service

(of the Sub-Secretary for Fisheries) before beginning operations.

*3. Secretariat General of the President’s National Environmental Commission (CONAMA)*—This agency determines environmental policy with respect to all activities that can impact the country’s natural resources and environment. One of its major tools is the environmental impact assessment (EIA) system, which it oversees. CONAMA, as a part of a national policy for renewable natural resources management (issued in January 1999), describes aquaculture as one of the most dynamic and productive areas of natural resource use. Three specific environmental concerns are mentioned: degradation of coastal waters; impact on natural species, and effects of high intensity salmon culture on some water bodies. The policy document also describes the need for the enactment of “rules for aquaculture” that regulate the environmental impact of this activity in Chilean waters. CONAMA has also developed guidelines for environmental impact assessments involving the culture of living marine resources (Guidelines for EIA for Hydrobiological Resources Culture and Processing Plants).

*4. Siting of aquaculture facilities*—In Chile, siting conflicts have most often occurred between aquaculture and tourism, small-scale fishery interests, and other users of rivers and coastal areas. Conflicts typically involve maritime traffic in the channels of ports and bays, maritime safety issues, the use of harbor space, and the conservation and protection of natural areas.

In an effort to reduce conflicts, a process called “Determining Areas Suitable for Aquaculture” was established. The purpose of the process was to determine areas suitable for aquaculture in each of Chile’s nine coastal regions. Commissions were set up in each region and information was collected from all interested parties. Based on this information, maritime and fishery authorities made draft decisions concerning the areas suitable for aquaculture with the final decisions enacted into Executive Decrees by the Ministry of Defense (Sub-Secretary of Marine Affairs). Final decrees are now in place for six regions but have not yet been issued for three other regions where differences of opinion apparently exist between the Sub-Secretary for Fisheries and the Sub-Secretary for Marine Affairs (the Navy).

It is likely that marine aquaculture will continue to be aggressively pursued in Chile. Environmental problems and conflicts with other users have been encountered but seem to be addressed. As mentioned above, there remain many good locations for marine aquaculture, especially in the southern area of the coast, but adequate infrastructure will have to be created to support the new activities. Like Norway, Chilean fish farmers have faced charges of “dumping” on the U. S. market with penalties and tariffs of up to 40% being imposed on 10 Chilean aquaculture companies. Nonetheless, it would appear that the future growth of the industry will depend on the level of world prices and the continued profitability of the products produced by marine aquaculture in Chile.

### ► **Australia**

Marine aquaculture is a growing activity in Australia with 85 percent of total production occurring in coastal waters. Marine and

freshwater aquaculture production was valued at A\$491 million (US\$278.5 million) in 1998. Leading industry species include pearl oysters, Southern Bluefin Tuna, and Atlantic salmon. Pearl production from tropical Western Australia and the Northern Territories represents 30-50 percent of the total industry value. Southern Bluefin Tuna production based on coastal net pen holding/fattening operations for export of sashimi grade tuna to Japan was valued at approximately A\$130 million (US\$74 million) in 1999. Atlantic salmon production centered in Tasmania using coastal net pens was valued at A\$63.6 million (US\$36 million in 1998 (Department of Agriculture, Fisheries and Forestry-Australia 2000; Allan 1999). Other marine species cultivated in coastal waters include Pacific and Sydney rock oysters, mussels, scallops, abalone and seaweed. In addition to these species, marine shrimp, barramundi, crocodiles, and aquarium fish are also under aquaculture and experimentation is taking place with a number of other species.

Interestingly, the Commonwealth government (the national government of Australia) does not seem to have had a significant role in marine aquaculture. An agreement in the 1980s gave the six states and the Northern Territory control over their coastal areas and the marine resources contained therein. The Commonwealth government, of course, is responsible for the conduct of the foreign policy of Australia and, as such, enters into various international agreements and treaties, some of which could have implications on marine aquaculture activities. Also, the Commonwealth government has, from time to time, provided funding for various kinds of coastal planning, management, and development activities.

Since marine aquaculture is presently regulated at the state (or territorial) level, there are substantial differences in the regulatory

frameworks presently in use. By way of example, the regulatory process of two states—Tasmania and South Australia—are briefly described below. The other four states and the Northern Territory follow somewhat similar approaches.

### Tasmania

The major aquaculture species under cultivation in Tasmania are Atlantic salmon and Pacific oyster, with a smaller volume of activities involving native oysters, blue mussels, scallops, abalone, and seaweed. New species under development include striped trumpeter and flounder.

The Division of Sea Fisheries of the Department of Primary Industry and Fisheries is the lead agency for aquaculture in Tasmania. Also involved are the Department of Environment and Land Management, local marine boards, the Department of Tourism, Sport and Recreation, and the Municipal Association of Tasmania. The principal enabling legislation is the Fisheries Act of 1959, the Fisheries Amendment Act (marine farming) of 1982, and the Crown Lands Act of 1970.

The regulatory framework involves leases, permits, and licensees. A marine farm lease for shallow water (including the use of the seafloor) or permit (for deep water, not including the use of the sea floor) provides tenure for up to 20 years. The holder of such a lease or permit is able to apply for a marine farm license which governs the operational use of the leased (or permitted) area (Anutha and O'Sullivan 1994).

Upon receipt of a marine farm application, the Division of Sea Fisheries consults with a number of other agencies using a mechanism called the Marine Farm Management

Committee. This committee meets on a monthly basis and consists of representatives of the following agencies:

- Division of Sea Fisheries
- Department of Environment and Land Management (Tasmania Property Services Group, Planning Division, Division of Environmental Management, Parks and Wildlife Service)
- Department of Tourism, Sport and Recreation (Tourism Division)
- Marine Board of Hobart
- Municipal Association of Tasmania (representing local governments)

If a proposal raises problems and is likely to have a major environmental impact, the Division of Sea Fisheries can recommend to the Department of Environment Control that a Development Proposal and Environmental Management Plan (DEMP) be required.

Rent and license fees are charged on an annual basis. Rents are based on sea acreage leased and license fees are related to the species being cultivated. In 1993, salmon farmers paid A\$1750 base rent plus A\$100 per hectare of area leased. The salmon license fee was A\$1500. A typical shellfish farmer paid \$100 base rent plus \$25 per hectare and a \$1500 license fee.

Typically, salmon net cages are located out to a maximum distance of 3-4 kilometers from the shoreline. Farms operated by different operators must be located at least one kilometer apart. In some circumstances (e.g., net cages containing large amounts of fish), video surveillance of the seafloor along set transects

under the cages takes place every six months. Cages are required to be moved from time to time to allow the benthos to recover.

### South Australia

It appears that South Australia has a rapidly growing aquaculture industry based on the intertidal culture of Pacific oysters and, more recently, the growout of southern bluefin tuna in sea cages. In addition, being tested are the green lip and black lip abalone, cage culture of snappers, and the southern rock lobster.

Until recently, the regulatory framework has been fragmented between a number of state agencies. Overlapping responsibilities existed in the area of leasing and licensing, resource allocation, environmental management, and developing planning. Now an Aquaculture Committee has been established as a subcommittee of the South Australia Planning Commission and it has been delegated authority to approve the issuance of leases and licenses and to give development approval.

The new Aquaculture Committee consists of representatives of the Department of Primary Industries, the Department of Environment and Natural Resources, the Department of Housing and Urban Development (HUD), the Conservation Council of South Australia, and the South Australian Fishing Industry Council. The Committee is supported by an Aquaculture Technical Advisory Group.

A single coordinated application form can be lodged with the nearest planning authority or with HUD to start the policy process (\$35 license fee). The application is circulated for comment to interested government agencies, local governments and industry groups. The

development application is then advertised for public comment over a two-week period (\$150 fee). The Aquaculture Technical Advisory Group (ATAG) assesses the application against the Aquaculture Development Guidelines, approved aquaculture management plans, and relevant legislation and government policy together with any objections received, and writes a report to the Aquaculture Committee for consideration at its next monthly meeting. The Aquaculture Committee considers the comments of the ATAG and other factors and makes a decision. The process can take as little as six weeks but normally takes from three to six months with appeals adding up to 12 months to the overall process.

Environmental impact statements (EIS) are required for significant developments in South Australia. Other things being equal, the development of the Port Lincoln tuna farming project (see below) would seem to have required the preparation of an EIS but, in this case, the existence of a Port Lincoln Aquaculture Management Plan done in 1993 appears to have met the requirements of an EIS. Indeed, aquaculture management plans have become an important method for allocating marine and coastal resources since 1987. There is now a system of aquaculture management plans in place or near completion for all of the existing major aquaculture areas in the state (**REFERENCES**).

In terms of rent and fees, the government of South Australia endeavors to recover the cost of administration and management of aquaculture in the state. Fair market value is charged for licenses and leases. A fully developed oyster site of 10 hectares, harvesting about 90,000 dozen bushels per year, would pay about \$5000 annually in fees and rents.

As mentioned above, one of the new developments in South Australia involves the

southern bluefin tuna. A substantial aquaculture operation involving bluefin tuna is being developed out of Port Lincoln. Juvenile tuna are caught in purse seines, moved to “tow” cages, and then towed up to 400 kilometers (over a one to two week period) to the vicinity of Port Lincoln where they are again transferred, this time to “growout” cages. These cages are up to 40 meters in diameter and 15-17 meters in depth. They are typically located in water depths of 18-25 meters and are up to 7.5 kilometers from the mainland. Growout cages can occupy no more than 30% of the site and must be at least one kilometer from both the shoreline and other aquaculture sites. Because of concerns over aesthetics, operators are tending to locate new sites at least four kilometers from the shoreline. As they move to more exposed sites, aquaculturists estimate that they will need cages that can withstand from five to six meter seas. Of course, quotas are required to take the tuna in the first place since southern bluefin tuna in Australia are under an ITQ system.

## ► New Zealand

The waters of the Southern Pacific Ocean surrounding New Zealand and its offshore islands support commercial fisheries for 32 species of marine fish and shellfish with landings valued annually at between NZ\$1.1 to NZ\$1.5 billion (New Zealand Seafood Industry Council, NZSIC, 2000). Significant expansion of the fishing industry to offshore and deepwater locations occurred following establishment of an Exclusive Economic Zone (EEZ) in 1978. The EEZ extends to 200 miles offshore and encompasses 1.2 million square nautical miles of clean, highly productive waters ideal for both commercial fisheries and aquaculture. In 1986, the government of New Zealand introduced a Quota Management System (QMS) to conserve

major fisheries stocks and improve the economic efficiency of the industry by adopting an integrated, ecosystems management approach (NZSIC 2000).

Marine aquaculture, valued at NZ\$149.2 million during 1998, is a relatively small but fast growing sector of the fishing industry. The seafood industry (including aquaculture) supports an estimated 10-11,000 jobs, the majority of which are located in rural coastal communities (NZSIC 2000). Fisheries and aquaculture development have also contributed to social cohesion via increased business participation and employment opportunities for members of native indigenous tribes (Maori and Iwi). Besides the economic value derived from commercial fishing and aquaculture, the superior quality of New Zealand’s coastal waters and diverse aquatic habitats are also highly valued for ecotourism, recreation and aesthetics.

The two principal products of New Zealand marine aquaculture industry are Greenshell mussels and Pacific (King) Salmon. Other shellfish species commercially produced in New Zealand but on a much smaller scale include Pacific Oysters, blue mussel and Paua or abalone. All species are farmed in relatively protected nearshore coastal waters. Salmon are produced in floating cages located in river mouths or in coastal ocean waters of Marlborough Sounds and Stewart Island. During 1998, the salmon industry was valued at NZ\$31.5 million. Japan (76%) and Australia (10%) are the largest markets for foreign exports of frozen, chilled and processed (smoked) salmon products (NZSIC 2000).

Greenshell mussels, which are native to New Zealand, are produced utilizing Japanese long line technology on farms moored along the coast in open waters of Marlborough Sounds, the Coromandel Peninsula, and Stewart Island. The

mussel industry, valued at NZ\$118 million during 1998, includes more than 600 farms occupying 2,850 hectares of coastal waters. The industry has expanded rapidly (>490%) since 1988 when exports were valued at NZ\$24 million. Live, chilled, frozen and processed products are exported to 55 countries. Recent advances in gear technology may allow future industry expansion into less protected offshore sites. Continuing and bright prospects for future growth of the mussel industry are attributed to innovative improvements in the areas of production, harvesting and processing and close attention to maintaining environmental and product quality. The industry, with government participation and support, has developed and instituted an Environmental Code of Practice (ECOP) that specifies best management practices that are both environmentally responsible and cost effective. The industry environmental policy stresses the “5R” principles of waste management – reduction, reuse, recycling, recovery and residual management (New Zealand Greenshell Mussels 2000).

The Ministry of Fisheries (Mfish), established in 1995 as a stand-alone agency, has statutory authority under the Fisheries Act for conservation and management of all marine and freshwater commercial and recreational fisheries including marine and freshwater aquaculture. The Ministry is not subsidized by the government and develops its operating budget based on fees and other administrative charges to resource users. The Ministry has responsibilities for:

- providing for the utilization of fisheries resources, while ensuring sustainability and contributing to the health of the wider aquatic environment;
- minimizing risks to the marine environment from unwanted organisms;

- developing frameworks and managing processes that ensure the Crown delivers to Maori on its Article 2 (Treaty of Waitangi) fisheries obligations; and
- ensuring the integrity of fisheries management systems  
(see <http://www.fish.govt.nz/>).

In cooperation with Mfish, the Ministry for the Environment and the Department of Conservation consult with fisheries stakeholders (including aquaculturists) to develop sustainability plans for managing New Zealand’s fisheries resources that incorporate environmental, cultural, economic and social factors.

Aquaculture, as a sub-sector of commercial fisheries, falls under the jurisdiction of the Ministry of Fisheries. The Ministry requires all farms to have a fishing permit for the removal or “harvest” of aquatic organisms from State waters. Regional and District Councils are responsible for application review and issuing leases and operating licenses for aquaculture facilities. Cultural, economic, and social and environmental factors, and the opportunity for public comment are considered in the granting of a marine farming lease or license. A fee structure (referred to as Aquaculture Levies and Transaction Charges) is applied to all holders of permits, leases or licenses to recover enforcement and research costs related to aquaculture.

As part of its mission for “developing frameworks and managing processes that will contribute to the efficient use of resources across the fisheries sector,” the Ministry of Fisheries, in 1998, authorized a review of the 1996 Fisheries Act. The resulting report *Fishing for the Future—Review of the Fisheries Act 1996*



examined the existing legislative framework for commercial fisheries management in New Zealand and recommended changes to improve the use of commercial fisheries resources (see Hartvelt 1998). With regard to the overall scope of the Fisheries Act, the review recommended:

- a fundamental realignment of the roles of Government and fisheries stakeholders and the implementation of transparent consultation and decision-making processes;
- a simplified and less prescriptive operating regime than exists under the Fisheries Act 1996; and
- devolving to fisheries rights holders the responsibility for fisheries management at the discretion of the Minister.

Among the review's conclusions and recommendations were several related to aquaculture. In part, the review concluded that legislation regulating aquaculture in New Zealand is fragmented and outdated. A number of issues face the aquaculture industry as a consequence. These include:

- a lack of certainty over rights and responsibilities of aquaculturists;
- aquaculture's relationship to wild fisheries; and
- overlapping regulatory regimes for the management of environmental effects.

To address these issues, the review recommended that aquaculture provisions should be included in the Fisheries Act to:

- 1) Appropriately define Aquaculture - by amending the Act to define aquaculture as any activity that occupies land or the aquatic

environment and/or uses structures for the purpose of exclusive possession and control of aquatic life.

- 2) Exempt Aquaculture from the Requirement to Have a Fishing Permit—by retaining provisions in the Act exempting aquaculture from the requirement to obtain a fishing permit.

- 3) Require an Authorization for Spat Collection—by amending the Act to require that spat collection have an authorization under the Act. This authorization could be in the form of a Fishing Permit and be regulated under the quota management system provisions of the 1996 Act.

- 4) Introduce a Marine Farming Section to the 1996 Act—by amending the Act to insert aquaculture provisions as a new Part to the Act. The suggested provisions specifically address such issues as marine farming occurring in a quota management area or fisheries management areas; the relationship of a marine farming authorization to coastal permits issued under the Resource Management Act (1991); restrictions for granting of new marine farming authorizations to current leaseholders; consideration of environmental, economic, social and cultural impacts of marine farming; public notification and comment to marine farming applications; arbitration procedures for contentious applications; terms of marine farming authorizations including modification, cancellation, duration, transferability, and environmental monitoring.

- 5) Limiting Overlap with the Resource Management Act 1991—provision should

made in the Marine Farming Section of the Amended Act to allow for equivalency of Resource Management Act 1991 provisions on the regulation of adverse effects of marine farming on the aquatic environment.

## ► Japan

The Japanese diet has six times more of its protein coming from seafood than the American diet. Hence, the Japanese have long had a very large and active fisheries industry. When wild capture fisheries began to decline in the 1970s, the Japanese naturally moved toward aquaculture to fill the gap. As a result, Japan now has a substantial set of aquaculture activities involving shellfish (especially scallops and “cupped” oysters), sea algae, salmon, yellowtail, bluefin tuna, amberjack, and others. Aquaculture provided 15% of Japan’s fish and seafood landings of 7.4 million metric tons in 1997. At the present time, most of the sea farming in Japan is devoted to the culturing of sea algae and shellfish of one type or another. With the exception of “sea ranching” of salmon, aquaculture activities in Japan at present are all conducted in sheltered coastal waters or inland seas.

While the enabling legislation for fisheries management including aquaculture (the Law of Fisheries) has been adopted at the national level, the brunt of the administration of the regulatory framework is conducted at the prefecture (state) or local level. Japanese coastal aquaculture, which is conducted in public waters, is legally protected by an “aquaculture right” (AR). The prefecture governor is formally responsible for the administration of fishing rights, including aquaculture rights, but this is delegated to the Division in charge of fisheries in the prefecture

government. Under Japanese federal law (the Law of Fisheries), only groups of fishermen, organized into fisheries cooperative associations (FCA, henceforth, cooperatives) can apply for an aquaculture right. However, because of the large investments typically involved, pearl farmers can apply for an aquaculture right on an individual basis.

Applications for an aquaculture right must include information on the species to be cultured, the type of facility to be constructed, sea area involved, seasonal nature of the activity, and other aspects of the proposed operation. The prefecture governor determines the precise area over which the right is to be granted and the conditions and limitations to be applied, after receiving advice from the Prefecture Fisheries Coordination Committee. This committee is responsible for overall planning with respect to fisheries and for establishing all fishing rights throughout the prefecture. Once granted, the aquaculture right is valid for five years and is renewable upon application to the prefecture.

The aquaculture right is divided into a number of lots each of which is assigned to a member of the responsible cooperative who wants to engage in aquaculture. The cooperative is required to create an AR management committee, which has the duty of developing rules on how to use the aquaculture right for the benefit of the participating fishermen. These rules apply to:

- fair allocation of lots
- the size of aquacultural facilities to be constructed
- the number of facilities to be allowed per unit area

- the stocking ratios, etc.

This approach to the regulation of aquaculture has the following advantages:

- The aquaculture right grants an exclusive use to a specific sea area for aquaculture so that fish farmers have the right to reject any person who may come into their aquaculture grounds with the potential for disturbing their activities.
- Fish farmers can maintain a harmonious order for the use of sea areas for aquaculture and it is unlikely there will be disputes among themselves.
- Maximum sustainable yield can be achieved if all of the participating fish farmers observe the rules established by the cooperative (Yamamoto 19—).

Two examples of aquaculture that have received considerable emphasis in Japan in the last several decades—“sea ranching” and scallop culture—are briefly discussed below.

### Sea Ranching

This is a resource enhancement system in which the target species are produced and nurtured at protected areas, then, when able to survive on their own, are released into the open sea and are finally, on their return, recaptured either by the general public or the group of fishermen who are involved in the earlier activities of fingerling or seed production and/or the nursing of the target species. Sea ranching in Japan currently involves chum salmon, “hokkai” shrimp, and red seabream. The national government invested more than 500 billion yen between 1976 and 1994 in activities promoting the development of sea ranching in various parts of Japan.

### Scallop Culture

In contrast to the situation in the United States where fishermen rely almost entirely on the wild harvest and the natural recruitment of spat (tiny scallops that settle on the seafloor after spawning) and on the wild harvest of mature animals, the Japanese scallop industry is entirely based on a directed effort to collect spat from the water and the growout of spat into marketable scallops using hanging nets, hanging lines, and on the bottom. In 1997, fishermen from Japan’s two most northern prefectures, Hokaido and Aomori, harvested 460 thousand metric tons (live weight) of scallops, meat weight of 88 thousand metric tons (or 195 million pounds). Careful scientific studies permit the aquaculturist to accurately predict when the spawning of scallops in particular bays is going to occur. Special mesh bags containing old pieces of gill net are hung on long lines with the topmost line 5-10 meters below the surface and lowest bags 10-15 meters off the bottom. When the spat reach a shell size of about 10 millimeters, they are transferred to larger mesh bags (called pearl nets because they are similar to those used in the pearl culture) to facilitate further growth. These nets (shaped into an enclosure) are hung two-three feet apart from a long line which is supported just below the water’s surface. Six to eight months later, when the juveniles reach a size of about 2-1/2 inches, the scallops are moved to the final growout phase, either by suspending them on long vertical lines using “ear” hanging (small holes drilled in the “ears” of each half of the scallop shell) or in “lantern nets” or in bottom cultured scallop beds. Subsequently, the mature scallops are harvested and processed. In 1997, 56 percent of the scallops were boiled, 27 percent were frozen, about 8 percent were dried, 6 percent

were canned, and only 3 percent were sold as fresh product (Rappaport 1999).

### **Issues Currently Facing Japanese Aquaculture**

1. More work is needed to develop hybrid species with higher growth rates (like the tilapia hybrid).
2. Too much of Japan's aquaculture industry depends upon fresh sardine as its food

source causing seawater pollution problems and disease of the fish being cultured. Red tides are also associated with uneaten feed. Mass production of pellet type feeds is urgently needed.

3. Coastal areas suitable for aquaculture are being exhausted. Hence, rather than extensive horizontal development, greater use will have to be made of the water column and seafloor and of areas further offshore.

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## **POLICY GUIDANCE FROM INTERNATIONAL ENTITIES**

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In addition to the experience of individual nations in the management of marine aquaculture, we can also, increasingly, look to international agencies to provide guidance on how aquaculture operations may be conducted in an environmentally sustainable fashion.

The UN Food and Agriculture Organization (FAO), addresses aquaculture as part of its mission relating to world food production. FAO has sought to apply principles of sustainable development to world fisheries, which include aquaculture. The result has been the issuance of a Code of Conduct for Responsible Fisheries, with companion guidelines that explicitly address application of the code of conduct to aquaculture development. In the United States, the National Marine Fisheries Service is now adapting FAO's Code of Conduct.

This section (drawn from Bunsick 1998) examines the guidelines provided by FAO, which incorporate guidance by the broader international environmental organizations as well as more detailed guidance from the International Council for the Exploration of the Seas (ICES). The chief guidance from the broader international environmental community

relates to the application of a precautionary approach to aquaculture. The ICES guidelines are mainly concerned with an international code of practice with respect to genetic resources.

### **► FAO Code of Conduct for Responsible Fisheries**

The Code of Conduct for Responsible Fisheries was adopted unanimously by FAO members (including the United States) on October 31, 1995. The Code is considered "soft law" in that countries voluntarily adopt it and there is no legal enforcement mechanism to require implementation. A key purpose of the Code is to provide overall guidance to individual countries as they develop their national legislation.

Article 9 of the Code of Conduct contains the major provisions for aquaculture (Figure 6.1). The Code focuses on areas of national jurisdiction, and includes specific guidance for three concerns: Transboundary ecosystems, genetic resources, and production-level considerations.

Figure 6.1. FAO Code of conduct contains the major provisions for aquaculture

## FAO Code of Conduct for Responsible Fisheries--Aquaculture Development (Art. 9)

### National Jurisdiction (Art. 9.1)

- Legal/administrative framework
- Development/management basis: advance evaluation, best scientific info available
- Strategies and plans
- Local community livelihood; access to fishing
- Procedures specific to aquaculture
  - Environmental assessment & monitoring
  - Minimize adverse ecological & related socio-economic changes

### Transboundary Ecosystems (Art. 9.2)

- Protect ecosystem
- Species, siting, management choices
- Consult on non-indigenous species
- Databases, information networks
- Monitoring mechanism

### Genetic Resources (Art. 9.3)

- Conserve genetic diversity
  - Minimize effect of escapes
- Int'l codes of practice (e.g. ICES)
- National codes to minimize risk of disease transfer, etc.
- Broodstock, eggs, fry, larvae
- Endangered species

### Production Level (Art. 9.4)

- Support rural communities, producers
- Participation
- Feeds, additives, fertilizers
- Therapeutics, hormones, antibiotics
- Regulate chemicals
- Waste disposal
- Food safety

**National jurisdiction.** Article 9.1 concerns the need for an overall legal and administrative framework for aquaculture, as well as a management approach based on advance evaluation using the best scientific information available and strategies/plans for industry development. Specific consideration needs to be given to local community livelihood and the need to maintain access to fishing grounds. Specific procedures are needed for environmental enforcement and monitoring and risk reduction (i.e., minimize adverse ecological and related socio-economic changes).

**Transboundary ecosystems.** Article 9.2 emphasizes the need to consider impacts of industry development on neighboring

jurisdictions. Natural ecosystems do not respect artificial political boundaries established by nations, and aquaculture facilities operating within one national jurisdiction could have impacts in other jurisdictions. Nations therefore need to include protection for such transboundary ecosystems in making decisions on which species to grow, where to locate an aquaculture production facility, and how to manage such facilities. Monitoring and data collection is especially important for operations in transboundary ecosystems; databases need to be maintained, and relevant information shared with neighboring countries. In particular, nations should consult with neighboring jurisdictions prior to authorizing non-indigenous species in transboundary ecosystems.

**Genetic resources.** Article 9.3 emphasizes the need to conserve genetic diversity by minimizing escape of cultured stock. The Code encourages states to voluntarily implement the Code of Practice on the Introduction and Transfer of Marine Organisms developed by the International Council for the Exploration of the Seas (ICES, discussed later in this chapter) and to establish national codes to minimize the risk of disease transfer, etc. Impacts on genetic resources need to be considered in provisions relating to all livestock (including broodstock, eggs, fry, and larvae), with particular attention to effects on endangered species.

**Production.** Article 9.4 considers social as well as practical aspects of aquaculture production. Aquaculture development should support rural communities and producers, and should involve public participation. Specific operational aspects must also consider impacts that may result from the everyday use of feeds, additives, and fertilizers and in the various therapeutics, hormones, and antibiotics administered to the stock to fight disease, promote growth, etc. Specific regulatory provisions are needed for the use of chemicals, disposal of waste, and food safety concerns (for example, requiring sufficient time for any drugs, etc. to leave the livestock prior to harvesting for sale on the market).

### ► **FAO Aquaculture Guidelines**

According to FAO's technical guidelines, aquaculture development and support planning should: 1) Encompass all relevant aspects of support and management of the industry; 2) consider existing plans and efforts aimed at food security, sustainable agriculture and rural development; and 3) be a collaborative effort among those concerned. For aquaculture to be

considered an appropriate and responsible use of land and water resources, approved locations must meet certain criteria (e.g., suitable for sustainable production and income generation; economically and socially appropriate; prevent or minimize conflict with other users; avoid undue externalities; respect nature reserves, protected areas, and critical or especially sensitive habitats). Relevant zoning or site regulations should conform with requirements of plans for regional development, river basin or coastal management, and their respective authorities. To achieve appropriate, sustainable development in the public interest, nations will need to build institutional capacity and strengthen linkages to agriculture, rural development, irrigation, engineering, and water development. Figure 6.2 presents the types of questions that need to be asked in evaluating compliance with FAO guidelines.

### ► **The Precautionary Approach**

FAO's Code of Conduct for Responsible Fisheries incorporates a precautionary approach based on Principle 15 of the Rio Declaration of the 1992 United Nations Conference on Environment and Development (UNCED, see Figure 1.2 in Chapter 1). The precautionary principle refers specifically to threats of serious or irreversible damage and provides a guiding principle for managing resources under scientific uncertainty. FAO's precautionary approach specifically addresses the conservation of species (both target and non-target) and their environment, while the UNCED definition refers more generally to environmental degradation.

FAO has provided guidance for applying the precautionary approach to species introductions. Overall, there is a need to consider future

**Figure 6.2. A Questionnaire based on the FAO Code of Conduct for Responsible Fisheries--Article 9****9.1 Areas under national jurisdiction**

- Has the best available scientific information been used?
- Are the effects on genetic diversity and ecosystem integrity evaluated in advance?
- Is there allowance for the rational use of resources shared with other activities?
- Are there negative impacts on livelihoods of local communities and their access to fishing grounds?
- Are there aquaculture-specific procedures for environmental assessment and monitoring?
- Are these procedures aimed at minimizing adverse ecological changes and related economic and social consequences?

**9.2 Trans-boundary aquatic ecosystems**

- Do existing aquaculture practices protect transboundary aquatic ecosystems?
- Does the management system ensure responsible choices of species, siting, and activities which could affect transboundary aquatic ecosystems?
- Is there a transboundary consultative process for introductions of nonindigenous species?
- Are there mechanisms to facilitate cooperation at the national, subregional, regional and global level (e.g., databases, information networks)?
- Is there a mechanism to facilitate cooperation in the monitoring of impacts?

**9.3 Use of aquatic genetic resources**

- Are there management measures that conserve genetic diversity and maintain integrity of aquatic communities and ecosystems?
- Are there efforts to minimize the harmful effects of introducing non-native species or genetically altered stocks? Is special attention given to transboundary ecosystems?
- Are steps to minimize adverse genetic, disease and other effects of escaped fish promoted?
- Is there a mechanism for cooperation toward elaboration, adoption and implementation of international codes of practice and procedures?
- Are risks of disease transfer and other adverse effects on wild and cultured stocks minimized in the genetic improvement of broodstocks, introduction of non-native species, and the production, sale, and transport of eggs, larvae or fry, broodstock or other live materials?
- Are procedures for selecting broodstock and producing eggs, larvae, and fry appropriate?
- Is research and development to protect, rehabilitate and enhance endangered species while conserving genetic diversity promoted?

**9.4 Production level**

- Do aquaculture practices support rural communities, producer organizations, and fish farmers?
- Is active participation of fish farmers and their communities promoted? Is community input incorporated?
- Are there efforts to promote improved selection and use of feeds, additives, and fertilizers?
- Do farm and fish health management practices favor hygienic measures and vaccines?
- Are therapeutants, hormones and drugs, antibiotics and other disease control chemicals used safely, effectively, and minimally?
- Is the use of chemicals hazardous to human health and the environment regulated?
- Is waste disposal (offal, sludge, dead or diseased fish, excess veterinary drugs, hazardous chemicals) hazardous to human health and the environment?
- Is food safety of aquaculture products ensured?
- Is maintenance of product quality promoted (through care before harvesting as well as during harvesting, on-site processing, storage, and transport)?

*\*These questions have been selected and modified from "Sustainable Aquaculture Certification: A Questionnaire Based on the FAO Code of Conduct for Responsible Fisheries" (Sproul).*

generations and to avoid changes that are not potentially reversible. Undesirable outcomes, as well as measures to avoid/correct anticipated problems, should be identified in advance. When problems occur, corrective measures should be initiated immediately and problems should be corrected within 2-3 decades. Where impacts are uncertain, priority should be given to conserving the productive capacity of the resource. Harvesting and processing capacity should be commensurate with sustainable levels of the resource. Fisheries management should be linked with general environmental management.

An important element in FAO's precautionary approach is the appropriate placement of the burden of proof (i.e., responsibility for providing relevant evidence). FAO's precautionary approach reverses the burden of proof by assuming 1) all fishing activities have environmental impacts and 2) it is not appropriate to assume that these are negligible until proved otherwise. However, the guidelines state that this does not imply that no fishing (and presumably no aquaculture) can take place until all impacts have been assessed and found negligible. It does require all activities be subject to prior review and authorization, with appropriate management plans and measures for assessing, monitoring, and addressing impacts. The standard of proof for decisions (i.e., the criteria used to judge evidence) should be commensurate with the potential risk to the resource, while also taking into account the expected benefits of the activities.

The key points in FAO's technical guidelines for implementing a precautionary approach are:

1. Changes in fisheries systems are only slowly reversible, difficult to control, not well understood, and subject to changing environment and human values.
2. Aquaculture species introductions should be treated as a purposeful introduction into the wild, based on the assumption that animals will usually escape (even from closed quarantine or hatchery facilities).
3. Escapes could produce irreversible, unpredictable impacts (e.g., changes in species distribution/abundance). Although these impacts usually cannot be eradicated, it may be possible to mitigate undesirable effects.
4. In implementing precautionary management, it is necessary to explicitly consider undesirable and potentially unacceptable outcomes and make contingency plans to avoid or mitigate these outcomes.
5. Nations should adapt ICES procedures to national law.

### ► ICES Code of Practice

The Code of Practice on the Introduction and Transfer of Marine Organisms developed by the International Council for the Exploration of the Seas (ICES) is cited by FAO as a model for individual nations to modify, adapt, and implement in addressing problems stemming from the difficulty of reversing an introduction and its adverse effects. The ICES Code provides a procedure for assessing the risks of intentional introductions on fisheries, including a requirement for research activities in advance of an introduction (as noted above, FAO guidelines treat all aquaculture introductions as intentional



based on the assumption that fish will escape from aquaculture enclosures). Pre-introduction research should include 1) a desk assessment of the biology and ecology of the intended introduction; 2) detailed analysis of potential environmental impacts (hazard assessment); and 3) examination of the species within its home range. A prospectus based on this research, including detailed analysis of potential impacts on the aquatic ecosystem (ecological, genetic, disease), should be submitted to ICES for approval. Procedures for introductions should include 1) brood stock quarantine; 2) limited introduction of first generation progeny to assess interactions with native species in open waters; 3) sterilization of all hatchery effluents; and 4) continuing study of the introduced species in its new environment.

ICES distinguishes between introduced or transferred species which are part of current commercial practice and the release of genetically modified organisms (GMOs), with the latter subject to more stringent precautionary measures. ICES encourages regulatory agencies in member countries to use the strongest possible measures to prevent unauthorized or unapproved introductions.

### ► Sustainable Development

Underlying FAO's guidelines on aquaculture development is the concept of sustainability. According to the Brundtland Commission, sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). Clearly, the precautionary approach is

consistent with this definition, since it implies the need to preclude development that has the potential to inflict irreversible harm (which obviously will affect future generations). The Brundtland Commission's definition has been adopted in the United States by the President's Council on Sustainable Development.

The definition of sustainable development adopted by FAO (FAO Council, 98th Session, 1988) focuses on its mission with respect to resource conservation and management: "The management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations." Because this definition focuses specifically on technological and institutional change, it has somewhat more direct applicability as a criterion for assessing policy options for an overall policy framework for the development of offshore marine aquaculture. Additional FAO guidance provides some possible ways to operationalize the sustainable development definition. Specifically, does the policy option being considered promote aquaculture development that:

- Conserves land, water, plant, and genetic resources?
- Is environmentally non-degrading?
- Is technologically appropriate?
- Is economically viable?
- Is socially acceptable?

## **LESSONS LEARNED RELEVANT TO THE POLICY AND REGULATORY FRAMEWORK FOR AQUACULTURE IN THE U. S. EEZ**

The experience from other nations discussed earlier in this chapter suggests some lessons for the United States as it develops the policy framework for aquaculture in federal waters and in the EEZ.

First, several general points. Fish farmers everywhere want to see less complex and better coordinated regulatory processes. This is especially true where a number of federal or state agencies all have regulatory authority. The establishment of an interagency committee consisting of all of the agencies with a regulatory role with a lead agency overseeing the process has been found to be useful in several countries (such as Australia and Japan).

Second, aquaculturists apparently typically feel that government policies and regulatory processes do not keep up with advancing technology and the changing needs of the industry, implying that some flexibility needs to be built into the regulatory process and that the government agencies involved need to have well trained and technically competent people on their staffs.

On a more detailed level, several observations can be made:

1. A two-step approach where a lease for a portion of the ocean (or seabed) is applied for and issued first, followed by application for a license to operate a specific aquaculture facility (in the leased area) seems to be a workable approach.
2. One of the major problems in all of the nations studied involve conflicts between

the siting of fish farms and other uses of coastal waters such as maritime traffic, capture fisheries, tourism, and the protection of natural areas. It appears to be important, then, to develop a set of siting criteria for aquaculture to minimize the chances of such conflicts emerging later. In several nations (such as in Chile, Norway), a formal process of determining “areas suitable for aquaculture” was undertaken early in the regulatory process.

3. The “capacity” of specific aquaculture sites (and net cages) in terms of number and density of fish to be safely allowed has also proved controversial. Criteria for determining capacity should be developed as a part of the formulation of the overall regulatory process (such as in Norway).

4. In areas having considerable promise for aquaculture, the development of aquaculture management plans in advance of a time when individual firms apply for leases and licenses has been found to be beneficial (such as in Australia).

5. In several national cases (such as Australia), the establishment of an interagency process, linking and synchronizing the actions of various government agencies involved in aquaculture management has played an important role in achieving a more efficient marine aquaculture siting and monitoring process.

With regard to the guidance for aquaculture development being provided by international organizations such as FAO and ICES, these rightly emphasize, in our view, a precautionary approach to aquaculture development; set forth the appropriate questions that must be asked of such development (e.g., does it conserve land, water, plant, and genetic resources? Is it

environmentally non-degrading? Is it technologically appropriate? Is it economically viable? Is it socially acceptable?); and puts the responsibility for providing evidence on potential impacts on the parties proposing the development and on the governmental agencies managing the development.

# Chapter 7



## PROPOSED POLICY FRAMEWORK FOR OFFSHORE MARINE AQUACULTURE

### INTRODUCTION

In this chapter, we propose a policy framework for managing offshore marine aquaculture, building on the analysis of issues identified in earlier reports and on actual experiences with offshore aquaculture practices in U.S. coastal states and in other nations. We first briefly review the major issues that need to be addressed and present a set of criteria for guiding the choice of a policy approach. We then present our own recommendations for a policy framework for managing offshore marine aquaculture building on past studies and experiences. We address marine aquaculture utilizing native/locally present species and hybrids. However, we do not address marine aquaculture involving the introduction of new species or utilizing genetically modified organisms (including transgenic species), as consideration of this issue was beyond the scope of our study.

With regard to federal agency responsibilities in a policy framework for offshore marine aquaculture, we concentrate on novel processes and additional agency responsibilities that we think will be necessary to establish a new system to manage the siting, leasing, operation, and monitoring of marine aquaculture operations in the EEZ. With regard to the variety of existing federal agency responsibilities concerning aquaculture promotion, research, and development, we do not address these explicitly in the recommended framework. It is our assumption that these responsibilities should remain in the various agencies with continued coordination by the Joint Subcommittee on Aquaculture through the leadership of the USDA.

## **SUMMARY OF ISSUES RAISED IN PAST STUDIES AND EXPERIENCES AND CRITERIA FOR EVALUATION**

Our review of past studies and reports related to offshore marine aquaculture, of federal authorities over marine aquaculture, and of previous and ongoing efforts to actually establish offshore marine aquaculture facilities in federal waters, has revealed a consistent set of three major common themes that work to hinder the development of this industry in the United States:

- the absence of a well-defined and efficient policy framework which fulfills public trust responsibilities in public waters while offering a predictable review, permitting, leasing, and monitoring process to the marine aquaculture industry
- concern with environmental impacts, the absence of a well-defined system of environmental review of offshore aquaculture projects, and the need to adopt strategies for avoiding and mitigating such impacts
- the importance of granting exclusive rights to particular ocean areas for marine aquaculture operations, while addressing impacts on other ocean users and other public trust responsibilities

More specifically, our review of past work in this area, of federal statutory authorities, and of past efforts to create aquaculture facilities underscores several points. First, few federal statutory authorities address aquaculture directly and none address the specific issues associated with offshore marine aquaculture. With few exceptions, federal agency statutory authority over offshore marine aquaculture is based on

agency interpretation of statutory authority over particular aspects of an aquaculture operation (Chapter 4). This results in the industry having to meet many different requirements from federal (and state) agencies in a process that is not clearly intelligible and is often subject to legal challenge (Chapter 3). Without a lead agency for offshore marine aquaculture, too, conflicts between regulatory agencies frequently occur (Chapter 3). Environmental review requirements for offshore aquaculture are ad hoc and often insufficient, frequently incurring legal challenge (Chapter 3, Chapter 2). There is no established process for assessing the impacts of offshore aquaculture on other ocean uses, and no established mechanisms for obtaining public input on offshore aquaculture development proposals (Chapter 2, Chapter 3). There is no established system of offshore aquaculture leasing to give the aquaculture operator security of tenure and an exclusive right of operation, including also obligations for compensation to the public for the use of public waters (Chapter 2). There are no established Aquaculture Best Management Practices which can serve as guidance to operators and government agencies alike (Chapter 2).

Our review of relevant experiences in the U.S. coastal states (Chapter 5) reveals a number of lessons applicable to offshore aquaculture in the EEZ. First, most of the U.S. coastal states active in aquaculture have designated lead agencies for this purpose. Most of the U.S. states have some type of marine aquaculture leases (involving some form of payment, e.g., fees, bonds), and most require public hearings and environmental review for aquaculture applications. In a number of U.S. coastal states

(e.g., Florida, Maine, Mississippi, Alaska), the permitting process for aquaculture development has been streamlined into a single multi-agency permit which includes certification by the state's coastal zone management program. In a number of states (e.g., Maine, Florida), an inter-agency committee for aquaculture management has been formally designated. A number of states, such as Florida, have created Best Management Practices for Aquaculture, which include compliance with clean water standards as well as regulations for the culture of non-native species. Several states (e.g., New Hampshire, Maine, Mississippi, Hawaii) have created very detailed procedures for environmental assessment and monitoring, including, for example, in New Hampshire, criteria for “unacceptable risk” and for reporting of “unusual events.” Ten coastal states have addressed aquaculture in their coastal zone management plans.

Our review of the policy frameworks present in other nations active in offshore aquaculture, and of the policy guidance offered by international organizations such as the FAO (Chapter 6), also suggests a number of lessons and echoes many of the themes evoked by practice in the U.S. coastal states. One of the themes emphasized in other nations is, as in Hawaii, the importance of a formal planning process for the designation of areas suitable (or not suitable) for aquaculture development (for example, in Norway and Chile) and the use of strict siting selection criteria, including spacing requirements between farms. In a number of the foreign nation cases (e.g., Australia, Japan), streamlined inter-agency processes have been created and a lead agency has been named, and aquaculture development plans have been prepared. In addition, the international experience stresses the precautionary approach, for example, in the FAO guidelines, and in requirements in effect in Norway—where it is the responsibility of the fish farmer to demonstrate that a farm will not cause

unacceptable pollution effects, and where criteria for determining capacity, in terms of number and density of fish to be safely allowed, have been developed.

In our proposed policy framework, which we present in the next section, we seek to combine various features of approaches suggested in past studies and of lessons learned from the experiences of the coastal states and of other nations. We first present a statement of the criteria guiding our recommended policy framework.

### ► Criteria Guiding Recommended Policy Framework

In our view, the orientation of the policy framework for offshore marine aquaculture should be neither unduly promotional nor arbitrarily restrictive. While recognizing that the development of aquaculture has been declared to be in the national interest (see the National Aquaculture Act of 1980), the framework seeks to ensure that marine aquaculture activities that occur in the U.S. Exclusive Economic Zone take place in an environmentally safe and sensitive manner with due respect for the legitimate interests and activities of others. Also, in view of the fact that little meaningful information on the possible impacts of offshore aquaculture is yet available, the framework must be adaptive in nature, evolving over time as additional data and information are obtained.

Our development of the framework is guided by the following criteria:

1. Encourages responsible open ocean aquaculture in the US EEZ.
2. Promotes a decision-making process that is efficient, coordinated, and predictable.

3. Employs a precautionary approach to avoid and minimize environmental impacts and promote integration into the ecosystem.
4. Applies separate criteria to native and non-native species.
5. Is consistent with existing U.S. laws and agency responsibilities.
6. Is equitable and fair to offshore aquaculture and to other U.S. users of the EEZ.
7. Is consistent, to the maximum extent possible, with the coastal, water, environmental, and aquaculture policies of adjacent coastal states.
8. Is consistent with U.S. obligations under international agreements.
9. Will fit within the context of an overall framework for sustainable development of the U.S. EEZ.
10. Produces a fair return to the public for the use of federal ocean space.
11. Is conducted in a transparent manner with opportunities for public involvement.
12. Is adaptive and promotes opportunities for innovation, data collection, and learning.

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## PROPOSED POLICY FRAMEWORK

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The draft policy framework for the development of an economically sustainable and environmentally sound aquaculture industry in the U.S. EEZ is first discussed in outline terms and then more specifically according to the various stages involved in locating and operating a marine aquaculture facility in federal waters (for definitions of “economically sustainable” and “environmentally sound,” please see Chapter 1, Figure 1.1).

### ► Outline of Major Features of the Proposed Policy Framework

The proposed policy framework should incorporate the following major features:

- Offshore aquaculture regulations should be streamlined and harmonized and a single multi-agency permit for aquaculture in the

EEZ should be established. In conjunction with the streamlining of regulations, the respective roles of federal and state agencies should be reconciled and clarified.

- Appropriate planning to identify suitable (and not suitable) areas for offshore aquaculture, avoiding projects that damage environmentally sensitive areas and avoiding undue interference with other users (navigation, national defense, fishing, recreation, etc.) should take place before areas are offered for aquaculture leasing.
- A leasing system which, on the basis of a preliminary plan provided by the aquaculture firm, gives the firm exclusive right (of limited time duration) for exploration and further development of an

operational plan should be established. Lease provisions should be consistent with public trust responsibilities and preference shall be given to firms which demonstrate an approach that prevents and reduces the production of pollutants and limits escapes. There should be an expectation that private users of public waters provide some compensation to the public in return for the exclusive right.

- A thorough environmental review process to assess the potential environmental impacts of the project and appropriate mitigation measures should be put in place.
- The leasing, permitting, and environmental review processes should be conducted in an open and transparent manner with opportunities for participation by the public and by affected interests.
- A monitoring process, which may involve conditions on operations such as insurance, bonds, or environmental monitoring requirements, should be put in place to insure the safety of operations, and, in the case of termination of operations, the removal of structures and the return of the area to its previous state.
- A lead federal agency for overseeing the management of offshore aquaculture in the EEZ should be named.

Our more detailed discussion of the proposed framework is organized according to the various stages involved in locating and operating a marine aquaculture facility in offshore waters:

- 1) Planning (including site selection, scope, and compatibility with other uses)

- 2) Permitting/leasing (including environmental review, conflict resolution, determination of permit/lease conditions)

- 3) Operation and monitoring of facilities and enforcement of permit/lease conditions

- 4) Termination of operations (including site restoration, liability).

## ► Planning

This is no doubt the least developed aspect of the offshore marine aquaculture management process—in practice, little has been done to determine which areas offshore are best suited for marine aquaculture development, are environmentally appropriate and are least likely to interfere with endangered species and marine mammals, and with other uses of offshore waters.

This is not the fault of the aquaculture industry nor of the agencies regulating offshore aquaculture, but it is due, instead, to the lack of an overall plan for the management, development, and conservation of the U.S. EEZ. This gap has been discussed in a number of books and reports (e.g., NRC 1997, Cicin-Sain and Knecht 2000), and there is growing consensus that such an effort should be undertaken, in the near future, as a joint federal-state activity. As part of this effort, it is likely that a set of ecologically-based marine regions will first be delimited and, using geographic information system tools, ocean features, processes and conditions, ocean resources, and ocean uses will be mapped. This process should reveal what areas are best suited for marine aquaculture, in terms of the requirements of the marine aquaculture activity itself, and in terms of avoidance of environmental risks and of conflicts with other uses.



The imperative of planning for appropriate marine aquaculture siting has been emphasized repeatedly both in actual practice and in the literature, since examples abound around the world of aquaculture operations failing and incurring significant environmental impacts because of improper siting (which in most cases is due to the absence of appropriate governmental guidance). As Hawaii's aquaculture manager, John Corbin, notes: "Proper siting is the sine qua non of aquaculture operations; that is why in Hawaii we have, through planning efforts, identified and mapped appropriate land sites for firms to consider and use and now we are applying the same approach to offshore aquaculture" (Corbin 2000). A similar approach is proposed by the Conservation Law Foundation which advocates the development of a zoning plan for the U.S. EEZ that will identify areas that need to be protected, areas for heavy industrial use, and areas for recreation (CLF 2000).

We recommend that the Congress develop legislation to provide an overall plan for the mapping, management, development, and conservation of the U.S. Exclusive Economic Zone that will address the needs we have identified above. In the interim, some steps toward systematic analysis of EEZ resources and uses can be taken through executive action and provide assistance, on a timely basis, in identifying areas particularly suited for offshore marine aquaculture and areas not suited for such operations.

Capacity for undertaking this type of activity (but not the explicit mandate to do so) is currently present at NOAA and at the U.S. Department of Interior. Three NOAA offices have special expertise in this regard: The National Ocean Service's Special Projects Office (which has done considerable work on

ecosystem-based mapping and planning); the Coastal Services Center in Charleston which has begun the process of mapping, using Geographic Information Systems, ocean processes, resources, and uses using the Southeast region as a model; and the Office of Ocean and Coastal Resource Management (which administers the coastal zone management program) which can serve as an effective bridge to state-based work. At the Department of Interior, three agencies are particularly relevant: the U.S. Geological Survey which has the mandate to assess the public lands resources of the United States; the Minerals Management Service with authority over offshore mineral resources and with much experience in the study of ocean resources and processes in the U.S. EEZ; and the U.S. Biological Survey with its mission to assess the nation's biological resources. For this work to occur, of course, these agencies would need to be given an explicit mandate—either through administrative action or through new congressional action on aquaculture. It is important that this planning process take place on a timely basis; otherwise, the development of the industry will be significantly hindered.

While these planning efforts are underway, proposals for offshore aquaculture operations will need to continue to be considered on the basis of the available information. The planning process could begin by identifying a limited number of areas, with expansion into additional areas occurring only after development has been demonstrated to be able to meet strict environmental and social criteria. It could also include the designation of zones for aquaculture--for example, for raising a particular species, employing a particular technology, or a pilot program designating specific areas of the ocean as aquaculture parks.

The process of planning we have sketched above would result in the timely identification of areas particularly suited for offshore aquaculture and those which are not, and would lead to the

next step—leasing/permitting. The planning process itself may include pre-permitting of sites based on the preparation of a Master Environmental Assessment (EA) or Master Environmental Impact Statement (EIS) and a first approximation of the carrying capacity (i.e., roughly how many farms may be supported in a particular area).

#### *Recommendation on Planning*

- *Develop legislation to provide an overall plan for the mapping, management, development, and conservation of the U.S. Exclusive Economic Zone.*
- *In the interim, through executive action, provide an explicit mandate to NOAA and DOI to develop assessments of EEZ areas suitable for various uses (including aquaculture) through mapping and analysis.*

## ► Permitting/Leasing

One of the most important findings that clearly emerges from past studies of the obstacles facing marine aquaculture development is the difficulty the industry encounters in obtaining permits from multiple federal and state agencies. To get a sense for this problem, one need only peruse the list of state and federal agencies from which the industry must obtain permits found in the aquaculture legal project conducted by the Mississippi-Alabama Sea Grant Legal Program (found on the web at <http://www.olemiss.edu/orgs/masglp/offshore.htm>). Similarly, the reader should recall the estimate of how long it took industry to obtain permits in the SeaStead experimental sea scallop project offshore Massachusetts (3 years). This is a central

problem that must be addressed in a new management scheme for offshore aquaculture.

The development of offshore oil projects off California (governed by the federal Minerals Management Service) in the 1980s also faced a similar set of problems, especially the conduct of separate environmental review processes for large offshore projects by the federal government and subsequently by the state/local governments. This issue was addressed by combining the separate environmental review processes into a “joint review process” which worked very well in achieving interagency coordination, a streamlined decision-making process, budget savings, and more predictability for industry.

Such a joint review process has been developed, in some states, for aquaculture in state waters offshore combining the permit requirements of the Army Corps of Engineers under Section 10 of the Rivers and Harbors Act, the EPA under section 402 of the Clean Water Act (NPDES permit), the state discharge and water quality classification standards, the state’s aquaculture laws, and the state’s coastal zone management laws, and involving a single permit application and information requirements. The standard permit restrictions and conditions of all reviewing agencies are combined into one joint application, employing a common baseline survey and a uniform environmental monitoring program.

Building on these experiences, we propose a permitting and leasing process for offshore marine aquaculture involving the following components:

- joint federal/state permitting coordinated by the U.S. Army Corps of Engineers
- environmental review of impacts on the natural and human environments and

adoption of measures to avoid and mitigate such impacts

- the awarding of two types of leases to industry applicants:
  - short-term provisional leases to allow applicants to develop the project concept and test its feasibility
  - longer-term leases, after permits have been granted, to operate in an ocean area with exclusivity rights for a defined period of time
- the creation of a new NOAA Office of Offshore Aquaculture to oversee the leasing and monitoring of offshore aquaculture operations, coordinate these activities with the permitting process, and serve as a facilitator for the development of offshore marine aquaculture.

### Joint permitting

We propose a system of joint federal/state permitting for offshore aquaculture facilities that would involve the major federal and state agencies with a role in regulating aquaculture operations and/or related roles (noted below). While each agency would award a permit on the basis of its own statutory requirements, the joint review process would insure that the following permits are co-terminus and involve a single application and review process.

- the Army Corps of Engineers (section 10 of the Rivers and Harbors Act)
- the EPA under section 402 of the Clean Water Act (NPDES permits)
- NOAA using several authorities:
  - review by the regional fishery management councils for impacts on commercial and recreational fisheries,

and on essential fish habitat

- review, together with the U.S. Fish and Wildlife Service, of impacts on marine mammals and endangered species
- review of consistency of proposed aquaculture operations with state coastal zone management plans (by OCRM after state federal consistency determinations)
- the state(s) coastal management agency for federal consistency with the state's federally approved coastal zone management plan
- the state(s) aquaculture agency
- the state(s) water quality agency (state certifications under section 401 of the Clean Water Act)

Given that the authority of the U.S. Army Corps of Engineers over navigation in U.S. waters under Section 10 of the Rivers and Harbors Act is of key importance in determining whether structures can be established in navigable waters of the United States, we recommend that the U.S. Army Corps be the coordinating agency to oversee the joint permitting process, in consultation with a new NOAA Office of Offshore Aquaculture (discussed later) which would oversee the leasing process as well as the operation, monitoring, and abandonment of offshore aquaculture facilities.

In terms of implementation of this approach, it would be preferable, in our view, to establish such a joint permitting process through new federal legislation on offshore marine aquaculture. In the interim, however, such an approach could be started by executive action, through a memorandum of understanding among the agencies concerned.

*Recommendation on Permitting:*

- *A joint federal/state permitting process for offshore marine aquaculture should be established under the coordination and leadership of the U.S. Army Corps of Engineers in consultation with the (new) NOAA Office of Offshore Aquaculture, first through executive action using an inter-agency memorandum of understanding, and ultimately in new congressional legislation on offshore marine aquaculture.*
- *The joint federal/state permitting process shall involve the use of one comprehensive application form and procedure to meet the application requirements of all agencies involved, that would involve the submission of a proposed operational plan.*

**Environmental reviews**

The joint review process should establish a process for evaluating environmental impacts that takes into account the level of risk associated with a particular project. Small or low impact projects would have a simpler, more rapid review process than larger projects with potentially greater impacts. Such a review should include compliance with the National Environmental Policy Act, and call for the preparation of environmental assessments or environmental impact statements. In addition, criteria must be established for making permitting decisions that address impacts on the natural environment and the human environment (i.e., impacts on other ocean users) based upon the precautionary approach. Such decisions should take into account factors/considerations such as those noted below.

***Factors related to the natural environment:***

- impacts of chemical and biological pollutants and nutrient wastes on the benthic environment, water column, and the organisms that inhabit them
- effects of introduction of non-native species to natural ecosystems (this may include a risk assessment)
- interactions with marine mammals, endangered species, and birds
- impacts on essential fish habitat (EFH)
- the prevention of harmful genetic interaction with wild stocks, through careful siting, use of non-reproductive stocks, minimization of escapes, prompt recapture of escaped fish, etc.
- the siting of offshore finfish aquaculture operations in areas with strong currents or tides that flush wastes
- the use (when feasible and appropriate) of feeds that minimize the degradation of the environment, such as those with low fishmeal content which lessen aquaculture's pressure on wild fisheries, and with high nutritional value and other characteristics that help minimize feed wastes
- the desirability (when feasible and appropriate) of raising different species together (such as finfish with mollusks) in order to make optimum use of water and nutrients and to minimize wastes
- minimization of the use of aquaculture drugs by stocking fish free of pathogens and parasites, minimization of stresses on

fish, and vaccination of fish against disease

***Factors related to the human environment:***

Assessment of the effects of the aquaculture operations on other major uses of the marine environment, e.g.,

- commercial fishing
- recreational fishing
- marine transportation
- water-based recreation, including ecotourism
- marine sanctuary areas
- offshore oil development
- offshore sand and minerals exploitation
- scientific uses
- military uses
- submarine cables and pipelines
- artificial reefs
- underwater cultural resources and historic sites
- marine biotechnology activities

***Public participation in the environmental review process***

Adherence to the requirements of the National Environmental Policy Act will ensure appropriate opportunities for public review and comment.

***Recommendation on Environmental Review and Public Participation:***

- *Review of offshore marine aquaculture projects should employ the precautionary approach, adhere to the environmental review requirements of the National Environmental Policy Act, and consider mitigation measures to address adverse impacts on other ocean uses.*
- *A set of special standards related to the impact of offshore aquaculture operations on the natural and human environments should be taken into account in the environmental review process.*
- *In general, an environmental assessment should be performed as part of the leasing process, and Environmental Impact Statements should be prepared for individual projects. The extent of the review process should reflect the risks associated with the project under consideration.*
- *The leasing, permitting, and environmental review processes should be conducted in an open and transparent manner with opportunities for participation by the public and by affected interests.*

**Leases**

The process of awarding leases to particular aquaculture companies should be guided by a set of principles, such as the following (suggested in Eichenberg and Vestal 1992):

- Leasing laws should integrate broad public trust criteria

- Submerged lands leasing programs should include criteria to establish priorities among aquaculture applicants competing for the same site (e.g., highest and best use, or most sustainable use incorporating economic, environmental, and social concerns, etc.)
- Aquaculture leasing laws should include provisions granting lessees not only specified rights to occupy the site, but should also grant exclusive rights to the cultured organisms
- Leasing laws should contain provisions prohibiting leasing of certain lands which should remain in the public domain

An offshore leasing program should also include consideration of the following elements (DeVoe 2000b):

1. *Scope* - bottom, water column and/or surface leases
2. *Size and duration* - The lease term should provide the culturist time to start and establish the operations and at the same time provide the regulatory agencies with enough flexibility to reassign or terminate leases for just cause.
  - A lease term of ten years, renewable every five years, would, in our view, provide an appropriate balance.
  - The size of each lease should be negotiated based upon the amount of acreage available and the capabilities of the culturist. Consideration, however, needs to be given to the cumulative impacts of offshore aquaculture facilities and spacing guidance needs to be developed.

- Two types of leases can also be considered: a short term experimental (or interim) lease (for 2-3 year period for a small area) to encourage the development and testing of new gear or techniques and/or to develop further the facility's operational plan, and the longer-term (about 10 year lease) for an applicant with a more developed operational plan.

3. *Exclusivity* - Public lands leasing programs should include requirements for the agency to assess the extent to which the applicant needs exclusive use of the site, and to the maximum extent possible, should reserve to the public the right to use the leased lands for all public trust purposes that will not unreasonably interfere with the culture operation.

4. *Costs* - Costs associated with the lease (e.g., fees, bonds, royalties, etc.) should be established at the outset and remain stable through the lifetime of the lease.

*Recommendation on Leasing:*

- *Leases (short-term or long-term) giving the aquaculturist exclusive rights to occupy the site and exclusive rights to the cultured organisms should be developed. Such leases should be guided by a set of principles relevant to public trust responsibilities and should specify the scope, size, duration, and other terms of the lease.*
- *The degree of exclusivity will be negotiable, and some form of compensation to the public for the exclusive rights granted will be expected.*

- *Rents collected should be used to establish a special fund to support offshore aquaculture management and to provide revenue-sharing to states for potential impact mitigation.*

### **Administration and Oversight of the Leasing Process**

There should be one agency and office which is charged with oversight and implementation of the leasing arrangements, and of subsequent monitoring and eventual abandonment of aquaculture facilities. We suggest that a new office be created for this purpose and be located at NOAA, the agency which already has significant responsibilities over the offshore marine environment. We suggest that consideration be given that this office, the NOAA Office of Offshore Aquaculture, be located organizationally near the NOAA Administrator's office to facilitate inter-agency interaction with the requisite federal and state agencies, and to facilitate interaction among all the relevant internal NOAA offices (National Marine Fisheries Service, National Ocean Service, and Sea Grant).

#### *Recommendation on Administering Agency:*

- *The creation of a new NOAA Office of Offshore Aquaculture (OOA) is recommended to facilitate the development of offshore marine aquaculture. Its primary mission will be to oversee and implement the leasing, environmental review, and subsequent monitoring of offshore aquaculture, including the eventual abandonment of offshore aquaculture facilities (the permitting process is an inter-agency process led by the Army Corps of Engineers).*

### **Sequence of permitting and leasing processes**

Different U.S. coastal states and national governments conduct the permitting/leasing process in different ways, e.g., some provide a lease up front, and then, after environmental review and consideration of impacts on other users, provide a permit; some provide a lease and permit simultaneously after conducting the environmental review; others determine areas suitable for aquaculture initially, then provide a lease to companies meeting certain criteria—the companies develop a detailed plan for development, an environmental review is conducted, and then a permit is awarded.

In our proposed approach, we stress the importance of first determining suitable areas for aquaculture; offering these areas for leasing (either longer term—such as 10 years, or short-term such as for two years) making an initial determination of environmental effects and effects on other users (i.e., a program-level environmental assessment); followed by a coordinated interagency permitting and environmental review process (i.e., a project-level environmental impact statement); and the subsequent awarding (or not awarding) of an operating permit. The permit/lease may include several sites, so that the farm may use one site for a few years, then move cages to another site to allow the earlier site to recover.

### **► Operation and Monitoring of Facilities**

Several U.S. coastal states have detailed programs in place for monitoring aquaculture operations. For example, Maine has an aquaculture monitoring program for establishing and maintaining a comprehensive information base pertaining to all aspects of the siting, development, and operation of aquaculture

facilities. The following types of information are collected for each site:

- Geophysical site characteristics, including currents and bathymetry
- Benthic habitat characteristics and effects, including changes in community structure and function
- Water column effects, including water chemistry and plankton
- Feeding and production data sufficient to estimate effluent loading
- Smolt and broodstock introduction and transfer data
- Disease incidence and use of chemical therapeutics
- Other ancillary information, as deemed necessary.

*Recommendation on Operations and Monitoring:*

- *Monitoring should be done by the aquaculture business, with periodic verification by the new NOAA Office of Offshore Aquaculture.*
- *In addition to establishing a monitoring program, procedures should also be developed for ensuring and reporting enforcement of permit/lease conditions, including legal penalties for non-compliance. This may include permit bond.*

## ► Abandonment of Facilities

Management of this phase of the offshore development process can draw lessons from the experience of the Minerals Management Service in administering its responsibilities under the Outer Continental Shelf Lands Act.

*Recommendation on Abandonment:*

- *All projects will be required to post a performance bond prior to placing structures or equipment in public waters as a form of insurance that such structures and equipment will be properly removed from the site upon the termination of the marine aquaculture operation and the site returned to a state substantially similar to what it was before the operations began.*

With regard to offshore oil production platforms, MMS regulations provide that all structures shall be removed from a lease within one year after lease termination. Lessees are obligated to verify site clearance for an area wider than the facility (for platforms, it is a 1,320-foot radius circle centered on the platform). For structures located in water depths of greater than 300 feet, the requirement for site clearance verification is a sonar search of the location; for waters depths of less than 300 feet, 100% of the area must be trawled in two directions, bringing up and disposing of all objects caught in the trawl (Waldemar 1998). The important aspect here is to establish requirements for aquaculture operators to remove all facilities and return the leased area to its original state.



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## CONCLUSION

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The draft policy framework discussed above is offered for the consideration of interested parties in the Administration, Congress, industry, environmental, and academic community for discussion and deliberation. No doubt parts of the proposed framework will need to be revised and changed, other parts fleshed out, other parts dropped entirely. There may be alternative ways of accomplishing the goals and directions we have suggested. We do think,

however, that the broad directions we have put forth on the basis of our review of the issues present in this area, of past work, and of the experiences of coastal states and other nations, are the appropriate directions toward which we should move in order to develop an economically sustainable and environmentally sound offshore marine aquaculture industry in the United States.

# Bibliography

- Ackefors, H. and A. Sodergren. 1985. Swedish experiences of the impact of aquaculture on the environment. *Int. Coun. Explor. Sea. C.M.* 1985/E: 40, 7p.
- Allan, G. 1999. Aquaculture in Australia: now and in the future. *World Aquaculture*, 30 (1) pp 39-44, 46-47, 51-54.
- Aquaculture Magazine*. 1999. "Open Ocean Aquaculture at the University of New Hampshire," November/December 1999, p. 87.
- \_\_\_\_\_. 2000. "A New Offshore Aquaculture Project for the Gulf of Mexico," 26 (1): 10-11.
- Archer, Jack H. 1994. The public trust doctrine and the management of America's coasts. Amherst: University of Massachusetts Press.
- Barnaby, Rollie. 2000. "Connecting Open Ocean Aquaculture and Commercial Fishermen," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.
- Barr, Bradley W. 1997. "Mariculture in Offshore Critical Habitat Areas: A Case Study of Stellwagen Bank National Marine Sanctuary." *Ocean and Coastal Law Journal* 2 (1997): 273-287.
- Becker, Geoffrey S. and Eugene H. Buck. 1997. *Aquaculture and the Federal Role* (CRS Report for Congress), Congressional Research Service, April 9, 1997.
- Bettencourt, Sofia U. and James L. Anderson. 1990. *Pen-Reared Salmonid Industry in the Northeastern United States*. Northeastern Regional Aquaculture Center Publication No. 100, November 1990.
- Brennan, William J. 1995. *Background Information and Recommendations for New England Fishery Management Council Development of an Aquaculture Policy and Management Strategy*, report submitted to New England Fishery Management Council, September 30, 1995.
- \_\_\_\_\_. 1997. "To Be or Not to Be Involved: Aquaculture Management Options for the New England Fishery Management Council." *Ocean and Coastal Law Journal* 2 (1997): 261-271.
- \_\_\_\_\_. 1999. *Aquaculture in the Gulf of Maine: A Compendium of Federal, Provincial and State Regulatory Controls, Policies and Issues*, report prepared for the Gulf of Maine Council on the Marine Environment, Aquaculture Committee, June 1, 1999.
- Bridger, Chris. 2000. Personal communication.
- British Columbia Environmental Assessment Office. 1997. *The Salmon Aquaculture Review Final Report*. (<http://www.eao.gov.bc.ca/project/AQUACULT/SALMON/report/toc.htm>)
- British Columbia Environmental Assessment Office. 1997. The Salmon Aquaculture Review Final Report, Volume IV - Part C, VII. Chile. Online publication: <[http://www.eao.gov.bc.ca/PROJECT/AQUACULT/SALMON/report/v4c\\_vii.htm](http://www.eao.gov.bc.ca/PROJECT/AQUACULT/SALMON/report/v4c_vii.htm)>.
- \_\_\_\_\_. 1998a. The Salmon Aquaculture Review Final Report, Volume IV - Part C, II. Norway. Online Publication: <[http://www.eao.gov.bc.ca/PROJECT/AQUACULT/SALMON/report/v4c\\_ii.htm](http://www.eao.gov.bc.ca/PROJECT/AQUACULT/SALMON/report/v4c_ii.htm)>.
- \_\_\_\_\_. 1998b. The Salmon Aquaculture Review Final Report, Volume IV - Part C, III. Scotland. Online Publication: <[http://www.eao.gov.bc.ca/project/aquacult/salmon/report/v4c\\_iii.htm](http://www.eao.gov.bc.ca/project/aquacult/salmon/report/v4c_iii.htm)>.
- Broussard, Meryl. 2000. Personal communication.
- Bunsick, Susan M. 1998. "Preferred National Policy on Marine Aquaculture," University of Delaware, Graduate College of Marine Studies, December 9, 1998.
- \_\_\_\_\_. 1999. "A Precautionary Approach to Offshore Marine Aquaculture in the United States," University of Delaware, Graduate College of Marine Studies, December 10, 1999.

Burrowes, Todd R. 1988. How Are You Going to Get Them Down to the Farm? Legal Obstacles to Salmon Farming in Maine. *Territorial Sea*. Vol. VIII, Number 3/4, Fall/Winter 1988.

CCG Consulting Group Limited and PricewaterhouseCoopers. 2000. The Financial and Economic Impacts of Federal on the Aquaculture Industry of Canada's East and West Coasts. A Phase II Report of the Federal Aquaculture Regulatory Review. Prepared for Canadian Aquaculture Industry Alliance – Ottawa. 75 pages. Report Online at: <[http://www.aquaculture.ca/CAIA\\_Bit2a.html](http://www.aquaculture.ca/CAIA_Bit2a.html)>. Also see <[http://www.aquaculture.ca/CAIA\\_Bit3.html](http://www.aquaculture.ca/CAIA_Bit3.html)>, <[http://www.aquaculture.ca/CAIA\\_Bit2b.html](http://www.aquaculture.ca/CAIA_Bit2b.html)> and <[http://www.aquaculture.ca/CAIA\\_Bit2c.html](http://www.aquaculture.ca/CAIA_Bit2c.html)>.

Canadian Aquaculture Industry Alliance (CAIA). 2000a. Canadian Aquaculture Industry Profile. CAIA web site: <[http://www.aquaculture.ca/CAIA\\_IndustryProfile.html](http://www.aquaculture.ca/CAIA_IndustryProfile.html)>.

Chamberlain, G. and H. Rosenthal. 1995. Aquaculture in the next century: Opportunities for growth—challenges of sustainability. *World Aquaculture* 26(1)21-25.

Chambers, Michael, Charles E. Helsley, Anthony C. Ostrowski. 2000. "Offshore Culture of the Pacific Threadfin *Polydactylus sexfilis* in Hawaii," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.

Chilean Trade Commission. 2000. Chile Seafood.. ProChile Web site: <<http://www.chileinfo.com/seafood/>>.

Cicin-Sain, B. and R. W. Knecht. 1998. *Integrated Coastal and Ocean Management: Concepts and Practices* (Washington, D.C.:Island Press).

\_\_\_\_\_. 2000. *The Future of U.S. Ocean Policy: Choices for the Next Century* (Washington, D.C.: Island Press).

Cicin-Sain, B., R.W. Knecht, L.D. Bouman, G.W. Fisk. 1995. "Emerging Policy Issues in the Development of Marine Biotechnology." In *Ocean Yearbook*, 1995.

Commission of the European Communities, Directorate-General for Fisheries. 1992. The Interactions of Aquaculture and the Environment: A Bibliographical Review. November 1992.

Conley, Dave. 1999. Commissioner for Aquaculture Development to Carry Out Legislative Review of Aquaculture. Online Press Release, June 17, 1999. Office of the Commissioner for Aquaculture Development. Department of Fisheries and Oceans Canada. Ottawa. Web site <[http://www.dfo-mpo.gc.ca/cad-cda/1999/cad1\\_e.htm](http://www.dfo-mpo.gc.ca/cad-cda/1999/cad1_e.htm)>.

*Conservation Law Foundation v U.S. Army Corps of Engineers*. 1991. US District Court for the District of Massachusetts, #91-10488WD, filed 2/5/91.

Corbin, John. 2000. Personal communication.

deFur, P.L. and Rader, D.N. 1995. Aquaculture in estuaries: Feast or famine? *Estuaries* 18(1A): 2-9.

Department of Agriculture, Fisheries and Forestry - Australia, Bureau of Rural Sciences. 2000. Australia Aquaculture Fact Sheet. Online Publication: <[http://www.nra.gov.au:80/docs/rural\\_science/fish/aqua.html](http://www.nra.gov.au:80/docs/rural_science/fish/aqua.html)>. June 2000.

Department of Fisheries and Oceans (Canada). 1995. Federal Aquaculture Development Strategy. Ottawa. Online Report: <[http://www.dfo-mpo.gc.ca/ocad-bcda/aqu\\_e.pdf](http://www.dfo-mpo.gc.ca/ocad-bcda/aqu_e.pdf)>.

\_\_\_\_\_. 2000a. Canadian Aquaculture Industry Profile. Ottawa. DFO web site: <<http://www.dfo-mpo.gc.ca/ocad-bcda/more.html>>.

\_\_\_\_\_. 2000b. Regulation and Support for Aquaculture in Canada. Ottawa. Web site: <<http://www.dfo-mpo.gc.ca/ocad-bcda/reg.html>>.

DeVoe, M.R. 1991. Regulatory Aspects of Aquaculture Development. In: Hargreaves, J.A. and D.E. Alston (eds.). Status and Potential of Aquaculture in the Caribbean. Proceedings of a Workshop. Advances in World Aquaculture, Volume 5. The World Aquaculture Society. P. 135-164.

\_\_\_\_\_. (ed). 1993. Introductions and Transfers of Marine Species: Achieving a Balance Between Economic Development and Resource Protection. Proceedings of a Conference and Workshop. S.C. Sea Grant Consortium, Charleston, SC. 201 pp.

\_\_\_\_\_. 1994. Aquaculture and the Marine Environment: Policy and Management Issues and Opportunities in the United States. Proc. United States-Japan Natural Resources (UJNR) Aquaculture Panel on "Recent Advances in Environmental Management of Aquaculture," Kyoto, Japan, November 26-December 2, 1992. Bull. Natl. Res. Inst. Aquaculture, Suppl. 1: 111-123.

\_\_\_\_\_, 1997. Marine Aquaculture Regulation in the United States: Environment Policy and Management Issues. In: B.J. Keller, Park, P.K., J.P. McVey, K. Takayanagi and K. Hoyosa, Eds., Proc. Of the United States-Japan Natural Resources (UJNR) Aquaculture Panel on "Mariculture, Water Effluent Quality and Environmental Impact," Corpus Christi, Texas, October 8-10, 1995. TAMU-SG-97-102.

DeVoe, M.R. and A.S. Mount. 1989. "An Analysis of Ten State Aquaculture Leasing Systems: Issues and Strategies." In *J. Shellfish Res.* 8(1):233-239.

DeVoe, M. Richard. 2000a. Marine Aquaculture in the United States: A Review of Current and Future Policy and Management Challenges. *Marine Technology Society Journal* 34(1):5-17.

\_\_\_\_\_. 2000b. Regulation and permitting. In: Stickney, R.R. (ed). Encyclopedia of Aquaculture. John Wiley and Sons, Inc., New York, NY (in press).

DeVoe, Richard. 1999. "Marine Aquaculture in the United States: Current and Future Policy and Management Challenges." In B. Cicin-Sain, R.W. Knecht and Nancy Foster, eds., *Trends and Future Challenges for U.S. National Ocean and Coastal Policy*. NOAA.

Eichenberg, Tim. 1993. "Marine Use Conflicts: The Case of Aquaculture." *Ocean Governance: Issues and Challenges*. Ocean Governance Study Group.

\_\_\_\_\_. 2000. Personal communication.

Eichenberg, Tim and Barbara Vestal. 1992. "Improving the Legal Framework for Marine Aquaculture: The Role of Water Quality Laws and the Public Trust Doctrine." *2 Terr. Sea Journal* 339.

Ewart, J.W., J. Hankins, and D. Bullock. 1995. "State Policies for Aquaculture Effluents and Solid Wastes in the Northeast Region." *Northeastern Regional Aquaculture Center Extension Bulletin Number 300*. 24p.

FAO Fisheries Department. 1993. *A Review of the Environmental and Legal Implications of Artificial Reefs*. FAO Fisheries Circular No. 865. Rome: FAO.

\_\_\_\_\_. 1995. *Code of Conduct for Responsible Fisheries*. Rome: FAO.

\_\_\_\_\_. 1996a. *A Checklist for Fisheries Resource Management Issues Seen from the Perspective of the FAO Code of Conduct for Responsible Fisheries*. Rome: FAO.

\_\_\_\_\_. 1996b. *FAO Technical Guidelines for Responsible Fisheries. No. 2: Precautionary Approach to Capture Fisheries and Species Introductions*. Rome: FAO.

\_\_\_\_\_. 1996c. *FAO Technical Guidelines for Responsible Fisheries. No. 3: Integration of Fisheries into Coastal Area Management*. Rome: FAO.

\_\_\_\_\_. 1997a. *Aquaculture Economics in Developing Countries: Regional Assessments and an Annotated Bibliography*. FAO Fisheries Circular No. 932. Rome: FAO.

\_\_\_\_\_. 1997b. *FAO Technical Guidelines for Responsible Fisheries. No. 5: Aquaculture Development*. Rome, FAO.

\_\_\_\_\_. 1997c. *Review of the State of World Aquaculture*. FAO Fisheries Circular No. 886 FIRI/C886(Rev.1). Rome: FAO.

(<http://www.fao.org/WAICENT/FAOINFO/FISHERY/publ/circular/c886.1/c886-1.htm>)

\_\_\_\_\_. 1998a. *GESAMP: Integration of Aquaculture into Coastal Management*. Rome: FAO.

\_\_\_\_\_. 1998b. *Integrated Coastal Area Management and Agriculture, Forestry and Fisheries*. Rome: FAO

\_\_\_\_\_. 1999a. *Marine Ranching: Global Perspectives with Emphasis on the Japanese Experience*. FAO Fisheries Circular No. 943. Rome, FAO.

\_\_\_\_\_. 1999b. *The State of World Fisheries and Aquaculture, 1998*. Rome: FAO.  
(<http://www.fao.org/docrep/w9000e/w9900e00.htm>)

Fenical, W., M. Greenberg, H.O. Halvorson, J.C. Hunter-Cevera. 1993. International Marine Biotechnology Conference. (Dubuque, Iowa: Williams C. Brown). Two volumes.

Fletcher, Kristen M. and Ginger Weston. 2000. "The Legal & Regulatory Environment: Offshore Aquaculture Permitting Process in the Gulf of Mexico," report prepared for the Sea Grant Aquaculture Consortium (accessed 4/17/00).

Florida Department of Agriculture and Consumer Services. 1998. The Florida Aquaculture Plan: 1998 Supplement. (, accessed 12/11/99)

GESAMP (IMO/FAO/Unesco-IOC/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 1991. *Reducing Environmental Impacts of Coastal Aquaculture*. Reports and studies No. 47. Rome: FAO, 1991

\_\_\_\_\_. 1996. *Monitoring the Ecological Effects of Coastal Aquaculture Wastes*. GESAMP Reports and Studies, No. 57. Rome: FAO.

\_\_\_\_\_. 1997. *Towards Safe and Effective Use of Chemicals in Coastal Aquaculture*. GESAMP Reports and Studies, No. 65. FAO: Rome, 1997.

\_\_\_\_\_. 2000. *Planning and Management for Sustainable Coastal Aquaculture Development*. Report of the GESAMP Working Group on Environmental Impacts of Coastal Aquaculture (Working Group 31). Draft, February 13, 2000.

Goldburg, Rebecca and Tracy Triplett. 1997. *Murky Waters: Environmental Effects of Aquaculture in the US*. (New York: Environmental Defense Fund).

Goudey, C.A. 1998a. Model Tests and Operational Optimization of a Self-Propelled Open-Ocean Fish Farm. in A. Biran, Ed. Proceedings Offshore Technologies for Aquaculture. Haifa, Israel, 13-16 Oct. 1998.

Goudey, C.A. 1998b. Design and Analysis of a Self-propelled Open-ocean Fish Farm. in conference proceedings Open Ocean Aquaculture '98, Corpus Christi, TX.

Goudey, Clifford A. and Ronald J. Smolowitz. 2000. "SeaStead: An Update on Sea Scallop Culture in the U.S. EEZ," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.

Government of Norway. Undated. *Aquaculture—A Motive Force in the Norwegian Coastal Industry*. Report No. 48 to the Storting (1994-1995).

Gulf of Mexico Offshore Aquaculture Consortium home page (<http://www.masgc.org/offshoreconsortium.html>, accessed 4/17/00).

Gulf States Marine Fisheries Commission. 2000. Summary of Aquaculture Programs by State. April 2000.

Halvorson, Harlyn O. 1993. *Aquaculture and the Marine Environment: The Shaping of Public Policy*. Workshop, Marine Biological Laboratory, August 30 - Sept. 1, 1993.

\_\_\_\_\_, 1996. Aquaculture Policy: Formulation and Implementation. NOAA Technical Memorandum NMFS-NE-109, pp. 12-25.

\_\_\_\_\_, 1997. "Addressing Public Policy Issues on Scallop Aquaculture in Massachusetts," *J. of Shellfish Research* 16: 287.

\_\_\_\_\_. 1998. "Aquaculture, Marine Sciences & Oceanography: A Confluence." *Connections* 13: 38-40.

Halvorson, H.O., Y. Le Gal, S. Miyachi, and J.A. Olafsen. 1995. Special Issue, Proceedings of the Third International Marine Biotechnology Conference (IMBC'94) Tromsø, Norway. *J. Marine Biotec.* 3 1-238.

Halvorson, Harlyn O., Cliff Goudey, Dale Leavitt, Ron Smolowitz, Richard Taylor. 1999. *Sea Scallop Aquaculture: 1999 Blueprint*. Northeastern Regional Aquaculture Center Publication No. NRAC 99-001, November 1999.

Halvorson, Harlyn O., Alex Keynan and Sir Hans Kornberg. 1995. Sea Scallop Aquaculture in Massachusetts: Position Paper. Workshop Cape Cod Community College, West Barnstable, MA July 24-25, 1995.

Hartevelt, Tony. 1998. Fishing for the Future - Review of the Fisheries Act 1996. Report prepared by PricewaterhouseCoopers for the New Zealand Ministry of Fisheries. September 1998. Report available online at <<http://www.fish.govt.nz/information/reviewfishing.html>>.

Havbruk Trade Magazine. 2000. Norwegian Salmon, Salmon trout and Arctic charr production. Online: <<http://www.havbruk.no/statistik/stat1.html>>.

Hawaii Department of Land and Natural Resources and Department of Agriculture. 1999. Implementation of Chapter 190D, Hawaii Revised Statutes: Ocean and

Submerged Lands Leasing. Report to the Twentieth Legislature, State of Hawaii, 2000 Regular Session, in response to Act 176 (Section 12), Session Laws of Hawaii 1999. December 1999.

Hawaii Sea Grant. Undated. "Offshore Sea Cage Demonstrates Potential for Open-Ocean Farming" ([http://www.soest.hawaii.edu/SEAGRANT/special\\_project.html](http://www.soest.hawaii.edu/SEAGRANT/special_project.html), accessed 4/17/00).

Hewitt, Rich. 2000. Blue Hill Bay group set to file lawsuit [article on-line]. Bangor Daily News. July 27, 2000. <[www.bangornews.com/cgi-bin/article.cfm?storynumber=18262](http://www.bangornews.com/cgi-bin/article.cfm?storynumber=18262)>, accessed July 27, 2000.

Hoagland P. et al. Wood Hole Oceanographic Institution In press.

*The Holmenkollen Guidelines for Sustainable Industrial Fish Farming*, in *Sustainable Fish Farming*. 1995. Proceedings of the first international conference on Sustainable Fish Farming. Oslo, Norway, 28-31 August. A.A. Balkema: Rotterdam/Brookfield.

Holmes, Martin. 2000. 'Code of Best Practice' to be Adopted by Shetland Salmon Industry. MARAQUA NEWS A newsletter on the Monitoring and Regulation of Marine Aquaculture in Europe. Spring 2000 Issue 3 ISSN 1466-2353. Online version <<http://www.biol.napier.ac.uk/maraqua/issue3.htm>>.

Hopkins, D. Douglas, R.A. Goldberg, and A. Marston. 1997. "An Environmental Critique of Government Regulations and Policies for Open Ocean Aquaculture." *Ocean and Coastal Law Journal* 2: 235-260.

Hopkins, J.S., P.A. Sandifer, M.R. DeVoe, A.F. Holland, C.L. Browdy and A.D. Stokes. 1995. Environmental Impacts of Shrimp Farming with Special Reference to the Situation in the Continental United States. *Estuaries* 18 (1A): 25-42.

Howell, Hunt, Barbaros Celikkol, Rollie Barnaby, and Ann Bucklin. Undated. "Development of an Open-Ocean Aquaculture Demonstration Project," University of New Hampshire, Open Ocean Aquaculture Home Page (<http://ekman.sr.unh.edu/AQUACULTURE/>, accessed 4/17/00).

Howell, Hunt, George Nardi, and Chris Duffy. 2000. "The Performance of Summer Flounder Grown in Ocean Net Pens in New Hampshire," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.

International Council for the Exploration of the Seas. 1996. *Code of Practice on the Introduction and Transfer of Marine Organisms, 1994*. Appendix A in FAO, *Technical Guidelines for Responsible Fisheries. No. 2: Precautionary Approach to Capture Fisheries and Species Introductions*. FAO: Rome.

IntraFish. 2000. Norwegian Seafood Production and Export: Aquaculture is Taking Over. Bordo, Norway. Online Report: <[http://www.intrafish.com/infrafish-analysis/norsk-sjomat\\_19-12-2000\\_eng/](http://www.intrafish.com/infrafish-analysis/norsk-sjomat_19-12-2000_eng/)>.

Ireland Department of the Marine and Natural Resources. 2000. Byrne Unveils Major Fish Farming Development Plan. Report Sets Strategy to Build £450m Irish Industry to Capitalise on Global Expansion.. Dublin. Online Press Release: <<http://www.irlgov.ie/marine/pressRelease/June00/8june.htm>>.

Ito, H. 1988. A history of scallop culture in Japan. Proceedings Australian Workshop. Hobert, Australian M.C.L. Dredge, W.F. Zaccharin, I.M. Joll. (eds) pp.42-50, also Report Ministry of Agriculture, Forestry and Fisheries, 1988.

Ito, H. 1998. World Aquaculture Society Meeting. Scallop Section Meeting.

Johnson, Howard M. (ed.). 1999. Annual Report on the United States Seafood Industry, seventh edition. H.M. Johnson & Associates: Bellevue, WA.

Joint Subcommittee on Aquaculture. Undated (a). *Aquaculture Research and Development: Strategic Implementation Plan*. (<http://ag.ansc.purdue.edu/aquanic/jsa/Strategicplan.htm>)

\_\_\_\_\_. Undated (b). *Guide to Federal Aquaculture Programs and Services* ([http://ag.ansc.purdue.edu/aquanic/jsa/federal\\_guide/Federal%20Guide.html](http://ag.ansc.purdue.edu/aquanic/jsa/federal_guide/Federal%20Guide.html)).

\_\_\_\_\_. 1983. National Aquaculture Development Plan: Volume One. Washington, D.C., 67 pp.

\_\_\_\_\_. 1993. Aquaculture in the United States, Opportunities and Recommendations. Report to the Federal Coordinating council on Science, Engineering and Technology, 21 pp.

\_\_\_\_\_. 1996. *National Aquaculture Development Plan*. Draft.

- Kaiser, Jeff and Shawn Achnee. 2000. "Mariculture Opportunities in the Gulf of Mexico: Experience with Seafish Mariculture, L.L.C., on an Offshore Platform, presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.
- Knecht, R.W., B. Cicin-Sain and D. Jang (eds). *Policy Issues in the Development of Marine Biotechnology* (in preparation).
- Laidler, John. 1998. "Deep Seeded," *The Boston Globe*, May 11, 1998, p. C1.
- Langen, Richard. 2000a. "Overview of the University of New Hampshire Open-Ocean Aquaculture Demonstration Project," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.
- \_\_\_\_\_. 2000b. Personal communication to Robert B. Rheault, February 17, 2000.
- \_\_\_\_\_. 2000c. "Submerged Longline Culture of Blue Mussels *Mytilus edulis* in the Open Ocean," presentation at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.
- Le Gal, Yves and Harlyn O. Halvorson. 1998. *New Developments in Marine Biotechnology* (New York: Plenum Press).
- Leavitt, D.F., Halvorson, H.O., and Mancuso, C. 1996. A Developing Sea Scallop Industry in Massachusetts. *Aquaculture News* 4: 16-21.
- Lindbergh, Jon. M. 1999a. Farming the Chilean Scallop. *Aquaculture Magazine*. July/August 1999. Pp. 27-37.
- \_\_\_\_\_. 1999b. Private Freshwater Sites: Are There Enough? *Aquaculture Magazine*. January/February 1999. Pp. 36-45 .
- \_\_\_\_\_. 1999c. Salmon Farming in Chile: Do the Benefits Exceed the Costs? *Aquaculture Magazine*. March/April 1999. Pp. 33-45.
- Lutz, C. Greg. 1999. "Red Drum: A Re-emerging Aquaculture Species," *Aquaculture Magazine*, July/August 1999, p. 38-45.
- MacDubhghaill, Uinsionn. 2000a. Some inshore fishermen against fish farms. Article published online at <<http://www.intrafish.com>>. August 11, 2000.
- MacDubhghaill, Uinsionn. 2000b. £21 million survey of Irish seabed begins. Article published online at <<http://www.intrafish.com>>. July 17, 2000.
- MacPherson, Doug. 1999. "Aquaculture," New Hampshire Public Radio report, aired Thursday, September 9, 1999 on *Morning Edition* (NPR Online, <http://search.npr.org/cf/cmn/cmnps05fm.cfm?SegID=58337>, accessed 4/17/00).
- Maine Department of Marine Resources. 1997. Maine's Aquaculture Strategy. November 1997. (<http://www.state.me.us/spo/mep/final.htm>, accessed 4/29/00).
- Marine Law Institute. 1992. *Improving the Legal Framework for Marine Aquaculture: The Role of Water Quality Laws and the Public Trust Doctrine*, Technical Report for the Northeastern Regional Aquaculture Center, July 31, 1992.
- \_\_\_\_\_. 1992. Legal Methods for Promoting Local Salmon Farming Operations in Down East Maine. National Coastal Resources Research & Development Institute Report No. NCRI-W-92-010. February 21, 1992.
- Maryland Department of Agriculture and National Association of State Aquaculture Coordinators. 1995. State/Territory Permits and Regulations Impacting the Aquaculture Industry. Prepared for the Joint Subcommittee on Aquaculture.
- Massachusetts Coastal Zone Management. 1995a. *Aquaculture Strategic Plan*, 1995 (MCZM web page: <http://www.magnet.state.ma.us/czm/aquatoc.htm>).
- \_\_\_\_\_. 1995b. *Aquaculture White Paper*. (MCZM web page: <<http://www.magnet.state.ma.us/czm/aquatoc.htm>>)
- McCoy II, H.D. 1989. Commercial aquaculture zones: A legislative proposal. *Aquaculture* (6): 39-46.
- Mieremet. 2000. Personal communication.
- Ministry of the Economy (Chile), Fisheries Department. 1999. Chile, A Good Trading Partner. Fishing & Aquaculture Industry Fact Sheet.
- NACA/FAO. 2000. Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy. Conference on Aquaculture in the Third Millennium, 20-25 February

2000, Bangkok, Thailand. NAA, Bangkok and FAO, Rome. 27pp.

\_\_\_\_\_. 2000. Report on the Expert Consultation on the Proposed Subcommittee on Aquaculture of the Committee of Fisheries. Bangkok, Thailand, 28-29 February 2000.

National Aquaculture Act of 1980, as amended. 16 U.S.C. 2801, *et seq.*

National Environmental Law Center. Downeast salmon farms face lawsuit for federal Clean Water Act violations. Press release. April 26, 2000.

*National Fisherman*. 1991.

National Marine Fisheries Service, National Oceanic and Atmospheric Administration.. 1996a. *Fisheries of the Northeastern United States, Amendments to the Northeast Multispecies, Atlantic Sea Scallop, and American Lobster Fishery Management Plans*, Proposed Rule and Request for Comments, published in *Federal Register*, Vol. 61, No. 197, October 9, 1996, pp. 52903-52905.

\_\_\_\_\_. 1996b. *Fisheries of the Northeastern United States, Atlantic Sea Scallop Fishery, Amendment 5*, Proposed Rule and Request for Comments published in *Federal Register*, Vol. 61, No. 184, September 20, 1996, pp. 49428-49430.

\_\_\_\_\_. 1997a. *Fisheries of the Northeastern United States, Amendments to the Northeast Multispecies, Atlantic Sea Scallop, and American Lobster Fishery Management Plans*, Final Rule published in *Federal Register*, Vol. 62, No. 7, January 10, 1997, pp. 1403-1405.

\_\_\_\_\_. 1997b. *Fisheries of the Northeastern United States, Atlantic Sea Scallop Fishery, Amendment 5*, Final Rule published in *Federal Register*, Vol. 62, No. 9, January 14, 1997, pp. 1829-1832.

\_\_\_\_\_. 1997c. *Implementation Plan for the Code of Conduct for Responsible Fisheries*. July 1997. Official agency web site:

National Oceanic and Atmospheric Administration. Undated. *Sea Grant. Marine Aquaculture: Economic Opportunities for the 21<sup>st</sup> Century*.

National Oceanic and Atmospheric Administration. 1998. *NOAA's Aquaculture Policy*.

National Research Council (NRC). 1978. *Aquaculture in the United States: Constraints and Opportunities*. National Academy Press, Washington, D.C. 290 pp.

\_\_\_\_\_. 1992. Committee on Assessment of Technology and Opportunities for Marine Aquaculture in the United States. *Marine Aquaculture: Opportunities for Growth: Report of the Committee on Assessment of Technology and Opportunities for Marine Aquaculture in the United States*, Marine Board, Commission on Engineering and Technical Systems, National Research Council. (Washington: National Academy Press).

\_\_\_\_\_. 1997. *Striking a Balance, Improving Stewardship of Marine Areas*. Committee on Marine Area Governance and Management (Washington, DC: National Academy Press).

\_\_\_\_\_. 1999. Commission on Geosciences, Environment, and Resources. Ocean Studies Board. Committee on Ecosystem Management for Sustainable Marine Fisheries. *Sustaining Marine Fisheries*. (Washington, DC: National Academy Press).

Naylor, Rosamond L., Rebecca J. Goldberg, Harold Mooney, Malcolm Beveridge, Jason Clay, Carl Folke, Nils Kautsky, Jane Lubchenco, Jurgenne Primavera and Meryl Williams. 1998. Nature's subsidies to shrimp and salmon farming. *Science* 282:883-884.

Naylor, Rosamond L., Rebecca J. Goldberg, Jurgenne H. Primavera, Mils Kautsky, Malcolm C. M. Beveridge, Jason Clay, Carl Folke, Jane Jubchenco, Harold Mooney, and Max Troell. 2000. Effect of Aquaculture on World Fish Supplies. *Nature* 405:1017-1024.

Nelson, G. Ross, M. Richard DeVoe, and Gary L. Jensen. 1999. Status, Experience, and Impacts of State Aquaculture Plans and Coastal Zone Management Plans on Aquaculture in the United States. *Journal of Applied Aquaculture* Vol. 9(1):1-21.

New England Fishery Management Council (NEFC). Undated (a). Aquaculture Policy (fax communication with NEFC, 5/25/99).

\_\_\_\_\_. Undated (b). Joint Agency Offshore Aquaculture Pre-Application Guidelines. (fax communication with NEFC, 5/25/99).

*New York Times*. "Coping With Supersalmon." May 14, 2000.



New Zealand Greenshell Mussels. 2000. Web site: <<http://www.greenshell.com/>>.

New Zealand Seafood Industry Council (NZSIC). 2000. Web site: <<http://www.seafood.co.nz/>>.

Nixon, D.W. 1994. Aquaculture: Impediments to growth. *Maritimes* 37(2): 2-4.

North Atlantic Salmon Conservation Organization. 1991. *Guidelines to Minimise the Threats to Wild Salmon Stocks from Salmon Aquaculture* Edinburgh: NASCO.

Norway. 1994-1995. *Aquaculture--A Motive Force in the Norwegian Coastal Industry*. Report No. 48 to the Storting.

Norwegian Institute of Marine Research. 2000. Annual Report of Aquaculture 1999. Bergen, Norway. Online Report: <<http://www.imr.no/english/publications/1999/aquaculture.htm>>.

Ocean Spar Technologies, web site (<http://www.oceanspar.com>)

Oceanic Institute. Undated (a). Marine Finfish Program information ([http://www.oceanicinstitute.org/Marine\\_Finfish/marinefinfish.htm](http://www.oceanicinstitute.org/Marine_Finfish/marinefinfish.htm), accessed 4/17/00).

\_\_\_\_\_. Undated (b). "Offshore Aquaculture Research Project Is Launched" (<http://www.oceanicinstitute.org/news/seacage.htm>, accessed 4/17/00).

Oesterling, Michael. 1993. Marine Aquaculture in the State of Virginia: A Status Report. Virginia Sea Grant.

Office of Technology Assessment, Offshore Aquaculture Committee. 1994. *Offshore Aquaculture: Technology and Policy Issues*.

Organization for Economic Cooperation and Development (OECD). 1989a. *Aquaculture: Developing a New Industry*. Paris: OECD.

\_\_\_\_\_. 1989b. *Aquaculture: A Review of Recent Experience*. Paris: OECD.

\_\_\_\_\_. 1996. *Reconciling Pressure on the Coastal Zone: Fisheries and Aquaculture*. Paris: OECD.

Pillay, T.V.R. 1997. Aquaculture Development and the Concept of Sustainability. In Nambiar, KPP and Tarlochan Singh (Editors). *Sustainable Aquaculture*. Proceedings of INFOFISH-AQUATECH '96

International Conference on Aquaculture. Kuala Lumpur, Malaysia. 25-27 September 1996. INFOFISH, pages 1-6.

Rappaport Stephen. 1999. A visit to Japan for technology transfer. *Fish Farming News* December.

Reichhardt, T. 2000. Will souped up salmon sink or swim? *Nature* 406:10-12.

Reinertsen, Helge and Herborg Haaland. 1995. *Sustainable Fish Farming*. Proceedings of the First International symposium on Sustainable Fish Farming. Oslo, Norway. 28-31 August 1994. (Rotterdam: A. A. Balkema)

Rhodes, Ed. 2000. Personal communication.

Rieser, Alison. 1997. "Defining the Federal Role in Offshore Aquaculture: Should It Feature Delegation to the States?" *Ocean and Coastal Law Journal* 2: 209-234.

Rieser, Alison and Susan Bunsick. 1999. "Aquaculture in the U.S. Exclusive Economic Zone (EEZ): Legal and Regulatory Concerns." In B. Cicin-Sain, R.W. Knecht, and Nancy Foster, eds., *Trends and Future Challenges for U.S. National Ocean and Coastal Policy*. NOAA.

Robertson, Robert A., Richard B. Nichols, and Roland T. Barnaby. 2000. "Open Ocean Aquaculture and Commercial Fishing in the Northwest Atlantic: A Study of Northern New England's Commercial Fishermen," paper presented at Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.

Rosenthal, Harald. 1997. Environmental Issues and the Interaction of Aquaculture with Other Competing Resource Users. In *Coldwater Aquaculture to the Year 2000*, Aquaculture Association of Canada Special Publication No. 2.

Rubino, Michael C. and Charles A. Wilson. 1993. *Issues in Aquaculture Regulation* (Bethesda, Maryland: Bluewaters, Inc.).

Sackton, John. 2000. Massive Ocean Aquaculture Cages, up to 100,000 cubic Meters, On Drawing Boards by Ocean Spar. Article published online at <[www.seafood.com](http://www.seafood.com)>, 14 Aug 2000.

Scottish Environmental Protection Agency. 1997. Marine Cage Fish Farming in Scotland: Regulation and Monitoring. A Compendium of Responses to SEPA's Consultation Paper. Online publication:

<<http://www.sepa.org.uk/publications/consultations/fishfarmresponses97.htm>>.

Scottish Executive. 1999. Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters. Online Publication: <<http://www.scotland.gov.uk/library2/doc06/mff-00.htm>>.

Smith, Breda. 1999. First Ocean Spar Technology Cage Installed in Ireland. BIM Aquaculture Newsletter, Issue No. 31, August 1999. Bord Iascaigh Mhara (Irish Sea Fisheries Board). Report online at <<http://www.bim.ie/aquaculture/technology1.htm>>.

Smolowitz, Ronald J. and Clifford A. Goudey. Undated. *Obstacles to Offshore Sea Scallop Culture in New England Waters*.

Smolowitz, Ronald, Cliff Goudey, Soren Henriksen, Edward Welch, Kenneth Riaf, Porter Hoagland, Hauke Kite-Powell, Roxanna Smolowitz, and Dale Leavitt. 1998a. *Sea Scallop Enhancement and Sustainable Harvesting: The SeaStead Project*, report prepared by Westport Scalloping Corporation pursuant to National Oceanic and Atmospheric Administration Award No. NA66FD0027, December 1, 1998.

Smolowitz, R., C. Goudey, K. Riaf, P. Hoagland, H. Kite-Powell, D. Leavitt, Rox. Smolowitz, and S. Hendriksen, et al. 1998b. Sea Scallop Enhancement and Sustainable Harvesting. Section C. Legal and Regulatory Aspects of Site Selection. The SeaStead Project. Report from the Westport Scalloping Corporation to NOAA, Award number NA66FD0027.

Sproul, John T. 1997. "Sustainable Aquaculture Certification: A Questionnaire Based on the FAO Code of Conduct for Responsible Fisheries." In Nambiar, KPP and Tarlochan Singh (Editors). *Sustainable Aquaculture*. Proceedings of INFOFISH-AQUATECH '96 International Conference on Aquaculture. Kuala Lumpur, Malaysia. 25-27 September 1996. INFOFISH, pages 154-158.

Statistics Canada. 1999. 1998 Canadian Aquaculture Production Statistics. Ottawa. Department of Fisheries and Oceans Canada web site: <<http://www.dfo-mpo.gc.ca/communic/statistics/aquacult/aqua98.htm>>.

Stickney, R.R., B. Costa-Pierce, C. Goudey, G. Loverich, V. Asper, J. Duff. 2000. "The Sea Grant Gulf of Mexico Offshore Aquaculture Consortium," presentation at

Aquaculture America 2000 conference, New Orleans, LA, February 5, 2000.

TenBruggencate, Jan. 1999. "A Farm Beneath the Waves," *The Honolulu Advertiser*, August 30, 1999 (<http://www.oceanicinstitute.org/news/083099.html>, accessed 4/17/00).

Tiddens, Art. 1990. *Aquaculture in America: The Role of Science, Government, and the Entrepreneur*. (Boulder, Col.: Westview Press, Inc).

Touhy, Dan. 1999. "Great Experiment: A Glimpse at Fishing's Future," *Foster's Online*, June 6, 1999 (, accessed 8/6/99).

Underwood, Julia. 1997. "Intertidal Zone Aquaculture and the Public Trust Doctrine." *Ocean and Coastal Law Journal* 2: 383-414.

University of New Hampshire. Undated. Open Ocean Aquaculture Permit Work Page ([http://nemo.unh.edu/erik/permit\\_pages/permit.htm](http://nemo.unh.edu/erik/permit_pages/permit.htm), accessed 4/17/00).

\_\_\_\_\_. 2000a. "Development of an Open-Ocean Aquaculture Demonstration Project: Progress Report," February 2000, University of New Hampshire, Open Ocean Aquaculture Home Page ([http://ekman.sr.unh.edu/AQUACULTURE/PROGRESS\\_FEB00/OOA\\_Prog\\_Feb00\\_Front.html](http://ekman.sr.unh.edu/AQUACULTURE/PROGRESS_FEB00/OOA_Prog_Feb00_Front.html), accessed 4/17/00).

\_\_\_\_\_. 2000b. "Open Ocean Aquaculture Project Overview," presentation by R. Langen, January 2000 (<http://ekman.sr.unh.edu/AQUACULTURE/>, accessed 4/17/00).

U.S. Army Corps of Engineers. Undated. Regulatory Program Overview. ([Http://www.usace.army.mil/inet/functions/cw/cccw/reg/oceover.htm](http://www.usace.army.mil/inet/functions/cw/cccw/reg/oceover.htm), accessed 5/3/00).

U.S. Department of Commerce. 1999a. Aquaculture Policy. Approved August 10, 1999.

\_\_\_\_\_. 1999b. *Turning to the Sea: America's Ocean Future*.

\_\_\_\_\_. 2000. Aquaculture Policy Guidelines. Draft. Version 2—January 11, 2000.

U.S. Environmental Protection Agency. 2000. U.S. Environmental Protection Agency's National Aquaculture

Effluent Activities and the Role of the Aquaculture Industry and the Joint Subcommittee on Aquaculture. Presentation at Aquaculture America 2000 (<http://ag.agnc.purdue.edu/aquanic/jsa/effluents/EPApresentationNO.html>, accessed 5/24/2000).

Waldemar Nelson International, Inc. 1998. Feasibility Study—Offshore Mariculture. A report of Waldemar International Inc. pursuant to National Oceanic and Atmospheric Administration (NOAA) Award number NA77FL0150.

Webber, Michael L. 1997. Farming Salmon: A Briefing Book. San Francisco: The Consultative Group on Biological Diversity.

World Commission on Environment and Development (the Brundtland Commission). 1987. *Our Common Future*. Oxford: Oxford University Press.

Wypyszinski, Alex W. 1994. *Governmental Regulation of Growth and Development: Improving the Legal Framework for Aquaculture in the Northeastern United States*.

Yoon, Carol Kaesuk. 2000. "Altered Salmon Lead the Way to the Dinner Plate, but Rules Lag." *New York Times*, May 1, 2000. Pages A1 and A20 (<http://www.nytimes.com/library/national/science/050100sci-gm-animal.html>, accessed 5/1/2000).

# Appendix 1

## LIST OF ADVISORY COMMITTEE MEMBERS

Charles Chesnutt	<i>U.S. Army Corps of Engineers</i>
John Corbin	<i>Hawaii Dept. of Agriculture</i>
Tom Ellis	<i>National Association of State Aquaculture Coordinators</i>
Jean Flemma	<i>House Resources Committee</i>
Rebecca Goldberg	<i>Environmental Defense</i>
Betsy Hart	<i>National Aquaculture Association</i>
Roger McManus	<i>Center for Marine Conservation</i>
Luke Nachbar	<i>Office of Senator Gregg (New Hampshire)</i>
Pietro Parravano	<i>Pacific Coast Federation of Fishermen's Associations</i>
Jeff Peterson	<i>U.S. Environmental Protection Agency</i>
David Redlin	<i>Office of Senator Roth (Delaware)</i>
Ed Rhodes	<i>National Marine Fisheries Service</i>
Louise Scura	<i>World Bank</i>
Margaret Spring	<i>Senate Commerce Committee</i>
Boyce Thorne-Miller	<i>SeaWeb</i>
Ken Turgeon	<i>Minerals Management Service</i>



# Appendix 2

STATE : \_\_\_\_\_

## Questions for Coastal State Aquaculture Coordinators

1. How would you describe the current status of the marine aquaculture industry in your state?

\_\_\_\_\_ Little or no interest in marine aquaculture

\_\_\_\_\_ Mainly experimental or research projects

\_\_\_\_\_ Some commercial activity

\_\_\_\_\_ Significant commercial activity

2. What types of marine aquaculture facilities currently operate in your state?

*(Please check all that apply)*

\_\_\_\_\_ Hatcheries

\_\_\_\_\_ Shellfish culture

\_\_\_\_\_ Net pens

\_\_\_\_\_ Cages

\_\_\_\_\_ Plant culture

\_\_\_\_\_ Other

Specify: \_\_\_\_\_

3. Are any of these facilities located in open ocean waters (i.e., offshore)?

\_\_\_\_\_ Yes

Describe: \_\_\_\_\_

Please indicate how far offshore: \_\_\_\_\_

\_\_\_\_\_ No

4. What types of leases does your state currently offer for marine aquaculture in state waters?

*(Please check all that apply)*

Bottom leases

Water column leases

Exclusive easements

Non-exclusive easements

Other

Specify: \_\_\_\_\_

None

5. Please indicate which of the following are required as part of the current process for siting marine aquaculture operations in your state:

	Mandatory	May be required	Not required	Don't Know
Public hearing				
Environmental review				
Bonds				
Royalty payments*				
Annual fees*				

\*If there are any royalty payments or fees, please specify the amount or formula used:

Royalty payments \_\_\_\_\_

Annual fees \_\_\_\_\_

6. Is there a lead agency for marine aquaculture in your state?

Yes

Specify: \_\_\_\_\_

No

7. Does your state currently have a policy in place for marine aquaculture?

Yes

Date implemented: \_\_\_\_\_

No (SKIP TO QUESTION 9)

8. Where is your state’s policy for marine aquaculture specified? *(Please check all that apply)*

Coastal zone management plan

General aquaculture strategy/plan

Marine aquaculture strategy/plan

Fisheries management strategy/plan

Economic development strategy/plan

Other

Specify: \_\_\_\_\_

9. If you answered “no” to Question 7, are there currently any efforts to develop a policy for marine aquaculture in your state?

Yes

Describe: \_\_\_\_\_

No

10. In your opinion, what are the best features of your state’s current approach to marine aquaculture?

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11. What would you recommend to improve the current approach to marine aquaculture in your state?

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12. What is your opinion with respect to the policies that should guide marine aquaculture in federal waters (i.e., beyond the limits of your state's jurisdiction)?

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13. As part of our project, we are compiling references on marine aquaculture leasing laws, regulations, and policy statements. If possible, can you please send us a copy of the relevant documents for your state?

Mail to: Center for the Study of Marine Policy  
Graduate College of Marine Studies  
University of Delaware  
301 Robinson Hall  
Newark, DE 19716

**THANK YOU FOR YOUR HELP ON THIS PROJECT!**

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Graduate College of Marine Studies  
University of Delaware  
301 Robinson Hall, Newark, DE 19716  
(302) 831-8086 - Phone  
(302) 831-3668 - Fax

***PLEASE FAX COMPLETED QUESTIONNAIRE TO (302) 831-3668 BY MAY 15, 2000***