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Guidance Relative to Development of Responsible Aquaculture Activities in Atlantic Coast States

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Introduction

Fishing activities and fishery products, including aquaculture, are important components of the world food supply and economy. Global demand of fishery products for consumption and industrial use increased more than 79% between 1980 and 1999, from 76 million metric tons to 137 million MT (FAO 2000). World fishery production through harvest and culture for human consumption increased by 85% (50.7 million MT to 93.8 million MT) from 1980 to 1997 (FAO 2000), and estimates predict it may increase another 21% to 114 million metric tons by 2010. As capture fisheries approach limits of productivity, aquaculture will play an increasing role in meeting the demand for fishery products. Globally, the percentage of total fishery products that came from aquaculture increased from less than 10% (7.35 million MT) in 1980 to more than 30% (42.7 million MT) in 1999 (FAO 2000). By 2030, estimates suggest that aquaculture will account for more than 50% of the fish consumed worldwide.

In the United States, there is potential for considerable expansion of the aquaculture industry. An increase in consumer demand for fishery products between 1980 and 1997 in the U.S. from 3.44 million MT to 5.66 million MT (Laureti 1999) highlights the need for increased production. The National Aquaculture Act (P.L. 96-362) was passed in 1980 to promote development of the aquaculture industry in the United States. In addition, extensive scientific knowledge and technology exist to support the growth of the U.S. aquaculture industry (NRC 1992). The percentage of total U.S. fishery products that came from aquaculture, however, was less than 9% (0.48 million MT) in 1999, compared to 30% globally (FAO 2000). A study by the National Research Council (NRC 1992) identified institutional and legal problems, such as permitting, property rights, user conflicts, and environmental issues as some of the main reasons for the slow expansion of the U.S. aquaculture industry. In many cases, these problems can be amplified due to differing missions among various agencies within a state or federal organization and lack of agency coordination.

The U.S. Department of Agriculture 1998 Census of Aquaculture (USDA 2000) reported 1,391 aquaculture farms in the fifteen Atlantic coastal states. Florida, Virginia, and North Carolina comprise 64% of the total farms with 449 farms, 294 farms, and 147 farms, respectively. Ponds, flow through systems, and closed recirculation tanks were the most common culture systems used. Cages, net pens, prepared bottom, and "other" (unspecified) systems accounted for less than 32% of the total. Aquaculture products were valued at approximately $222.5 million in 1998. The three highest value crops were food fish ($102M), ornamental fish ($56.4M), and molluscs ($48.8M). The value of aquacultured food fish in Maine ($64.6M) and ornamental species in Florida ($56.2M) accounted for over 54% of the total value.

Development of aquaculture in the United States could contribute significant positive social and economic benefits locally, nationally, and internationally, and aquaculture is formally recognized as being in the public interest in some states (*e.g.*, Florida). Social benefits include quality food to supplement harvests of wild fish, export products to improve the nation's balance of trade, enhancement of commercial and recreational fisheries, and economic opportunities for

communities through new aquaculture jobs and development or expansion of aquaculture support industries. Potential environmental benefits from aquaculture include production of organisms for stock enhancement or replacement, production of plants to restore damaged wetlands, and production of organisms for the biological control of invasive aquatic plants, and, in reference to mollusc culture, water quality improvement and creation and restoration of benthic habitats.

When not properly managed, however, aquaculture can have negative environmental, social, and economic impacts (Black 2001, Tlusty *et al.* 2001, Tomasso 2002). Conflicts may occur with commercial fishing industries and recreational or public interest sectors over resource allocation or for aesthetic reasons. Risks to wild populations include genetic alteration, spread of disease, and introduction of non-indigenous species. Improper facility design, siting, or operation can impact the physical habitat, diminish water quality, or impact wild populations in a variety of ways. Many of these impacts can be avoided through the development of appropriate administrative and regulatory programs and industry standards.

To ensure that the benefits of aquaculture are realized in a manner that is environmentally sound, economically viable, and socially acceptable, there is a broad range of issues that should be addressed, many of which were identified by the NRC (1992). Comprehensive administrative frameworks that clearly identify regulatory authority and industry and agency responsibilities will facilitate and strengthen permitting procedures, ensure proper oversight of the industry including protection of stakeholder rights and effective regulation and enforcement, and establish accountability for adverse environmental effects and non-compliance. Guidelines for design and siting of facilities and operational protocols will minimize adverse effects on the physical environment and wild populations, and minimize conflicts with other user groups. Appropriate policies and guidelines will ensure that industry burden to implement such policies is reasonable and does not unduly restrict the advancement of the industry while their implementation remains socially acceptable and environmentally sound.

Production of aquatic organisms is commonly considered an agricultural enterprise. Federal and state agriculture agencies and Land Grant university programs provide to the U.S. aquaculture industry services that are traditional to terrestrial agriculture. These services include, but are not limited to crop insurance, veterinary services, industry statistics, marketing (research and advocacy), farm design, pesticide management and licensure, and animal and plant husbandry. The U.S. Department of Agriculture is expanding its programs to encompass aquaculture, and has created five regional aquaculture centers to provide applied research and production information appropriate for those regions. Sea Grant also provides significant funding and technical assistance and conducts research for development and research of aquaculture systems and programs, including funding. Aquaculture has been a long-standing interest of the National Marine Fisheries Service (NMFS), and NMFS has provided substantial support to the growth and development of U.S. based aquaculture.

The mission of the Atlantic States Marine Fisheries Commission (Commission) is “to promote the better utilization of the fisheries, marine, shell, and anadromous, of the Atlantic seaboard by the development of a joint program for the promotion and protection of such fisheries...”

(ASMFC 2001). Many of the issues the Commission deals with are relevant to both capture fisheries and aquaculture, including preservation and enhancement of our natural resources, habitat concerns, and data collection and monitoring. The Commission has a desire to ensure that aquaculture development is conducted in concert with maximizing the benefits from natural harvest fisheries and protection of their habitat. This document offers useful guidance for states in dealing with these topics in a way that will facilitate development of responsible aquaculture.

Many Atlantic coastal states have enacted legislation, regulations, and programs which address many of the topics contained in this document. However, few states have fully addressed all topics. References and examples are provided for many of the topics in order to assist those states that choose to more fully address aquaculture development within their jurisdictions. The examples provided are not a comprehensive list of examples for a topic, but are meant to give the reader a starting point to find more information. Because of the variability of species, culture systems, and ecosystems along the Atlantic coast, there is no single solution to any given topic. Inclusion of specific references, therefore does not imply endorsement by the Commission. Contact information (e.g. mailing address, phone number, web page address) for the programs listed in the examples can be found in Appendices B and C.

References

Atlantic States Marine Fisheries Commission. 2001. Interstate Fisheries Management Program Charter. 23 pp.

Black, Kenneth C. (editor). 2001. The Environmental Impacts of Aquaculture. Sheffield Academic Press, United Kingdom. 214pp.

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Objectives

In September 1998, the National Marine Fisheries Service (NMFS), in cooperation with the Commission and its member states, conducted a state-federal Atlantic coastal aquaculture workshop (NMFS 1998). This workshop developed recommendations on several different areas, including strategic planning, fishery management plan integration, aquaculture data collection, and integration of mandates related to aquaculture. Several recommendations focused on potential future work in coordination of aquaculture activities. Relevant recommendations from the workshop include the following.

- Partnerships among state and federal fishery management agencies should be improved relative to aquaculture and associated marine resources stewardship responsibilities.

- The Food and Agriculture Organization of the United Nations (FAO) "Code of Conduct for Responsible Fisheries"(FAO 1995) may have some relevance to state/federal relationships concerning aquaculture. The Commission should review the applicable section of the Code involving aquaculture, adapt it where appropriate, and (possibly) adopt it.

- Prominent interstate issues concerning aquaculture and multi-state drainages (shared waters) include: water quality, fish health, stock genetics and introductions, enhancement potential for rebuilding natural stocks, and associated long-term monitoring needs.

- Roles of the Commission on pertinent aquaculture issues include development of aquaculture standards/best practices; review of the "Code of Conduct for Responsible Fisheries", establishing a framework for provision of necessary information of aquaculture to technical committees and management/policy boards (NMFS 1998).

These recommendations outlined the objectives of the current document.

The intent of this document is to provide guidance to state fisheries management agencies and other state agencies with authority over, or other interest in aquaculture to address industry development and other aquaculture activities within their jurisdiction. The guidance presented is voluntary for Commission member states and is not intended for use by the Commission itself in the development of aquaculture regulations. Provided is a list of topics that should be considered by those states that want to develop more detailed procedures, protocols, or "codes of practice" in support of responsible aquaculture. These guidelines may also be used as a reference document by ASMFC Commissioners so that they may more fully understand the myriad environmental, administrative, ecological, and industry related matters that should be considered when dealing with more species-specific aquaculture issues.

Specific objectives of this report are:

- ➢ to provide guidance for responsible aquaculture activities, taking into account the relevant biological, technological, economic, social, environmental, and commercial aspects;
- ➢ to serve as an instrument of reference to help jurisdictions establish or improve the legal, institutional, and regulatory framework required for development and exercise of responsible aquaculture;

- ➢ to provide guidelines and criteria for elaboration and implementation of policies for assuring health and viability of fisheries resources and their habitats in the presence of aquaculture development;

- ➢ to provide guidance which may be used where appropriate by individual states in the formulation and implementation of interjurisdictional agreements and other legal instruments;

- ➢ to facilitate and promote technical, financial, and other cooperation for the conservation of fisheries resources with consideration for the development of responsible aquaculture;

- ➢ to assure protection of living aquatic resources, their habitats, and coastal areas from impacts associated with aquaculture activities.

This document has not been developed with the intent to provide specific implementation strategies or detailed procedures or protocols for any given topic. Because of the wide range of species under culture, culture systems used, and ecosystems along the Atlantic coast, it would not be practical to develop a single, comprehensive document with specific policies for all the topics addressed in this document. Such details are more appropriately developed for individual jurisdictions, species, or industry sectors. Also, this document is not an attempt to improve upon or contradict existing programs, such as the Animal and Plant Health Inspection Service and the National Shellfish Sanitation Program, that address many of the included topics. It will, however, serve as a checklist of topics that state and other agencies may wish to consider, and an abbreviated list of references and examples from which to learn more about the topic and how other agencies have handled similar issues.

Although not all topics are relevant to every jurisdiction, states are encouraged to consider all of the topics presented in this report. States can then determine which issues are important locally or regionally and act accordingly. Because the guidance proposed in this report is voluntary, states are not required by this report to take action on any issue.

References

Food and Agriculture Organization of the United Nations. 1995. Code of Conduct for Responsible Fisheries. 74pp.

National Marine Fisheries Service. 1998. State-Federal Atlantic Coastal Aquaculture Workshop: Findings and Recommendations. 19pp.

Structure and Content

This document is modeled after the Food and Agriculture Organization of the United Nations (FAO) "Code of Conduct for Responsible Fisheries, Article 9 (Aquaculture Development)" (FAO 1995), and its supporting document, FAO "Technical Guidelines for Responsible Fisheries 5" (FAO 1997), but is more specifically tailored for the U.S. Atlantic coast states. Recommendations were developed to be applicable to offshore, coastal, and inland aquaculture of marine, diadromous, and freshwater species.

Guidance was developed using a two-part process: 1) contribution from Atlantic coast aquaculture experts, industry representatives, and university personnel to identify relevant topics and concerns in draft form, and 2) review and modification of the draft for applicability to Atlantic coast states. Topics relevant to aquaculture were identified by a Steering Committee composed of state, federal, and industry representatives and then grouped into the following five broad categories:

- Natural Environment
- Biological and Ecological Integrity
- Siting, Permitting and Monitoring
- Administration
- Industry Development.

Guidance was developed for topics relevant to each category through a series of workshops and workgroup meetings. Participation at these meetings and workshops included aquaculture and fishery experts from state, federal, industry, university, and non-government organizations (Appendix A). Input has also been received from the Commission's Management and Science Committee, Law Enforcement Committee, and Habitat Committee, as well as state and federal fisheries, aquaculture, and habitat interests during open comment periods.

The guidance proposed in this document is intended to allow the development of responsible aquaculture, while preserving natural resources, including Atlantic coastal fisheries and fish habitat. It should be noted that, although not explicitly expressed in the recommendations, preservation of human health and welfare is also a high priority and should be considered at all stages during aquaculture development. Aquaculture, as with any industry, should be developed and managed in such a way that aquaculture facilities, their operation, and their products and byproducts do not present threats to the environment or public health and safety.

Each topic presented includes a title, guidance on how the topic may be addressed, rationale that supports the guidance, a brief list of examples and references from which to gather additional information, and a list of related sections within the document. There are many references in this document to specific agencies or organizations involved with aquaculture. Federal agencies, including the U.S. Department of Agriculture (USDA), USDA Animal and Plant Health Inspection Service (APHIS), Environmental Protection Agency (EPA), Food and Drug

Administration (FDA), Army Corps of Engineers (ACOE), U.S. Coast Guard (USCG), and the National Marine Fisheries Service (NMFS) closely regulate or provide critical services to the industry and its various components. In addition, international organizations, such as the Food and Agriculture Organization of the United Nations (FAO) and the International Council for the Exploration of the Seas (ICES) have developed guidance documents for several important topics pertinent to aquaculture. Many Atlantic coastal states have also enacted legislation and/or regulations to address many of these topics. However, few states have fully addressed all topics. References are provided for these topics in order to assist those states that choose to more fully address aquaculture development within their jurisdictions. Inclusion of examples does not imply endorsement by the Commission. A partial list of state and federal agencies, as well as national and international organizations is provided in Appendices B and C.

It is recognized that each state may use a different definition for aquaculture that is legally binding in their jurisdiction. For the purposes of this guidance document, however, aquaculture and its components are defined as follows:

Aquaculture: The farming of aquatic organisms including, but not limited to fish, molluscs, crustaceans, echinoderms, and plants. Farming implies some sort of intervention in the rearing process to enhance production including, but not limited to controlled propagation, feeding, protection from predators, etc.

Commercial aquaculture: Aquaculture to produce products intended for sale. Commercial aquaculture implies individual or corporate ownership of the stock being cultivated.

Fisheries management aquaculture: Aquaculture intended to restore stocks of, enhance the recruitment of, or establish fisheries for one or more aquatic species.

Research and education aquaculture: Aquaculture intended to provide organisms for educational, research, or display purposes.

References

Food and Agriculture Organization of the United Nations. 1995. Code of Conduct for Responsible Fisheries. 74pp.

Food and Agriculture Organization of the United Nations. 1997. FAO Technical Guidelines for Responsible Fisheries 5: Aquaculture Development. Rome, Italy. 40pp.

NATURAL ENVIRONMENT

Aquaculture has, as do many other uses of the aquatic environment, the potential to affect the environment at the aquaculture site and surrounding areas. In public trust lands and waters, it is important to avoid or minimize any adverse impacts in these areas and, where possible, to establish practices that enhance the environment. Impacts on the environment can be prevented or minimized if agencies, industry, and other stakeholders cooperatively develop sound aquaculture strategies. Monitoring of the physical environment, biota, and water quality in the area should be considered before an aquaculture facility begins operation and during operation to ensure that the facility does not cause any unacceptable environmental impacts. Many management practices can increase the efficiency of aquaculture practices, minimize impacts, and have the potential to improve environmental quality.

Best Management Practices

GUIDANCE: The development and use of Best Management Practices should be encouraged for all aquaculture operations.

Adherence to Best Management Practices (BMPs) and similar documents that outline efficient and environmentally responsible operational procedures and technologies can minimize environmental impacts and encourage production. Best management practices have been used in agriculture and other industries for many years. Aquaculture BMPs and other similar documents should be designed to avoid or minimize environmental impacts while encouraging efficient and responsible aquaculture practices. BMPs can prevent or minimize effects to soil, ground and surface water, and wetlands by managing operations, such as effluents, therapeutic use, dredging, and facility design. BMPs can promote environmental protection through environmental impact assessment, effluent awareness, and protection of native ecosystems. Operational benefits that may result from BMPs include improved aquatic organism health, improved acceptance by other user groups, decreased operational costs, improved product quality and marketability, and concise and non-redundant permitting and paperwork.

The development of BMPs should be done cooperatively between states and industry, with contribution from other stakeholders. BMPs developed for state operated aquaculture facilities may serve as operational models for the industry. Because the aquaculture industry is evolving and growing, and aquaculturists need to use and develop novel approaches to challenges, BMPs should be adaptable and dynamic.

Examples of best management practices and documents advocating their use include:

- Florida Department of Agriculture - Aquaculture Best Management Practices
- Food and Agriculture Organization of the United Nations - Code of Conduct for Responsible Fisheries
- Atlantic States Marine Fisheries Commission - Protocols for aquaculture of Atlantic sturgeon in Addendum I: ASMFC Terms, Limitations, Enforcement Requirements
- Global Aquaculture Alliance - Codes of Practice for Responsible Shrimp Farming
- Georgia Department of Agriculture - Agricultural BMPs for Protecting Water Quality in Georgia (applied to aquaculture activities)
- U.S. Marine Shrimp Farming Program - Preliminary Quality Assurance Guidelines for *Penaeid* Shrimp Seed and Broodstock
- Shrimp Improvement Systems, LLC - Best Management Practices for Shrimp Health Maintenance

See also: Lease Agreements, Permitting and Planning; Industry Management Practices.

Water Quality and Quantity

Supply

GUIDANCE: Approved aquaculture facilities should be assured access to water of sufficient quality and quantity for successful operation, provided the water supply for public use is not adversely diminished.

Safe and efficient production of cultured and wild organisms often requires an ample supply of clean water. Insufficient quantities or poor quality of intake water can hinder the productivity and profitability of an aquaculture operation. Steps should be taken to ensure an equitable balance between various public and private uses of limited water resources. Aquaculture operations should not be sited where the water supply is of insufficient quantity or quality for successful operation. The determination of "sufficient" may be operation specific, since different types of operations can function at different ranges of water quality and quantity, and some operations may even be beneficial to areas with reduced water quality (*e.g.* production of shellfish to remove suspended organic particles).

Discharge

GUIDANCE: Sound aquaculture practices and water quality management should be promoted to ensure that aquaculture operations do not deleteriously affect the quality of the water. At a minimum, these measures should meet state and federal water quality regulations.

Some aquaculture operations have the potential to degrade the quality or quantity of water available for public uses, while others may improve water quality. Water quality issues associated with aquaculture operations should be addressed during the planning/design, construction, and production phase. These issues include:

- site selection,
- feeding or supplementary diet practices,
- disease control and use of therapeutics,
- disposition of grow-out and processing wastes,
- normal site and crop maintenance,

- water circulation and flow pattern assessment,
- evaluation of nutrient loading and associated phytoplankton growth, and
- analysis and treatment of suspended solids.

Appropriate pollution prevention measures should be implemented to minimize impacts of wastewater discharge. In general, aquaculture operations should not discharge wastewater containing nutrients, suspended solids, and other substances, in amounts sufficient to degrade the integrity of receiving ecosystems. Environmental monitoring and data collection programs can be used to monitor the effects of discharge on local water quality and the surrounding environment. It is crucial that state water quality continue to meet or exceed the requirements of existing water quality regulations to ensure the availability of sufficient amounts of clean water for aquaculture and other uses.

Close communication should be maintained between states and the aquacultured industry regarding reliable, cost-effective techniques to measure and monitor water quality and use of practices that reduce impacts of aquaculture on water quality. Incentives may be established for aquaculturists to take extra measures to improve water quality beyond those levels established in regulation.

Federal and state agencies have developed regulatory programs implementing legislation to protect water quality and quantity. Examples include:

- Environmental Protection Agency - Clean Water Act
- Environmental Protection Agency - Proposed effluent guidelines for aquaculture
- Food and Drug Administration - National Shellfish Sanitation Program
- New Jersey Division of Fish and Wildlife - Water Policy and Supply Council guidelines for water diversion
- State of Florida - Aquaculture Best Management Practices
- U.S. Department of Agriculture - Water Quality Information Services
- Georgia Department of Agriculture - Best Management Practices to Protect Water Quality
- North American Lake Management Society - BMPs to protect water quality
- Rhode Island Department of Environmental Management - Water Quality Certificate [for aquaculture applicants]

See also: Facility Design and Siting; Disposal of Facility Waste; Therapeutic and Chemical Usage; Environmental and Facility Monitoring; Data Collection and Management; Research, Extension and Information Exchange.

Protection of Physical Habitat

GUIDANCE: Appropriate mechanisms to prevent or minimize loss or physical alteration of public trust habitats resulting from construction and operation of aquaculture facilities should be cooperatively developed and adopted by states, industry, and adjoining jurisdictions.

Construction or operation of aquaculture facilities may have negative impacts on both aquatic and terrestrial physical habitats. The potential for negative impacts to physical habitat should be addressed during the environmental assessment and permitting process. This evaluation should be accompanied by exploration of appropriate strategies to avoid, minimize, or mitigate these impacts. Strategies that avoid or minimize negative impact should be applied prior to and during construction of an aquaculture facility, and through appropriate monitoring and operational protocols afterwards. In instances when public trust lands or waters are negatively impacted, it is important that these impacts are addressed through development and implementation of appropriate minimization or mitigation strategies. Habitats that are rare, of special significance, or especially sensitive may need special consideration. In many Atlantic coast states an environmental review is required or could be required for an aquaculture application (Cicin-Sain *et al*. 2001).

Aquaculture facilities may represent an opportunity for preservation or enhancement of habitats or provide other benefits to fish and wildlife habitats. Potential trade offs between habitat types should be weighed in the context of appropriate public and private values. Incentives may be considered for aquaculture operations that provide a demonstrated gain to fish or other wildlife habitats.

State and federal agencies have implemented regulations, legislation, and other mechanisms to protect the physical environment, including:

- Connecticut Department of Agriculture Bureau of Aquaculture
- Connecticut Department of Environmental Protection - permit requirements for placement of fill, dredging and structures.
- NOAA Coastal Zone Management Program - Coastal Zone Management Act
- Army Corps of Engineers - Mohegan Tribe Permit Application
- Florida Department of Agriculture - Best Management Practices for aquaculture activities, includes provisions for wetlands protection
- Massachusetts Office of Coastal Zone Management - Aquaculture Strategic Plan Environmental Review Recommendations (Chapter V)
- State of South Carolina - Marine Resources Act of 2000
- Cicin-Sain, B., S.M. Bunsick., R. DeVoe, T. Eichenberg, J. Ewart, H. Halvorson, R. Knecht, R. Rheault. 2001. Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 mile U.S. Ocean Zone. Center for Study of Marine Policy, University of Delaware.

See also: Environmental and Facility Monitoring; Facility Design and Siting; Facility Reclamation.

Therapeutic and Chemical Usage

GUIDANCE: The adoption of aquaculture practices that promote responsible use of therapeutic and chemical treatments should be encouraged.

Only a few drugs and chemicals have been approved for use in aquaculture. Practices that strive to optimize production and to employ aquatic health management programs can reduce the need for therapeutic and/or chemical interventions. Guidelines on proper chemical usage by industries neighboring aquaculture facilities can protect aquaculture operations and the environment.

Therapeutic and/or chemical interventions can be minimized through appropriate stocking density and husbandry management techniques that can ensure product quality and minimize disease incidence. When a disease is suspected, a proper diagnosis should be made by a qualified aquatic animal health professional. Issuance of prescriptions can only be made by a licensed veterinarian. Many drugs and chemicals have mandatory withdrawal times for animals used for human consumption, which must be strictly followed. The proper use of drugs and chemicals in aquaculture will help to minimize environmental exposure from potential drug/chemical threats.

Appropriate guidelines should be developed and established for the proper use of other chemicals (*e.g.* pesticides, insecticides) near aquaculture facilities, including those used for non-aquaculture related activities. All chemical applicators should be advised to avoid compromising aquaculture facilities through aerial spraying of agents with high drift potential and high toxicity for aquatic organisms. Establishment of routine monitoring activities for specific agents may be beneficial, especially in environmentally sensitive areas.

Requirements for the use and disposal of drugs and chemicals, as well as record keeping and reporting requirements are mandated through the Food and Drug Administration Center of Veterinary Medicine and the Environmental Protection Agency. Aquaculturists should be provided with updated regulatory information, and industry should be required to keep accurate on-farm records of drugs and chemicals.

Information on therapeutic and chemical usage is available from the following:

- Food and Drug Administration
- Environmental Protection Agency - Licensing and Certification
- U.S. Department of Agriculture - Animal and Plant Health Inspection Service
- Federal Joint Subcommittee on Aquaculture - National Coordinator for Aquaculture New Animal Applications
- National and State Cooperative Extension Agencies
- University of Nebraska at Lincoln - Pesticide Education Program

See also: Health Management; Health Evaluation; Environmental and Facility Monitoring; Data Collection and Management.

Disposal of Facility Waste

GUIDANCE: Comprehensive aquaculture facility waste management practices that minimize waste and the potential negative impacts of waste disposal should be promoted.

Improper waste disposal practices can present a hazard to human and animal health as well as the environment. Proper management and disposal of biological waste (*e.g.* feed products and animal by-products), chemical waste (*e.g.* cleaning products and therapeutics), and physical waste (*e.g.* unwanted gear, shipping and packaging materials, plastics) by aquaculture facilities will minimize these risks.

Efficient and comprehensive waste management practices can significantly reduce the quantity of waste that must be disposed and subsequent negative environmental impacts. Waste management and disposal practices should be considered during facility siting and design, and through all phases of production. Wastes that cannot be recycled or used should be disposed of in a safe and approved manner in accordance with local laws and regulations. Excess drugs and pesticides should be disposed of according to label directions and applicable laws and regulations. Control of odors and feeding regimes should also be considered.

Recycling and alternative uses of waste material should be encouraged, when practical, to reduce the cost of disposal and the amount of waste that must be disposed. Recycling and alternative use of aquaculture waste, such as polyculture, composting, or use of waste as fertilizer, can result in cost savings to aquaculture facilities, reduction in waste disposal, and reduction of environmental impacts while providing benefits such as low cost fertilizer to the public and other sectors of agriculture.

Several state and federal agencies have implemented programs for disposal of facility waste, including:

- New Jersey Department of Agriculture - Animal Waste Protocol for Aquaculture
- Idaho Department of Environmental Quality - Waste Management Practices for Aquaculture Operations
- British Columbia Ministry of Agriculture, Food and Fisheries - Aquaculture Waste Control Regulations
- Environmental Protection Agency - Clean Water Act - requires permit for discharge of waste into the nation's waterways

See also: Water Quality and Quantity; Protection of Physical Habitat; Therapeutic and Chemical Usage.

Facility Reclamation

GUIDANCE: Steps should be taken to assure that public trust resources occupied by aquaculture facilities will revert through sovereignty to the state after being vacated and/or abandoned by the operator of the facility. Proactive measures should be taken in anticipation of intentional or unintentional facility or property abandonment to ensure that publicly owned sites can be reclaimed without public expense and with minimal risk of long-term impact.

An aquaculture facility or its components may be vacated after use for many different reasons. These may range from closure of an entire facility for financial reasons to loss of gear or structures due to natural disasters. Established guidelines for reclamation activities can speed the reclamation process and may be especially beneficial when problems arise such as uncertainty of property rights, monitoring or legal responsibility for the risks associated with abandoned facilities.

A process should be established to ensure that public trust resources revert to the state upon abandonment by the aquaculture facility. This process should also ensure that any unacceptable impacts or alterations of public trust habitat be ameliorated, remediated, or restored. Appropriate measures might be developed for instances when abandoned privately owned sites have secondary effects on public resources.

A legal framework might be established to enable assessment of risk prior to permit issuance, to deny permits in instances of unacceptable risk, and to take remedial action upon facility failure or abandonment. Such a framework could include reversion, restoration, and remediation language in licenses, leases, and other forms of proprietary authorization. Regulatory agencies and industry should work together to develop remediation, reclamation, and restoration plans that include permit conditions for gear removal and site remediation. Such plans could identify options for financial support of remediation activities, such as performance bonds and letters of credit. The performance bond should be of a sufficient duration and amount to cover the costs of removal of any structures and restoration of sites to the satisfaction of the regulatory agency. Several Atlantic coast states require or may require some sort of financial obligation (performance bonds, royalties, or annual fees) for lease holders which can be used for reclamation and mitigation efforts (Cicin-Sain *et al*. 2001).

Several state agencies have addressed issues regarding facility reclamation including:

- State of South Carolina - Statutes related to mariculture of molluscan shellfish - escrow account
- Rhode Island Coastal Resources Management Council
- State of New Hampshire - Code of Administrative Rules
- State of Florida - Aquacultured Policy Act - per acre surcharge for leases
- State of South Carolina - Marine Resources Act of 2000
- Cicin-Sain, B., S.M. Bunsick., R. DeVoe, T. Eichenberg, J. Ewart, H. Halvorson, R. Knecht, R. Rheault. 2001. Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 mile U.S. Ocean Zone. Center for Study of Marine Policy, University of Delaware.

See also: Lease Agreements, Permitting and Planning; Ownership and Tenancy Privileges; Protection of Physical Habitat.

BIOLOGICAL AND ECOLOGICAL INTEGRITY

Aquaculture facilities and their operation can have both positive and negative effects on the surrounding environment and ecosystem. Potential benefits from aquaculture include production of organisms for stock enhancement or replacement, production of plants to restore damaged wetlands, and production of organisms for the biological control of invasive aquatic plants, and in reference to mollusc culture, water quality improvement and creation and restoration of benthic habitats. Potential physical effects include changes to critical habitat from inappropriate facility siting, altered thermal regimes, or increased turbidity from wastewater discharge. Increased nutrient loads from wastewater may eventually lead to anoxia in receiving waters. High concentrations of fish can lead to increases in predator populations or may facilitate the transmission of disease. Escapement of cultured stock can have detrimental effects on genetic diversity of conspecific wild populations, and has the potential to affect community structure. Development of aquaculture practices that minimize negative impacts and promote the benefits of aquaculture will help to conserve biological and ecological integrity of the local environment.

Stock Source and Containment

GUIDANCE: Protocols for the selection of stock source and containment of aquaculture stocks should be developed for the different types of aquaculture that take into consideration the potential for interactions with wild stocks.

Concerns regarding genetic fitness of cultured and wild stocks and transfer of disease to both wild and cultured products can be addressed through proper stock source selection and containment measures. Aquaculturists should be made aware of the various potential genetic implications, disease transfer concerns, and community effects associated with some culturing activities. Criteria used for the selection of aquacultured stock that will eventually be purposefully released to the environment (*i.e.* fisheries management aquacultured) may be different from those used for research or commercial aquacultured that are not intended for release. Regardless of the aquacultured objectives and activities, the criteria for selection of stock source should attempt to prevent or minimize disease, genetic, and community effects on local wild populations. Stock selection criteria should be used in conjunction with appropriate containment strategies, sterilization techniques, and other practices to minimize deleterious interactions with wild or other aquaculture stocks, including harmful genetic effects, escapement of non-indigenous species, and spread of disease agents in effluents. The potential for escapement of cultured stock through vandalism should also be addressed.

Stock acquisition of indigenous species should be based upon availability of local wild stock, when possible, and follow other specific protocols (such as a prescribed broodstock genetics plan) to avoid detrimental effects on native stocks or established fisheries. The issue of population effects of removals of managed stocks and/or ecologically linked stocks may need to be addressed. Stock removals of managed species may need to be counted against quotas or accounted for in population models and stock management decisions. When wild stock is collected, particular care needs to be exercised to avoid undesired species or strains mixing with desired species, or the selection of stock with undesirable traits. The use of non-indigenous species may present particular concerns.

Information on stock source selection and containment can be found through the following agencies:

- Maine Aquaculture Industry Association - Containment Management System for Atlantic salmon (currently being developed)
- South Carolina Department of Natural Resources - Procedures for permitting non-indigenous shrimp importation and possession - source questionnaire and containment requirement
- American Fisheries Society - Use and Effects of Cultured Fish in Aquatic Ecosystems
- North American Commission of the North Atlantic Salmon Conservation Organization - Protocols for Introduction and Transfer of Salmonids
- Atlantic States Marine Fisheries Commission - Recommendations Concerning the Stocking of Striped Bass in Atlantic Coastal Waters
- International Council for the Exploration of the Seas - Code of Practice on the Introductions and Transfers of Marine Organisms
- Maine Atlantic Salmon Conservation Plan
- DeVoe, M.R. (ed.) 1992. Introductions and Transfers of Marine Species: Achieving Balance Between Economic Development and Resource Protection. South Carolina Sea Grant Consortium. Charleston, South Carolina. 198 pages.

See also: Genetic Integrity; Health Management; Health Evaluation; Distinction of Wild Stocks and Aquaculture Products; Non-indigenous Species.

Health Management

GUIDANCE: Health management strategies for aquaculture organisms should be created and implemented through the cooperative effort of states, federal agencies, industry, veterinarians, and scientists.

Aquatic Organism Health Management

Comprehensive health management systems can help to minimize disease transmission among cultured stocks, and between cultured and wild stocks. Environmental and husbandry conditions should be monitored to provide an indicator of disease incidence and severity. Health management systems should incorporate available disease expertise, information on the severity and infectivity of specific pathogens or parasites, geographical and historical information, meteorological conditions, and identification of indigenous and cultured species potentially affected.

Aquaculturists should be encouraged to adopt practices that promote disease prevention. Effective aquatic animal health management policies recognize the primary importance of disease prevention before employing innovative diagnostics and treatment regimes. Effective animal health programs contribute to optimizing animal productivity. Some basic tenets of aquatic organism health management that should be considered are:

- maintain water quality,
- promote disease prevention, diagnosis, monitoring, and treatment,
- report disease outbreaks, when necessary,
- optimize nutrition,
- employ quarantine protocols, and
- ensure proper sanitation of facilities and equipment and disposal of mortalities.

With efficient aquatic organism health management, advances in technology can be better used and understood for disease prevention, diagnosis, and treatment.

Proactive measures for disease diagnosis and containment

It should be recognized that the presence of a pathogen does not equate to disease. Information on containing a disease outbreak and appropriate authorities and points of contact for each state should be provided to all aquaculturists. Notification of suspicion and verification of disease should be considered essential. Disease research and local and regional collaboration in disease matters should be encouraged in all states.

Criteria should be established for disease classification based on:

- ➢ geographic range and distribution of the pathogen or parasite in North America and for each state,
- ➢ availability of accurate diagnostic tests and treatments,
- ➢ pathogenicity and virulence of the pathogen,
- ➢ reviewed scientific literature on the nature of the pathogen or parasite,
- ➢ species of organisms at risk, and
- ➢ creation of regional and national databases for potential pathogens and parasites.

Disease Transmission

Strategies should be developed in order to plan for the occurrence of a variety of diseases and to contain outbreaks of diseases listed as potential threats. These strategies should incorporate basic tenets for aquatic organism health management and incorporate means for risk analysis, so actions can be taken in the event of an outbreak to prevent further transmission of disease to other aquaculture stocks and wild populations. Health management practices at aquaculture facilities should ensure against reinfection after reportable disease outbreaks. Risks should be evaluated regarding disease transfer from wild stocks or frozen and live products imported from other countries or states, where potential pathogens exist, especially if these products are used for, or come in contact with, other aquaculture or wild stocks. A mandatory quarantine or veterinary screening may reduce the potential for disease transmission to local wild or cultured stocks. Risks from aquaculture activities should also be evaluated relative to risks of transfer by other vectors, both natural and anthropogenic.

Agencies that have implemented aquatic organism health management protocols and/or health certification programs include:

- ➢ Food and Drug Administration - Center for Veterinary Medicine
- ➢ U.S. Department of Agriculture - Animal and Plant Health Inspection Service (APHIS) - programs and services to protect health of aquatic plants and animals, including a National Aquatic Animal Health Plan
- ➢ American Veterinary Medical Association - Aquaculture and Seafood Advisory Council
- ➢ New Jersey Division of Fish and Wildlife, and Department of Agriculture
- ➢ Florida Marine Research Institute - Aquatic Health Program
- ➢ South Carolina Department of Natural Resources - Procedures for permitting non-indigenous shrimp for importation and possession - disease control component
- ➢ Office of International Epidemiology (Office International des Epizooties)- International Aquatic Animal Health Code

See also: Health Evaluation; Therapeutic and Chemical Usage; Water Quality and Quantity; Diseased Product Destruction; Lease Agreements, Permitting and Planning; Transfer and Transport.

Wildlife and Cultured Stock Interactions

GUIDANCE: Mechanisms to ensure that aquaculture facilities and operations avoid or minimize harmful effects to both wild aquatic and terrestrial organisms should be developed and adopted.

The possible effects of aquaculture on wild stocks and their habitats, especially those of endangered, threatened or protected species, should be addressed through implementation of appropriate planning, permitting, and operational practices. Strategies should decrease the potential for aquaculture operations to alter local ecological communities, which can lead to inter- and intra-specific effects on local fish and wildlife populations. Consideration should include potential interactions with structures and machinery. Examples of possible effects from aquaculture operations include changes in species composition, genetic diversity, or community structure, loss of habitat, introduction of diseases, and effects of shading of benthic habitats by floating or suspended enclosures. These impacts might be controlled through adoption of appropriate operational practices, criteria for design and siting of facilities, protocols for the selection of culture species and stock source, and protocols governing the sale and transport of aquaculture animals and products.

The potential for negative effects should be assessed through environmental assessment during the siting and design phases. Environmental and facility monitoring programs should be used during facility operation to determine if negative interactions are occurring and if mitigation efforts are needed or are effective.

Examples of interactions between wild and wild-cultured stocks, and possible solutions, include:

- Release of brown trout (predator) into brook trout (prey) streams
- *Nori sp.* longline culture interaction with oyster reefs
- Seal depredation on pen cultured salmon
- British Columbia Salmon Farmers Association - Predation Working Group
- Increases in cormorant populations feeding in open aquaculture systems
- USDA, APHIS, Wildlife Services - wildlife depredation management

See also: Stock Source and Containment; Predator Control; Lease Agreements, Permitting and Planning; Genetic Integrity; Facility Design and Siting; Environmental and Facility Monitoring.

Genetic Integrity

GUIDANCE: Strategies should be adopted to minimize the potential that the genetic fitness (including both genetic variation and genetic composition) of wild populations would be diminished by aquaculture activities.

Genetic diversity in cultured stocks may be limited compared to wild populations. Reduced genetic diversity, whether intentional (*e.g.* selective breeding for desirable culture traits) or unintentional (*e.g.* limited broodstock) may cause undesirable effects that can be passed on to wild populations through interbreeding of wild and cultured stock.

The genetic concerns and implications for any given aquaculture facility will depend on the type of aquaculture being performed (fisheries management, commercial, or research aquaculture). Intentional or unintentional escape or release of cultured non-indigenous or genetically modified species may impact local or regional ecosystem structure, biodiversity, wild-stock fisheries, and other economic or sociological entities. The consequences of escape or release vary greatly, depending on the species and the ratio of the number of cultured to wild conspecific animals. These consequences are difficult to predict, and once manifested, are difficult to reverse. Intensive domestication of cultured species to minimize the impact of interaction between escaped culture species and wild conspecifics is controversial and requires species specific consideration. If the potential for interbreeding is high, then more effort needs to be made to assure that aquacultured organisms are genetically similar to wild stocks to reduce potential impacts.

Because the products of fisheries management aquaculture will be released into the wild for stock enhancement or restoration purposes, it is particularly important to mimic, as much as possible, the genetic diversity of the natural population so that the natural genetic diversity of the population can be preserved. Protocols should be developed to ensure that broodstock intended for stock enhancement or restoration purposes is selected from the most appropriate gene pool. All stock enhancement and restoration efforts should be monitored for the genetic effects of the stock enhancement on the recipient wild population.

When aquaculture is being conducted for purposes other than intentional release to the wild, redundant mechanisms should be devised to ensure the containment of any cultured species that is not indigenous or has been genetically selected or modified. To minimize the potential for negative effects resulting from unintentional escape, aquaculture of native or indigenous, non-genetically selected species should be encouraged, as should research to enhance the feasibility of native species aquaculture and marketability of native species aquaculture products.

Aquaculturists should be advised of the benefits to both their aquaculture operations and to the environment of integrating good genetic principles into their aquaculture activities. Appropriate

methods should be developed for selective breeding (domestication) and early detection of negative side effects during the selection process. Such methods should include full consideration for the potential risks to wild stocks and strive to minimize the impacts to genetic integrity of wild stocks.

Information on genetic integrity include:

- North American Commission of the North Atlantic Salmon Conservation Organization - Protocols for the Introduction and Transfer of Salmonids (Part III Protocols for Maintenance of Genetic Diversity)
- Alaskan Department of Fish and Game - State of Alaska Finfish Genetics Policy
- San Joaquin District Department of Water Resources - Genetic Maintenance: San Joaquin River Management Plan for Salmon
- Atlantic States Marine Fisheries Commission -Recommendations Concerning the Stocking of Striped Bass in Atlantic Coastal Waters
- Atlantic States Marine Fisheries Commission - Culture and Stocking of Atlantic Sturgeon
- Hindar, K, N. Ryman, and F. Utter. 1991. Genetic effects of cultured fish on natural fish populations. Canadian Journal of Fisheries and Aquatic Sciences 48: 945-957.

See also: Stock Source and Containment; Non-indigenous Species; Health Management; Research, Extension and Information Exchange.

Non-indigenous Species

GUIDANCE: Use of indigenous species for aquaculture should be encouraged to reduce the potential negative effects associated with non-indigenous species introductions. Consultation should be made with neighboring states and all levels of government, as appropriate, before placing or introducing non-indigenous species into trans-boundary aquatic ecosystems.

In certain circumstances, use of non-indigenous species in aquaculture has been successful. However, their use requires risk assessment with regard to potential impact from intentional or unintentional release, or outbreak of disease not previously encountered in the region. These concerns can be minimized when indigenous species are used for culture. However, use of indigenous species presents unique concerns for amplification of pathogens and possible genetic concerns.

Although only a small fraction of non-indigenous species become damaging invasive species, steps should be taken to avoid or minimize adverse effects on wild stocks and geographically associated aquaculture activities from intentional and unintentional introduction of non-indigenous species. Ecological assessment and surveys of local aquatic ecosystems can help determine what local species may be affected by aquaculture development and what local species may be utilized instead of importing non-indigenous species. Existing guidelines for evaluating the use of non-indigenous species and invasive species should be reviewed, with attention to implementation steps during and following the decision to use such species. Research to enhance the feasibility of indigenous species aquaculture and marketability of indigenous species aquaculture products should be promoted.

Risk assessment procedures should be used to evaluate the environmental risks of non-indigenous species during the species and source selection process. Issues that should be addressed include, but are not limited to:

- the potential for release, escape, or accidental loss of cultured stock,
- the fitness for survival and reproduction of the cultured animals and potential interactions that may occur between cultured and native or indigenous fauna and flora,
- steps needed to avoid or minimize negative effects, such as genetic technology and improved containment designs and practices, and
- contingencies and remedial solutions to mitigate any negative effects that do occur.

Agencies that have developed protocols for addressing issues involving non-indigenous species include:

- ➢ International Council for the Exploration of the Sea (ICES) - Code of Practice on the Introductions and Transfers of Marine Organisms
- ➢ Food and Agriculture Organization of the United Nations (FAO) - International Introductions of Inland Aquatic Species
- ➢ Maryland Department of Natural Resources (included in permitting requirements)
- ➢ Maine Department of Marine Resources legislation
- ➢ State of New Hampshire - Code of Administrative Rules
- ➢ State of Florida - Aquaculture Best Management Practices
- ➢ National Invasive Species Council. 2001. Meeting the Invasive Species Challenge: National Invasive Species Management Plan. U.S. Department of the Interior, Washington, DC. 80 pages.
- ➢ Anonymous. 1996. Generic Nonindigenous Aquatic Organism Risk Analysis Review Process: For estimating risk associated with the introduction of nonindigenous aquatic organisms and how to manage for that risk. Risk Assessment and Management Committee, Aquatic Nuisance Species Task Force. U.S. Government Printing Office:1998-693-132/62087 Region No. 10. 32 pages.

See also: Stock Source and Containment; Genetic Integrity; Research, Extension and Information Exchange.

Predator Control

GUIDANCE: Appropriate methods to minimize loss of cultured product from predation and the resulting effects on wild predators should be cooperatively developed and adopted by state and federal agencies and industry.

Exposed culture systems are attractive to wildlife, especially birds, as a source of food and as aquatic habitat. Operators are often restricted in their action to control predation because of regulations and public opinion, especially with protected species. Predator control guidelines can minimize wildlife interactions that are detrimental to both natural resources and aquaculture operations.

Controls should be developed that provide reasonable depredation allowances and options to discourage or relocate nuisance species. Non-lethal means of discouragement should be the first step to avoid loss of cultured product from predators. Appropriate facility siting, enclosures or exclosures, or carefully chosen chemical means are some additional ways to avoid predation losses. In most situations, a range of control methods will need to be explored to assist in choosing the best method. Several methods used concurrently may be necessary for optimal effectiveness.

Sometimes control of wild predator populations through limited taking can be an acceptable environmental, social, or economic loss. Some methods of lethal control may have fewer negative side effects and should be recommended where possible. Research in the field of predator control for culture systems should be encouraged and supported by regulating agencies and industry. A rapid permit system for lethal controls might be considered, where appropriate.

Several agencies have developed predator controls for a variety of species, including:

- U.S. Fish and Wildlife Service - cormorant control mechanisms in the South Atlantic
- U.S. Fish and Wildlife Service and Aquaculture Extension Offices - cooperative agreements regarding depredation permits
- NMFS Office of Protected Species - sea/net pen mechanisms
- State of New Jersey - Aquaculture Development Act - mechanisms for resolution of predation problems
- USDA Risk Management Agency - crop insurance
- USDA, Farm Service Agency - Crop and Natural Disaster Assistance
- USDA, APHIS, Wildlife Services - wildlife depredation management

See also: Wildlife and Cultured Stock Interactions; Facility Design and Siting; Industry Participation in Policy Development; Research, Extension and Information Exchange; Regulatory Impediments to Aquaculture.

Health Evaluation

GUIDANCE: Health evaluation programs and policies should be created and implemented to prevent the importation or release of disease pathogens or parasites of regulatory concern. These policies should support development and utilization of technologies to identify and control disease organisms.

Health inspection and evaluation programs can minimize the potential for disease pathogens and parasites to be inadvertently introduced during production, transfer, or transport of aquacultured animals and product. Health evaluation programs and policies, including certificates of inspection, should be developed that clearly identify criteria for evaluation of animals and product prior to certification, and outline methods to periodically review those criteria. These programs should recognize and encourage the development and use of technologies to identify and control disease organisms. When necessary, health evaluation and tests for specific disease organisms should be completed by a state-approved veterinarian or aquatic organism health professional. Regional cooperation and collaboration in health evaluation, aquatic organism health, species selection, and transfer and transport policies should be encouraged.

Certificates of inspection and disease testing records could be included with shipments of aquaculture organisms or product, providing information such as species, health history, name and address of the original source, and chain of custody for that shipment. Transfer or transport of non-indigenous species or products might be subject to stricter evaluation to minimize the risk of introducing pathogens. An alternative to including a certificate of inspection or disease testing records with a shipment may be authorization obtained from appropriate regulatory authorities. To allow for repeated or multiple shipments, expedited systems such as preshipment source approvals, general permits, or memoranda of understanding could be used. Programs that periodically certify the source of the stock or products might be evaluated as an alternative to inspection of individual shipments. Incoming international shipments should follow guidelines established by appropriate governing authorities.

Disease/pathogen evaluations are also utilized to assure food safety. The mandatory procedures to report pathogens of human concern (*i.e.* shellfish viruses, dinoflagellates, and metabolites) and controls of harvest and distribution of product are well established (*e.g.* Interstate Shellfish Sanitation Commission, National Shellfish Sanitation Program, and Food and Drug Administration). Quarantine/seizure/advisory practices for aquaculture products exceeding public health guidelines are overseen by several regulatory authorities.

Examples of health evaluation programs include:

- South Carolina Department of Natural Resources - Requires source approval for shrimp and clam aquaculture
- New York Department of Environmental Conservation - Requires a health certificate
- Maine Department of Inland Fisheries and Wildlife - Health Laboratory Services
- Massachusetts Division of Fisheries and Wildlife - Health Laboratory Services
- State of Florida - Aquaculture Best Management Practices
- Connecticut Department of Agriculture, Bureau of Aquaculture - Health Laboratory Services
- Office of International Epidemiology - International Aquatic Animal Health Code
- USDA, APHIS - National Aquatic Animal Health Plan
- National Marine Fisheries Service - National Seafood Inspection and Certification Program

See also: Transfer and Transport; Health Management; Stock Source and Containment.

Transfer and Transport

GUIDANCE: Creation and implementation of uniform or compatible practices and procedures for intrastate, interstate, and international transfer (including importation), transport, and sale of aquaculture products should be coordinated among state and federal agencies and industry, as should the ability to identify and trace cultured products back to the producer.

Transfer and Importation

The transfer and importation of aquatic organisms and products, including non-indigenous species, should be regulated for the protection of the natural aquatic ecosystem and for the protection of established aquaculture activities from the potential negative impacts of inadvertent or intentional releases of competitors, predators, or disease agents. These practices may include an application process which documents information on the organism or product, such as source and health status, and the intended aquaculture activities, and may provide an administrative process involving professional review and approval or rejection of the application with proper record keeping of all activities.

Transportation and Sale

Guidelines should be employed or developed where needed to ensure that aquacultured food products are protected from contamination and deterioration during shipment and to ensure that products can be traced back to the producer. Identification of aquaculture products should be accomplished through an accurate paper trail. In those instances where a paper trail is inadequate for conservation, management and enforcement purposes, other options for identifying and tracing aquaculture products from producer to consumer should be cooperatively developed by regulatory agencies and industry.

The transportation and sale of aquacultured organisms could be regulated to allow the possession and sale of aquacultured organisms without unnecessary constraints of wild caught organisms (*e.g.* size limits, closed seasons, etc.) to assure that wild caught organisms are not illegally possessed or sold as products of aquaculture. Where appropriate, management of the transportation and sale of aquatic organisms should be accomplished through development, adoption, and implementation of cooperative practices which may include effective paper trails, prohibition on co-mingling of wild and cultured products, and accurate record keeping.

Information on transfer and transport of aquaculture products can be obtained through:

- South Carolina Sea Grant Program
- Food and Drug Administration - Interstate Shellfish Sanitation Conference and Interstate Certified Shellfish Shippers List
- State of Florida - Aquaculture Best Management Practices
- State of Rhode Island - Legislation for shipment, importation, and transfer of aquaculture products
- State of New Hampshire - Code of Administrative Rules
- Atlantic States Marine Fisheries Commission - A Procedural Plan to Control Interjurisdictional Transfers and Introductions of Shellfish (1989)
- USDA, APHIS - National Aquatic Animal Health Plan
- Anderson, W.D., C. Battey, M.R. DeVoe, J.N. Kraeuter, A. Segars, J.M. Whetstone (eds.). 2002. Eastern United States Interstate Shellfish Seed Transport Workshop. S.C. Sea Grant. 42 pp.

See also: Health Management; Non-indigenous Species; Distinction of Wild Stocks and Aquaculture Products; Health Evaluation.

SITING, PERMITTING AND MONITORING

When aquaculture operations require the use of public resources, they compete with other traditional uses of public trust water, lands, and living resources. Proper siting and operation of aquaculture facilities are important to minimize their potential to alter local environments and impact other public uses. This can be assured through development of sound policy, user allocation strategies, and monitoring programs. Clear protocols can minimize conflicts between user groups and encourage development of environmentally responsible and economically viable aquaculture ventures.

Lease Agreements, Permitting, and Planning

GUIDANCE: Strategic plans, permitting systems, and lease policies should be developed that include consideration for aquaculture, or they may be developed specifically for aquaculture.

Development of state strategic plans that outline criteria for allocation of public land and water resources may be beneficial to the aquaculture industry in the siting and operation of a facility. Planning for aquaculture activities can reduce potential for conflicts with other user groups vying for the same public resources (e.g., recreational and commercial fishing). Strategic plans should clearly address the regulatory permit standards, compliance criteria, and the proprietary responsibilities (including fiduciary, lease or license responsibilities, and mitigation requirements) in the administration and management of public trust lands, waters, and living resources. When possible, permits and leases should provide flexibility to accommodate new and evolving technologies. These standards should be periodically updated, based on field monitoring results and the best available science to ensure that sound environmental practices are followed.

The following topics should be considered in the development and review of strategic plans and the legal/regulatory requirements for aquaculture:

- Coastal zone management planning and policy activities;
- Local land use zoning, regional or local plans, state laws, and policies related to the use of public trust lands;
- Identification of points of contact for regulatory and advocacy activities regarding aquaculture;
- Development of joint aquaculture permit processing procedures between agencies in order to minimize duplication of effort and promote streamlining in the application review process;
- Clear identification of the terms and conditions of leases, licenses, and permits, including those for abandonment, removal of structures, and reversion of public trust lands;
- Clear identification of siting criteria and lessor/lessee requirements for permits, leases, and/or licenses. Inclusion of areas that are intrinsically or specifically precluded or inappropriate sites;
- Fees, if any, that are commensurate with the size, scope, and cost to the agency; and

➢ Level of assessment and monitoring commensurate with the type and scope of aquaculture proposed.

Most Atlantic coastal state agencies have enacted a permitting system for aquaculture operations, and several have developed planning documents including:

- ➢ State of Rhode Island - Permitting legislation for molluscan shellfish
- ➢ State of Connecticut - Statutes provide for lease in state and town waters
- ➢ Massachusetts Office of Coastal Zone Management - Aquaculture Strategic Plan
- ➢ Maryland Department of Natural Resources - Action Plan for Aquaculture Development
- ➢ Rhode Island Department of Environmental Management - Requires filing of an operation plan
- ➢ South Carolina Coastal Resources Management - General permit for clam mariculture
- ➢ Virginia Marine Resources Commission - Regulation pertaining to on-bottom shellfish structures and general permit for shellfish gardening
- ➢ State of Florida - Aquaculture Policy Act
- ➢ Commonwealth of Pennsylvania - Currently developing a decision tree for aquaculture permitting and regulation
- ➢ Cicin-Sain, B. S.M. Bunsick., R. DeVoe, T. Eichenberg, J. Ewart, H. Halvorson, R. Knecht, R. Rheault. 2001. Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 mile U.S. Ocean Zone. Center for Study of Marine Policy, University of Delaware.

See also: User Conflicts and Resource Allocation; Industry Participation in Policy Formation; Regulatory Impediments to Aquaculture; Ownership and Tenancy Privileges; Facility Design and Siting; Environmental and Facility Monitoring; Compliance Verification.

Facility Design and Siting

GUIDANCE: Facility siting and design criteria in the permitting process should assess effects on the environment, other resources, and other users, based on the best available information.

Site selection in many technologies is the overall key to minimize impact and protect diversity of ecosystems adjacent to aquaculture farms. Aquaculture facility design (as opposed to operational design) and the selection of locations to construct and operate aquaculture facilities are critical decisions impacting the environment surrounding the aquaculture site as well as other resources and users in the area. Site selection criteria may include hydrology, sensitive fringing habitats, etc. Consideration of the relationship of the cultured species, facility design, operational plan, and site biophysical characteristics can address concerns regarding adverse effects on the environment, other resources, and other users. Modeling of water use, flow dynamics, and nutrient discharge of proposed sites, and uptake of nutrients and suspended organic matter of proposed shellfish beds, might be useful to investigate potential impacts, both positive and negative, to the local environment, wildlife populations, and other resource users.

Design considerations should focus on eliminating or minimizing adverse interactions with local fish and wildlife populations, impacts on benthic communities, navigation hazards, and interference with other users, while ensuring structural integrity, workforce safety, and operational efficiency. The best hydrographic and engineering design criteria should be encouraged for upland, nearshore, and offshore aquaculture facilities, and evaluation should consider location of the facility with respect to potential impact from storms and floods. Siting and facility design criteria should be both comprehensive and flexible to ensure compatibility with the environment, other resources, and other users while encouraging operator compliance and providing for technology development. In many Atlantic coast states an environmental review is required or could be required for an aquaculture application in marine waters (Cicin-Sain *et al*. 2001).

Agencies that have developed protocols for facility design and siting include:

- Florida Department of Agriculture - Aquaculture Best Management Practices and Aquaculture Policy Act
- Maine Department of Marine Resources - Procedures for site review
- State of New Hampshire - Code of Administrative Rules
- The National Estuarine Research Reserve Program - Modeling of coastal water bodies
- National Marine Fisheries Service Northeast Region - Aquaculture Guidance Document
- Silver, W., and J. W. Sowles. 1996. Modeling environmental impacts of marine finfish aquaculture. Journal of Applied Ichthyology 12: 75-81.
- Cicin-Sain, B., S.M. Bunsick., R. DeVoe, T. Eichenberg, J. Ewart, H. Halvorson, R. Knecht, R. Rheault. 2001. Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 mile U.S. Ocean Zone. Center for Study of Marine Policy, University of Delaware.

See also: Water Quality and Quantity; Protection of Physical Habitat; User Conflicts and Resource Allocation; Regulatory Impediments to Aquaculture.

User Conflicts and Resource Allocation

GUIDANCE: To support development of responsible aquaculture, a public process should be instituted to identify potential areas of interaction among user groups and methods to resolve or minimize potential conflicts.

As one of many potential uses of public trust land, water, and living resources, aquaculture planning should take into consideration established or emerging uses of the same resources, such as navigation, recreational and commercial fishing, and aesthetic interests. Aquaculture operations, particularly those using public resources, should be sited following guidelines that consider the social and economic interests of all resource user groups. Alternative dispute resolution methods that fairly evaluate the concerns of all parties, such as mediation and facilitated dispute resolution, should be considered. The public should have access to unbiased, informative materials that discuss the advantages and disadvantages of aquaculture to prevent bias and conflict due to misunderstanding. Several Atlantic coast states require a public hearing prior to issuance of a marine aquaculture permit (Cicin-Sain *et al*. 2001).

Many Atlantic coastal states have existing permitting procedures for encroachment over submerged lands, including:

- State of New Jersey - Administrative code
- Virginia Marine Resources Commission - Subaqueous Permit Review Process
- Maine Department of Marine Resources - Administrative Procedure Act for hearing procedures
- The Australian Bureau of Agricultural and Resource Economics (ABARE) - Report identifying approaches used to resolve resource use issues for aquaculture
- State of New Hampshire - Code of Administrative Rules
- Cicin-Sain, B., S.M. Bunsick., R. DeVoe, T. Eichenberg, J. Ewart, H. Halvorson, R. Knecht, R. Rheault. 2001. Development of a Policy Framework for Offshore Marine Aquaculture in the 3-200 mile U.S. Ocean Zone. Center for Study of Marine Policy, University of Delaware.

See also: Facility Design and Siting; Lease Agreements, Permitting and Planning; Ownership and Tenancy Privileges.

Environmental and Facility Monitoring

GUIDANCE: Effective environmental and facility monitoring programs should be implemented for proposed and existing aquaculture facilities.

Environmental and facility monitoring is useful in conducting site evaluation, identification of positive or negative environmental changes, coordination of problem solving efforts, and evaluating the efficacy of regulations. Appropriate data collection programs can supply data that can facilitate siting, design, and operational decisions, which can minimize adverse affects on the environment or local communities. Collection of baseline environmental data, such as habitat information, water quality, species composition, and environmental health status should be coordinated through cooperative or individual state and industry data collection programs at sites of proposed aquaculture operations to determine if that site is appropriate. Data collection programs at existing facilities should collect similar information and should include monitoring of receiving waters, including sediments under net pens to ensure the facility is performing to appropriate standards and regulations, and for adaptive management purposes. Data collection at abandoned or reclaimed sites can be used to evaluate effectiveness of reclamation activities.

Facility specific information should also be collected from operating facilities. Such information could include type of aquaculture operation, structures needed for culture, type and density of feeding regime, intake and discharge rates, footprint analysis, protected species interactions, chemical usage, number of escapees, and production values. This information is useful in determining if the facility is performing to appropriate standards and regulations, and for compilation of industry statistics which might be beneficial for industry promotion and development. Care should be taken with handling and distribution of facility data as some such information may be proprietary.

Monitoring requirements can be included in the permitting process and may be proportional to the size, pollutant stream, and potential impact of aquaculture operations. When practicable, water quality standards and monitoring requirements for aquaculture should be flexible or tailored to specific operations.

Agencies that require environmental and/or facility monitoring include:

- Maine Department of Marine Resources - Requires environmental characterization and monitoring under the aquaculture application procedure
- New Brunswick Department of Agriculture, Fisheries and Aquaculture - Aquaculture Monitoring Program
- Virginia Marine Resources Commission - Regulation pertaining to monitoring systems for striped bass aquaculture
- State of New Hampshire - Code of Administrative Rules
- Massachusetts Office of Coastal Zone Management - Aquaculture Strategic Plan
- Florida Department of Agriculture and University of Florida - Clam Lease Assessment, Management, and Modeling using Remote Sensing (CLAMMRS)
- National Marine Fisheries Service Northeast Region - Aquaculture Guidance Document

See also: Water Quality and Quantity; Protection of Physical Habitat; Facility Design and Siting; Data Collection and Management; Facility Reclamation; Compliance Verification.

ADMINISTRATION

Responsible aquaculture development could be facilitated by an administrative framework that includes standard procedures for data collection, regulation, and law enforcement to protect the rights of all stakeholders, and to minimize adverse effects to the natural environment. Effective administration of aquaculture activities is imperative for minimization of conflicts, reduction of risks to wild stocks, and successful industry development. The lack of regulatory consistency across political boundaries presents many challenges for aquaculture operations, especially given the wide array of interested user groups and regulatory agencies from local, national, and international perspectives. Interjurisdictional coordination of these interest groups could help to avoid unnecessary conflicts and enhance user group cooperation.

Distinction of Wild Stocks and Aquaculture Products

GUIDANCE: Aquaculture practices should be consistent with existing regulations governing managed species, or alternately, appropriate distinctions should be made between cultured species and their products, and managed wild harvest species and their products. Consistency among states as well as between state and federal regulations should be encouraged.

Exemption of properly identified aquaculture products from regulations affecting harvest of wild fishery products should be considered. Organisms produced through aquaculture are privately owned and may be treated differently from fishery harvests from public resources. Where fisheries management controls developed for conservation and stock management purposes are not applied to cultured organisms, consistent and efficient methods to distinguish between the two types of product can facilitate enforcement actions and handling of product. Requiring the products of commercial aquaculture to be subject to wild stock management measures such as size limits, seasons or sale prohibitions could constrain the growth of the aquaculture industry. Conversely, the products of commercial aquaculture must be distinguishable from wild harvest products to ensure that wild organisms are not being illegally marketed as aquacultured products. This may include allowances for harvest and utilization of legally collected broodstock and seedstock from native or indigenous sources for aquaculture purposes, if such harvests do not jeopardize the vitality of the wild stock or conflict with existing fishery management plans. Consideration should be given to allow the limited take of animals for breeding that may not be permitted for traditional commercial or recreational fishing. Research priorities might include the development of efficient and inexpensive field and forensic techniques to distinguish wild and cultured animals and products.

Agencies that require marking and/or identification of aquaculture products include:

- Maryland Department of Natural Resources - Identification requirements
- New York Department of Environmental Conservation - Identification requirements
- Southeast Asian Fisheries Development Center, Aquaculture Department - genetic tagging research for identification of aquaculture products
- State of New Hampshire - Code of Administrative Rules
- South Carolina Marine Resources Act of 2000

See also: Transfer and Transport; Ownership and Tenancy Privileges; User Conflicts and Resource Allocation; Regulatory Impediments to Aquaculture; Compliance Verification; Research, Extension and Information Exchange.

Stock Enhancement

GUIDANCE: Fisheries management aquaculture should be evaluated as an option to enhance or establish populations when there are biological, social, or economic benefits.

Some natural populations of aquatic organisms have declined due to environmental degradation, overfishing, or other types of ecosystem disruption. Population levels of harvested species, their prey, or important habitat such as submerged vegetation or corals may fall to dangerously low stock levels. In many instances, fisheries management aquaculture has been used to successfully enhance or re-establish such populations (*e.g.* American shad, striped bass, Eastern oyster). Based on certain successes, fisheries management aquaculture programs with proper objectives should be considered as a potential method to restore or enhance natural populations. Stocking of cultured animals may also be considered to establish populations for social or economic reasons, such as put and take fisheries. Consideration should be given to the source of the organisms for stocking and the culture methods used to rear those organisms, as the objectives and methods used to culture organisms for release may be different than those for commercial or other purposes.

Efforts to restore or supplement wild stocks should include consideration of obtaining stockable fish or shellfish from the private sector as well as from public hatcheries. Utilizing existing private aquaculture facilities can reduce or eliminate public monies being invested in permanent facility construction and maintenance used for fishery enhancement. Cost comparisons on procurement of animals for fisheries management aquaculture should be made from the private and public sectors when major funding considerations are made. This can be especially important in implementation of experimental or pilot scale efforts or when efforts will be conducted over a relatively short time frame. Public-private partnerships (*e.g.* private leasing of public lands for enhancement aquaculture) may also be considered.

Information on stock enhancement specific to aquaculture activities include:

- World Aquaculture Society - Working Group on Stock Enhancement
- Mote Marine Laboratory - Marine Stock Enhancement and Aquaculture R&D Program
- U.S. Fish and Wildlife Service - Coordinated Atlantic coast striped bass stocking program
- National Marine Fisheries Service - Regional Science Centers
- Cooperative rearing and stocking of Atlantic salmon by State of Maine Atlantic Salmon Commission, US Fish and Wildlife Service, NMFS, and Maine industry.

See also: Stock Source and Containment; Industry Development; Genetic Integrity.

Ownership and Tenancy Privileges

GUIDANCE: Aquaculture rights and privileges should be defined for open water, water column, and submerged land lease sites and for the ownership of products cultured within these sites. Where these rights and privileges are not defined, public information documents should be developed and made available.

Clarification of privileges and ownership of cultured organisms, and property rights of leased areas can minimize disputes regarding such privileges. Where necessary, criteria and policies for property and ownership rights relevant to aquaculture sites and products should be established. Some states accommodate such issues through leasing or permitting legislation. Discrepancies in existing policies between states or sectors should be coordinated to the extent possible. A compilation of state laws and regulations relative to the coastal zone in state waters, aquaculture site ownership or privileges, site leases and licenses, and ownership of product would be beneficial. Adequate law enforcement capabilities serve to protect aquaculture products from theft and reduce potential public health concerns.

Information on ownership and tenancy privileges can be obtained from:

- State of New Jersey - Aquaculture Development Act
- New Jersey Division of Fish and Wildlife - Administrative Code on leasing of bottom for aquaculture
- Virginia Marine Resources Commission - Guide to Virginia's Laws and Regulations and Requirements for Marine Shellfish Aquaculture Activities.
- State of Florida - Aquaculture Policy Act

See also: User Conflicts and Resource Allocation; Lease Agreements, Permitting and Planning.

Data Collection and Management

GUIDANCE: Appropriate databases and information networks should be established and supported in order to collect and disseminate aquaculture information.

For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout the rearing period contribute to commercial aquaculture, while aquatic organisms which are exploitable by the public as a common property resource are the harvest of fisheries. Increasing the amount of available data from aquaculture activities may improve the ability to monitor the growth and development of the industry, monitor trends, and evaluate research needs. Collection and exchange of data between aquaculturists, management agencies, and other user groups is important to monitor growth of the industry, properly plan for future growth, and ensure regulatory compliance.

Standardization of data collection and data management procedures should be considered on regional and national levels. A comprehensive list of data elements that should be collected should be developed, along with protocols for collection and reporting of data and data management procedures. Collaboration between state and federal agencies and industry may be required to identify all data elements and develop procedures that do not overburden industry. Types of data elements that may be collected include licensing and permitting data, information about facility operation, and harvest and sale statistics. Sufficient consideration should be given to ensuring confidentiality, respect for proprietary information, and minimizing industry burden.

Standardized registries of aquaculture operations could facilitate information flow. At a minimum, place of business and species under culture should be recorded. Registries could be regional or national to encourage sharing of information on a larger scale.

Several states and federal agencies have developed data collection programs for aquaculture activities, including:

- State of Rhode Island - Legislation requires that records be kept and maintained for molluscan shellfish
- Maryland Department of Natural Resources - Requires record keeping
- Commonwealth of Pennsylvania - Requires record keeping
- State of Florida - Biennial aquaculture survey
- USDA, National Agricultural Statistics Service - produces on a five year interval a census of U.S. agriculture including aquaculture
- Atlantic Coastal Cooperative Statistics Program (ACCSP) - standardization of fisheries dependent data collection and data management activities

See also: Environmental and Facility Monitoring; Compliance Verification; Industry Development; Research, Extension and Information Exchange; National and International Development.

Compliance Verification

GUIDANCE: Compliance criteria should be outlined and compliance verification procedures developed using the most cost effective and least intrusive methods available.

Inefficient or negligent operation of an aquaculture facility can be detrimental to the environment. Systematic and equitable compliance criteria and verification can help ensure that aquaculture facilities are operating in an environmentally responsible manner. The objectives of compliance criteria should be to ensure that aquaculture operations have minimal impacts on the environment, fish and wildlife resources, other aquaculture operations, and other resource users. Compliance criteria should be consistent with environmental standards and not be unduly burdensome to the aquaculturist.

Compliance verification procedures should obtain sufficient information to evaluate whether aquaculture facilities are in compliance with regulations. Verification procedures that minimize cost and effort on the part of the aquaculturist should be preferred.

Examples of compliance verification programs include:

- The State of Florida has a compliance verification program with a critical component that concerns the employment of compliance officers with at least a Master of Science degree in Aquaculture
- South Carolina Department of Natural Resources - Procedures for permitting non-indigenous shrimp importation and possession

See also: Data Collection and Management; Environmental and Facility Monitoring; Lease Agreements, Permitting and Planning.

Industry Participation in Policy Formation

GUIDANCE: A regulatory process should be developed and/or modified to solicit aquaculture industry and other stakeholder involvement in formulation of policy and controls which may affect aquaculture and marketing of aquaculture products.

Adequate consideration of aquaculture industry interests during policy development could reduce the potential for regulations and policies that restrict industry's growth or its ability to employ new technology and make other advancements. Aquaculture is affected directly and indirectly by controls set in place via a wide range of governmental mechanisms employed by various authorities. Controls may include:

- state, federal, and interjurisdictional fishery management plans and subsequent regulations,
- federal and state environmental protection laws and regulations,
- Best Management Practices, and
- permit conditions.

These controls are developed by state and federal managers and regulators with public involvement which may include public comment periods or public hearings, advisory committee input, communications with agency personnel and appointed elected officials, or other means. These means ideally would utilize the knowledge and expertise of independent aquaculturists and industry associations when formulating controls. To ensure the advantages of this expertise are realized, representation of private aquaculture should be solicited to the extent possible during formulation of controls that may affect aquaculture.

The majority of state, federal and interjurisdictional agencies have formalized advisory processes, as well as opportunities for public comment. Aquaculturists are encouraged to contact these agencies for more information and fully participate in these forums. Agencies that have formalized advisory processes to address aquaculture issues include:

- New Jersey Department of Agriculture - Aquaculture Advisory Council
- Virginia Marine Resources Commission - Aquaculture Management Committee
- State of Maryland - Aquaculture Advisory Committee
- State of Florida - Aquaculture Review Council and Aquaculture Interagency Coordinating Council

See also: Industry Development; User Conflicts and Resource Allocation; Lease Agreements, Permitting and Planning.

INDUSTRY DEVELOPMENT

Aquaculture can contribute positive economic and environmental benefits locally, nationally, and internationally. These benefits include year round availability of high quality food to supplement harvests of wild fish from stocks that are declining or at maximum sustainable yield, products to export to improve the nation's balance of trade, enhancement of commercial and recreational fisheries that are fully utilized, and economic opportunities for communities through new aquaculture jobs and development or expansion of aquaculture support industries.

Aquaculture growth and development in the U.S. has been constrained by societal, economic, technical, and regulatory issues. Marine aquaculture, in particular, often crosses regulatory boundaries of state and federal agencies charged with coastal zone management, navigation, water quality maintenance and improvement, and resource management responsibilities. Many existing laws and regulations were developed without consideration to aquaculture. This has resulted in increased industry burden and confusion.

Industry Development

GUIDANCE: For development of the aquaculture industry to occur, aquaculture should be defined in a consistent manner, and a policy and planning framework should be developed.

Societal, economic, and technical constraints that hamper aquaculture development include public perception of the influence of aquaculture on water quality, user group competition, and interactions with natural resources. Several steps can be taken to minimize these constraints and assist industry development, including implementation of a regulatory framework, development of a solid scientific and engineering base, and development of infrastructure and funding to support these activities. Specific tasks and objectives may include:

- Designate a lead agency or agencies to promote commercial aquaculture through activities which may include formation of a stakeholder advisory council, and creation of aquaculture policy and a planning document that are periodically revised and updated to reflect industry progress, obstacles and needs;

- Support and implement improved higher education programs that blend the disciplines of engineering, economics, business, marine and freshwater fisheries, ecology, and environmental management to yield a well-balanced aquaculture curriculum to create a variety of undergraduate, graduate, and post-graduate degrees;

- Create, via public or public-private partnerships, technology centers to be used for developmental programs and aquaculture parks to foster new and environmentally sensitive commercial development;

- Promote aquaculture as a potential tool for fisheries stock mitigation and enhancement by a) investigating aquaculture's role in the preservation of threatened or endangered species and genetic diversity, b) developing culture techniques for species necessary for effective mitigation of negative effects on fish and shellfish stocks, and c) developing and implementing improved methods for determining the effectiveness of using culture stock for fish and shellfish enhancement activities; and

- Develop methods for addressing and resolving conflicts between aquaculture and other users of aquatic and terrestrial environments, including professional risk management.

Information on aquaculture development can be obtained from the following sources:

- Massachusetts Office of Coastal Zone Management - Aquaculture Strategic Plan Economic and Development Recommendations (Chapter IV)
- U.S. Department of Agriculture Marketing Service, Foreign Agriculture Service, and Financial Services
- U.S. Department of Agriculture - Regional Aquaculture Centers
- National Marine Fisheries Service - Office of Industry and Trade
- Commonwealth of Pennsylvania - Aquaculture Development Plan
- State of Maryland - Action Plan for Aquaculture Development
- State of New Jersey - Aquaculture Development Act
- Virginia Department of Agriculture and Consumer Services - Virginia Aquaculture Plan: Potential Markets and Prospects for Aquaculture Expansion
- State of Florida - Aquaculture Plan
- State of Georgia Aquaculture Development Commission - Georgia Aquaculture Development Plan

See also: Lease Agreements, Permitting and Planning; Regulatory Impediments to Aquaculture; Industry Participation in Policy Formation; National and International Development; Research, Extension and Information Exchange; Industry Management Practices; User Conflicts and Resource Allocation.

Regulatory Impediments to Aquaculture

GUIDANCE: Aquaculture should be considered in regulatory processes to ensure that aquaculture interests are addressed and development of the industry is not unnecessarily restricted. Existing regulations and policies should be reviewed for flexibility, and revised as necessary to ensure responsible aquaculture.

Aquaculture development might be unnecessarily limited by policies and regulations that lack the flexibility to accommodate innovation and an evolving industry. Other challenges may include duplicative and overlapping jurisdictions, conflicting or duplicative permit requirements, burdensome application and monitoring costs, and unpredictable timelines. Identification of such impediments and consideration of aquaculture when developing new policies can reduce the potential for similar limitations in the future.

In order to facilitate implementation of individual state regulations, it is important to formulate, coordinate, and implement a unified regulatory process. Many existing laws and regulations were developed prior to the realization of the needs of aquaculture. It may be necessary to evaluate and revise such policies to include consideration of the needs and issues of aquaculture. This may include a coordinated or joint application process to reduce the number of permitting requirements, or cooperative intra- or interstate partnerships to address common issues, and develop compatible solutions to such issues. For example, consideration of aquaculture during development of fishery management plans could ensure that responsible aquaculture is addressed in conjunction with commercial and recreational fishing activities.

Partnerships between regulatory agencies, cooperative extension services, industry and other stakeholders can create best management practices that offer a variety of operational options to meet specific environmental goals and may be used to reduce regulatory requirements. Partnerships would allow parameters related to species selection, facilities, production plans and location to be accommodated and the environment protected while jobs and income are created.

Several state and federal agencies have addressed regulatory impediments to aquaculture, including:

- ➢ Massachusetts Office of Coastal Zone Management - Aquaculture Strategic Plan Regulatory Reform Recommendation (Chapter III)
- ➢ Maine Department of Marine Resources - Legislation for a minimum size exemption for aquaculture products
- ➢ Commonwealth of Virginia - House document to identify regulatory constraints to shellfish aquaculture
- ➢ Northeast Regional Aquaculture Center - Regulatory impediments project
- ➢ New Jersey Department of Agriculture - Office of Aquaculture Coordination
- ➢ State of Florida - Aquaculture Policy Act
- ➢ National Research Council - Marine Aquaculture: Opportunities for Growth (1992)
- ➢ National Aquaculture Act and National Aquaculture Development Plan - Provide for the sustainable development of aquaculture in the United States

See also: Industry Development; Industry Participation in Policy Formation; Lease Agreements, Permitting and Planning; Research, Extension and Information Exchange; User Conflicts and Resource Allocation.

Industry Management Practices

GUIDANCE: Well defined industry management practices should be developed and adopted to help address the myriad issues that arise from the combinations of aquaculture species, facility types, and other variables. Extension services should be encouraged to provide information and technology transfer that would allow aquaculturists to implement the latest management practices and technologies and encourage information exchange.

Due to the complex matrix of species, production systems, farm locations, management goals, and economic pressures, implementation of generalized standards and regulations may not be practical for all phases of aquaculture. Well defined industry management practices specific to aquaculture components and conditions may be able to replace the need for some regulations, mandatory BMPs, and other controls on industry. Industry management practices should achieve environmental sustainability and compatibility. Incorporation of industry management practices into state programs could help achieve more effective ecosystem management through 1) better stewardship of the environment, 2) development and strengthening of environmental ethics in the aquaculture industry, and 3) the achievement of a sustainable, healthy environment and economy. Aquaculture industry associations have adopted, or are developing a wide variety of consensus guidelines to confirm or achieve environmental stewardship goals and ideals.

The aquaculture industry has benefitted from the efforts of the state extension services to transfer information and to assist in implementation of management practices and technology. Best management practices and similar environmentally sound production and management related guidelines should be rapidly and effectively disseminated by education and extension services.

Examples of industry management practices include:

- Pacific Coast Shellfish Growers Association - Environmental Policy
- British Columbia Minister of Agriculture, Fisheries and Food - Industry code of practices for salmon aquaculture (currently being developed)
- U.S. Marine Shrimp Farming Program - Preliminary Quality Assurance Guidelines for *Penaeid* Shrimp Seed and Broodstock
- Oceanic Institute - Specific Pathogen Free Shrimp Breeding Program: Preparation and Infrastructure
- Shrimp Improvement Systems, LLC - Best Management Practices for Shrimp Health Maintenance
- U.S. Trout Farmers Association - Trout Producer Quality Assurance Program
- Catfish Farmers of America - Catfish Quality Assurance Program

See also: Best Management Practices; Research, Extension and Information Exchange; Industry Development.

Diseased Product Destruction

GUIDANCE: Effective disease control and inventory destruction procedures, including justification for such actions, should be developed to prevent the spread of disease to public waterways and other aquaculture facilities.

Incidence and spread of disease can be harmful to aquaculture stocks and wild stocks. Policies for handling diseased products can minimize these risks. Disease control can be accomplished through a variety of mechanisms that may include guidelines for selection of stock source, health certification programs, safe operational protocols, best management practices, and transfer and transport guidelines. To facilitate disease identification, a list of pathogens and parasites of concern should be developed. Where possible, identification of disease pathogens and parasites should be verified by a state approved aquatic health specialist.

Producers should be encouraged to develop a comprehensive disease action plan to make their facilities as secure from disease introduction as possible, to minimize disease pathways, to address possible disease outbreaks, and to develop inventory destruction procedures. Such a plan could be incorporated into a state issued aquaculture permit. A disease action plan would include steps to take in the event of a real or suspected disease outbreak and relevant contact information for state approved aquatic health professionals. Specific issues that may be addressed in the plan include containment and quarantine procedures, guidelines for the removal of dead or dying animals, and environmentally safe protocols for destruction and disposal of mortalities and destroyed product. Plans should clearly state the consequences of suspected or verified disease contamination. Actual disposition of stocks or products should not present risk to native or indigenous biota or lawful aquaculture stocks.

Many state and federal agencies have fish health and/or veterinary services available to assist aquaculturists in identifying disease organisms, including:

- Food and Drug Administration - Center for Veterinary Medicine
- U.S. Department of Agriculture - Animal and Plant Health Inspection Service (APHIS)
- New Jersey Division of Fish and Wildlife, and Department of Agriculture
- State of Florida - Aquaculture Best Management Practices
- Florida Marine Research Institute - Aquatic Health Program
- Maine Department of Inland Fisheries and Wildlife - Health Laboratory Services
- Massachusetts Division of Fisheries and Wildlife - Health Laboratory Services
- Connecticut Department of Agriculture, Bureau of Aquaculture - Health Laboratory Services

See also: Health Management; Health Evaluation; Stock Source and Containment; Best Management Practices; Transfer and Transport; Therapeutic and Chemical Usage; Lease Agreements, Permitting and Planning; Disposal of Facility Waste.

Seizure of Product and Inventory Disposition

GUIDANCE: Controls should be developed and implemented that allow for and clearly specify regulatory and enforcement actions related to seizure and disposition of aquaculture stocks and products in instances of regulatory, permit, or health code violation.

Procedures for seizure of product can clarify when such actions are necessary and the appropriate steps to take, thereby minimizing industry frustration and confusion, public safety uncertainties, possible loss of product, and increased industry burden. In preparation of aquaculture controls, circumstances which may result in product seizure should be identified to the extent possible along with guidelines regarding the eventual disposition of seized product. The statutory or legal basis for product seizure and disposition should be well documented. Detailed guidelines should be developed that set forth protocols and procedures for seizure and disposition of products. Alternatives to mandatory seizure and destruction of privately owned property should be identified and utilized as appropriate. The perishable nature of aquaculture stocks and products should be considered, and the value of privately owned stocks and products should be legally protected.

Specific protocols for seizure can be obtained from:

- New Jersey Department of Agriculture
- U.S. Department of Agriculture
- Food and Drug Administration - Interstate Shellfish Sanitation Program
- Georgia Department of Natural Resources Wildlife Resources Division
- Maryland Department of Natural Resources, Natural Resources Police
- Many state and federal law enforcement agencies

See also: Compliance Verification; Lease Agreements, Permitting and Planning; Ownership and Tenancy Privileges.

Research, Extension, and Information Exchange

GUIDANCE: Research to support environmentally sound aquaculture development should be conducted. Research results should be transferred directly back through extension, outreach, and technology transfer programs to the various aquaculture audiences.

Coordinated research and information exchange can facilitate industry development and growth. The research, extension, and stakeholder interaction model has been extremely successful in development of U.S. agriculture, including the catfish industry through the Land Grant System. More recently, the Sea Grant System, modeled after the Land Grant principle, has been successful in extending the template to coastal and marine issues. The Regional Aquaculture Centers, supported through the U.S. Department of Agriculture, have been successful in encouraging cooperative and collaborative research and extension education programs in aquaculture having regional or national application. Since aquaculture is such a complex industry, industry support groups, non-traditional research institutions, and regulatory agencies will also enter the research, extension, and stakeholder interaction arena and add to the successful development of the aquaculture industry. The development of aquaculture, as in any other production industry, will be based on a combination of basic and applied research. Basic research must be undertaken in anticipation of industry needs.

Research results should be transferred through extension, outreach, and technology transfer programs in order to increase industry acceptance. Delivery to stakeholders should be made via traditional and innovative extension methods. Traditional extension methods include individual contacts, group workshops and conferences, and demonstration projects of innovative techniques on commercial facilities. Some innovative technology transfer programs are satellite conferences and internet-based learning.

The long-term sustainability of the industry can be supported by formal education programs in academic settings. Research needs can be identified through the needs of the commercial aquaculture industries and should encompass traditional and innovative production systems (*e.g.* polyculture) and marketing strategies. Direct producer contributions into research programs should be solicited to facilitate efficient and rapid industry development.

Cooperative extension and other education programs include:

- U.S. Department of Agriculture Cooperative State Research, Education and Extension Service
- USDA Regional Aquaculture Centers
- National and State Sea Grant programs
- Commonwealth of Pennsylvania - Aquaculture Producer Resource Program, Aquaculture Market Information Program, Education Enhancement Program
- The Sound School - a regional vocational aquaculture center located in Connecticut
- Many Atlantic coast universities provide aquaculture education

See also: Industry Development; Industry Management Practices; National and International Development.

National and International Development

GUIDANCE: Development of internationally attractive and competitive private sector aquaculture should be encouraged, with consideration given to international market opportunities and the impacts of foreign products on the U.S. industry.

Many sectors of the U.S. aquaculture industry would benefit from expansion in international markets. In order to compete in the global market, development of responsible aquaculture in the U.S. should not be limited to local or regional development. Global competition could be facilitated and enhanced by industry and governmental cooperation. Programs and legislation such as the Aquaculture Development Act and the National Aquaculture Development Plan have been developed to support and coordinate aquaculture activities on a broad geographic scale and to encourage national and international development of a biologically sound and economically viable aquaculture industry. Such programs should be implemented and supported in order to meet their goals and objectives. Improved national and international development will depend on the ability to effectively address the issues outlined in these programs and this guidance document.

Information and agencies involved in industry development include:

- Joint Subcommittee on Aquaculture - National Aquaculture Development Plan
- World Aquaculture Society
- Food and Agriculture Organization of the United Nations Code of Conduct for Responsible Fisheries, Article 9
- Commonwealth of Pennsylvania Export Promotion Program

See also: Industry Development; Lease Agreements, Permitting and Planning; Industry Participation in Policy Formation.

Glossary

Aquaculture: The farming of aquatic organisms including fish, molluscs, crustaceans, and plants. Farming implies some sort of intervention in the rearing process to enhance production, including but not limited to regular stocking, feeding, protection from predators, etc.

Best Management Practices: A set of operational and procedural practices designed to meet or exceed established standards or guidelines while increasing operational efficiency and productivity where possible. Not all BMPs designed for environmental stewardship will improve productivity, nor will all production based BMPs lead to better environmental stewardship.

Carrying Capacity: The maximum population size or number of individuals that can be supported by available resources.

Commercial Aquaculture: Aquaculture to produce products intended for sale. Commercial aquaculture implies individual or corporate ownership of the stock being cultivated.

Conspecific: Of the same species.

Diadromous: Regularly migrating between freshwater and seawater for reproduction. This category includes anadromous fishes (e.g. striped bass and American shad) and catadromous fishes (e.g. American eel).

Disease Free Stock: Stock that originate from farms and broodstock, which are continually screened for specific disease causing pathogens.

Disposition: Fate of the product (e.g. human consumption, livestock food, bait, etc.). In the instance of product seizure, disposition may include quarantine, destruction, sale, or return to producer.

Enclosure: Any containment system used to prevent escapement of cultured products or ingress of predators. Types of enclosures include but are not limited to tanks, pens, raceways, net systems, and cages.

Exclosure: A system of barriers or other obstructions used to prevent entry of predators or other wild populations into an aquaculture system. Examples of exclosures include net systems, fences, bubble curtains, and noise barriers.

Fisheries Management Aquaculture: Aquaculture intended to restore stocks of, enhance the recruitment of, or establish fisheries for one or more aquatic species.

Genetics: Scientific study of heredity and variation

Genetic Composition: The collection of genes (possible traits) in an individual organism within or among populations (the genetic makeup of an individual).

Genetic Diversity: The number and variety of genotypes in a population, taking into account the relative abundance of each genotype.

Genetic Fitness: Measured by the relative contribution one individual makes to the gene pool of the next generation.

Genetic Integrity: The ability of a breeding population to remain adapted to its natural environment.

Genetic Variation: Offspring exhibiting individually different appearances from parent and siblings; the source of genetic variation includes mutation and recombination

High Health Stock: Stocks that often are bred as specific pathogen free and disease free stock.

Invasive Species: A historically non-indigenous species that becomes established in the area into which it was released.

Non-Indigenous Species: Any species intentionally or accidentally transported and released by humans into an environment outside its present range (ICES 1994).

Physical Habitat: The local environment in which an organism normally lives and grows. The physical habitat defines the chemical and structural components of the environment.

Industry Management Practices - *see* Best Management Practices

Research and Education Aquaculture: Aquaculture intended to provide organisms for educational, research, or display purposes.

Restoration: Rebuilding of a population or stock to a self-sustaining level.

Specific Pathogen Free (SPF): Stock that have been bred for resistance to a specific disease or pathogen.

Supplementation: Increasing the size of a population through stocking.

Additional aquaculture definitions can be found on the AquaText web page at www.aquatext.com.

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Sixth Floor
Washington, DC 20005

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Great Bay Aquaculture LLC
153 Goslin Rd.
Portsmouth, NH 03801

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100 Old Homestead Rd.
Warwick, RI 02889

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P.O. Box 15425
West Palm Beach, FL 33416

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15 Industrial Blvd.
Turners Falls, MA 01376-1610

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P.O. Box 2031
Kingston, RI 02881

Edwin Rhodes
National Marine Fisheries Service
1315 East-West Hwy
Silver Spring, MD 20910-3282

Scott Robinson
Georgia Department of Natural Resources
Fisheries Management Section
2121 Hwy 278 SE
Social Circle, GA 30025

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South Carolina Department of Natural Resources
P.O. Box 12559
Charleston, SC 29412

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University of Connecticut
562 New London Tpk
Norwich, CT 06360

Al Stokes
Waddell Mariculture Center
P.O. Box 809
Blufton, SC 29910

Dale Theiling
South Carolina Department of Natural Resources
P.O. Box 12559
Charleston, SC 29422

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Central Wharf
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Georgetown, SC 29442

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Food and Drug Administration
200 C St SW
Washington, DC 20204

Paul Zajicek
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Division of Aquaculture
5th Floor
1203 Governors Square Blvd.
Tallahassee, FL 32301

Appendix A-3. Individuals that participated in the Commission's Management and Science Committee / Habitat Committee Aquaculture Subcommittee, which was responsible for all final modifications of text and guidance included in this document.

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East Setauket, NY 11733

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PO Box 418
Port Republic, NJ 08241

Harry Mears / Deirdre Kimball
National Marine Fisheries Service
Northeast Region
1 Blackburn Dr
Gloucester, MA 01930

Chip Neikirk
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2600 Washington Avenue 3rd Floor
Newport News, VA 23067

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562 New London Tpk
Norwich, CT 06360

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South Carolina Department of Natural Resources
P.O. Box 12559
Charleston, SC 29422

Byron Young
New York Department of Environmental Conservation
205 N. Belle Meade Rd
East Setauket, NY 11733

Appendix B-1. Compilation of Atlantic coast state management agencies responsible for aquaculture activities.

Maine

Maine Department of Inland Fisheries and Wildlife
284 State St
41 State House Station
Augusta, ME 04333-0041
www.state.me.us/ifw

Maine Department of Marine Resources
21 State House Station
Augusta, ME 04333
Contact: Laurice Churchill/Penn Estabrook
www.state.me.us/dmr/

New Hampshire

University of New Hampshire - Cooperative Extension Division
Kingman Farm
Durham, NH 03824
Contact: J. J. Newman
www.unh.edu

New Hampshire Department of Agriculture
P. O. Box 2042
Concord, NH 03302
Contact Cliff McGinnis
www.state.nh.us/agric

New Hampshire Fish and Game Department
2 Hazen Drive
Concord, NH 03301
Contact: Bob Fawcett, Bruce Bonenfant (freshwater)
www.wildlife.state.nh.us

225 Main St
Durham, NH 03824
contact: Bruce Smith (marine)

Massachusetts

Massachusetts Department of Food and Agriculture
Suite 500
251 Causeway Street
Boston, MA 02114-2151
Contact: Scott Soares
www.state.ma.us/dfa

Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement
251 Causeway Street, Suite 400
Boston, MA 02114
Contact: Dan McKiernan (Marine)
Contact: Bob Arini (Freshwater)
www.state.ma.us/dfwele

Massachusetts Office of Coastal Zone Management
251 Causeway St.
Suite 900
Boston, MA 02114-2199
www.state.ma.us/czm/

Rhode Island

Rhode Island Department of Environmental Management
235 Promenade St.
Providence, RI 02908-5767
Contact: Arthur Ganz
www.state.ri.us/dem/

Rhode Island Coastal Resources Management Council
Stedman Government Center
4808 Tower Hill Road
Wakefield, RI 02879-1900
Contact: Dave Alves
www.crmc.state.ri.us

Rhode Island Legislative Commission on Aquaculture
235 Promenade Street, Suite 500
Providence, RI 02908

Connecticut
Connecticut Department of Agriculture
PO Box 97
Milford, CT 06460
Contact: John Volk
www.state.ct.us/doag

Connecticut Department of Environmental Protection
Bureau of Natural Resources - Fisheries
79 Elm St.
Hartford, CT 06106-5127
Contact: William Hyatt
www.dep.state.ct.us

New York
New York Department of Environmental Conservation
50 Wolf Road
Room 522
Albany, NY 12233-4753
Contact: Philip Hulbert
www.dec.state.ny.us

Bureau of Marine Resources
205 N. Belle Mead Road
Suite 1
East Setauket, NY 11733
Contact: Debra Barnes
www.dec.state.ny.us/website/dfwmr/marine/

New Jersey
New Jersey Department of Agriculture
P.O. Box 330
Room 204
Trenton, NJ 08625
Contact: Erik Cohen
www.state.nj.us/agriculture

New Jersey Division of Fish and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400
Contact: Jim Joseph (Marine)
Contact: Kurt Powers (Freshwater)
www.state.nj.us/dep/fgw

Pennsylvania
Pennsylvania Department of Agriculture
2301 N. Cameron
Harrisburg, PA 17110-9408
Contact: Leo L. Dunn
www.pda.state.pa.us

Pennsylvania Fish and Boat Commission
1601 Elmerton Avenue
Harrisburg, PA 17110
Contact: Ricalon Hoopes
www.fish.state.pa.us

Delaware
Delaware Department of Agriculture
2320 South Dupont Highway
Dover, DE 19901-5515
Contact: Bruce Walton
www.state.de.us/deptagri

Delaware Division of Fish and Wildlife
89 Kings Highway
Dover, DE 19901
Contact: Roy Miller
www.dnrec.state.de.us/fw

Maryland
Maryland Department of Agriculture
50 Harry S Truman Parkway
Annapolis, MD 21401-7080
Contact: Karl Roshcer
www.mda.state.md.us

Maryland Department of Natural Resources
580 Taylor Ave.
Annapolis, MD 21401
Contact: Steve Minkkinen
www.dnr.state.md.us

Virginia
Virginia Department of Agriculture and Consumer Services
P.O. Box 1163
Richmond, VA 23218
Contact: T. Robins Buck
www.vdacs.state.va.us

Virginia Department of Game and Inland Fisheries
4010 West Broad Street
Richmond, VA 23230
Contact: Ron Southwick
www.dgif.state.va.us

Virginia Marine Resources Commission
2600 Washington Avenue
Newport News, VA 23607
www.mrc.state.va.us

North Carolina
North Carolina Department of Agriculture and Consumer Services
PO Box 27647
Raleigh, NC 27611-7647
Contact: Tom Ellis
www.agr.state.nc.us

North Carolina Department of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699
Contact: Preston Pate
www.enr.state.nc.us

South Carolina
South Carolina Department of Agriculture
P.O. Box 11280
Columbia, SC 29211
Contact: David Tompkins
www.scda.state.sc.us

South Carolina Department of Natural Resources
217 Fort Johnson Road
P.O. Box 12559
Charleston, SC 29422
Contact: Albert Segars
Contact: Mac Watson (Freshwater)
Contact: Dale Theiling (Marine)
www.dnr.state.sc.us

South Carolina Department of Health and Environmental Control
1362 McMillan Avenue
Suite 400
Charleston, SC 29405
Contact: Curtis Joyner
www.scdhec.net

Georgia
Georgia Department of Agriculture
19 Martin Luther King, Jr. Drive, SW
Atlanta, GA 30334
www.agr.state.ga.us

Georgia Department of Natural Resources
Wildlife Resources Division
2123 Hwy 278 SE
Social Circle, GA 30025
Contact: Ted Hendrickx
www.dnr.state.ga.us

Florida

Florida Department of Agriculture and Consumer Services
Division of Aquaculture
1203 Governor's Square Blvd Fifth Floor
Tallahassee, FL 32301
Contact: Sherman Wilhelm
www.floridaaquaculture.com

Division of Animal Industry
605 East Main St
Bartow, FL 33830
Contact: Denise Petty, DVM (Animal health)

Florida Fish and Wildlife Conservation Commission
100 Eighth Avenue, SE
St. Petersburg, FL 33701
Contact: Ed Moyer (Freshwater)
Contact: Ken Haddad (Marine)
www.floridaconservation.org

Appendix B-2. Partial list of Federal aquaculture programs and services. Contact information for these agencies can be obtained through the internet by searching for the agency name or through the Joint Subcommittee on Aquaculture website at http://ag.ansc.purdue.edu/aquanic/jsa/. (Source: Joint Subcommittee on Aquaculture Guide to Federal Aquaculture Programs and Services)

Federal Aquaculture Research Sites

U.S. Department of Agriculture

- Cooperative State Research, Education, and Extension Service
- Aquaculture Research Service
- Regional Aquaculture Centers
  - Northeast Regional Aquaculture Centers
  - Northcentral Regional Aquaculture Centers
  - Western Regional Aquaculture Centers
  - Southern Regional Aquaculture Centers
  - Tropical and Subtropical Regional Aquaculture Centers

U.S. Department of Commerce/National Oceanic and Atmospheric Administration

- National Marine Fisheries Service
- Oceanic and Atmospheric Research/Sea Grant College Program
- National Ocean Service/Office of Ocean and Coastal Resource Management - National Estuarine Research Reserve System
- Aquaculture Information Center

U.S. Department of Interior

- U.S. Fish and Wildlife Service

National Science Foundation

Federal Aquaculture Marketing Service

U.S. Department of Agriculture

Agricultural Marketing Service

- Federal-State Marketing Improvement Program
- Livestock and Seed Program
- Transportation and Marketing Division
- Rural Business-Cooperative Service

Foreign Agricultural Service

- Trade Assistance and Promotion Office
- Foreign Market Research
- Emerging Markets Program
- Export Enhancement Program
- Facility Guarantee Program
- Foreign Market Development Program
- Export Credit Guarantee Programs

- Supplier Credit Guarantee Program
- Market Access Program
- Exporter Counseling
- Trade Shows
- Trade Leads Research Function
- FAS Trade Lead Search Form

U.S. Department of Commerce/National Oceanic and Atmospheric Administration
- NMFS Office of Constituent Services

Financial Services
U.S. Department of Agriculture
- Farm Service Agency
- Office of Risk Management (Crop Insurance Information)
- Emergency Conservation Program
- Noninsured Crop Disaster Assistance Program
- Emergency Loan Assistance
- Farm Loan Programs

U.S. Department of Commerce/National Oceanic and Atmospheric Administration
- NMFS Office of Constituent Services/Fisheries Finance Program

NMFS Office of Industry and Trade

International Services
U.S. Department of Agriculture
- Foreign Agricultural Service
- Trade Assistance and Promotion Office
- Agricultural Marketing Opportunities

U.S. Agency for International Development

Weather Information
National Weather Service
- National Environmental Satellite Data and Information Service
- Guide to Federal Aquaculture Programs and Services

Grant and Loan Programs
U.S. Department of Commerce/National Oceanic and Atmospheric Administration
- NMFS Office of Constituent Services
  http://www.nmfs.gov/trade/newgrant.htm

Information Services
U.S. Department of Agriculture

- National Agriculture Library
- Alternative or indigenous Farming Systems Information Center
- Water Quality Information

U.S. Department of Commerce
- NOAA Library and Information Network

Regulatory Agencies
U.S. Department of Health and Human Services

Food and Drug Administration
- Center for Food Safety and Applied Nutrition
- Center for Veterinary Medicine
- Interstate Shellfish Sanitation Program

Environmental Protection Agency

U.S. Army Corps of Engineers

U.S. Department of the Interior
- U.S. Fish and Wildlife Service

Aquatic Animal Health Services
- Animal and Plant Health Inspection Service
  - Plant Protection and Quarantine
  - Animal Damage Control Division
  - Center for Veterinary Biologics
  - National Veterinary Services Laboratories
- APHIS Services for the Aquaculture Industries
  http://www.aphis.usda.gov/vs/aqua/aquaphis.html

Aquaculture Statistics
U.S. Department of Agriculture
- National Agriculture Statistics Service
- Economic Research Service

U.S. Department of Commerce
- Economic and Statistics Administration

Extension/Sea Grant Contacts
- Primary Aquaculture Extension Contacts
- National Sea Grants Program
- Contacts for Regional Aquaculture Center - aquaculture information and publications

Other Federal Agencies Involved in Aquaculture Activities

NOAA/National Ocean Service/Office of Ocean and Coastal Resource Management/Coastal Zone Management
U.S. Department of the Interior/U.S. Geological Service
NOAA/NMFS Office of Protected Species

Appendix C. Contact information for other U.S., interjurisdictional, national and international organizations used as examples in this guidance document.

Alaska Department of Fish and Game
P. O. Box 2552
Juneau, AK 99802
www.state.ak.us/adfg/adfghome

American Fisheries Society
5410 Grosvenor Lane
Bethesda, MD 20814
www.fisheries.org

American Veterinary Medical Association
1931 North Meacham Rd.
Suite 100
Schaumburg, IL 60173-4360
www.avma.org

Atlantic Coastal Cooperative Statistics Program (ACCSP)
1444 Eye Street, N.W. 6th Floor
Washington, DC 20005
www.accsp.org

Atlantic States Marine Fisheries Commission (ASMFC)
1444 Eye Street, N.W. 6th Floor
Washington, DC 20005
www.asmfc.org

Australian Bureau of Agriculture and Resource Economics
GPO Box 1563
Canberra ACT, 2601
Australia
www.abare.gov.au

British Columbia Ministry of Agriculture, Food & Fisheries
P. O. Box 9058, STN PROV GOVT
Victoria, BC V8W 9E2
http://www.gov.bc.ca/agf/

British Columbia Salmon Farmers Association
#302-871 Island Hwy.
Campbell River BC V9W 2C2
Canada
www.salmonfarmers.org

Catfish Farmers of America
1100 Hwy 82 East, Suite 202
Indianola, MS 38751
www.catfishjournal.com/

Eastern United States Shellfish Seed Transport Workshop
http://www.scseagrant.org/pdf_files/shellfish_abstracts.pdf

Global Aquaculture Alliance
5661 Telegraph Road
Suite 3A
St. Louis, MO 63129
www.gaalliance.org

International Council for the Exploration of the Sea (ICES)
Palægade 2-4
DK-1261
Copenhagen, Denmark
www.ices.dk

Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
www2.state.id.us/deq/

Joint Subcommittee on Aquaculture
http://ag.ansc.purdue.edu/aquanic/jsa/
The Joint Subcommittee on Aquaculture website provides an extensive list of U.S. and international aquaculture organizations, including addresses and/or websites.

Key Lab of Marine Sciences and Numerical Modeling
Key Lab of Ecology and Engineering for Marine Ecology and Environment, SOA, China
First Institute of Oceanography, SOA
Xianxialing Road
Hi-Tech Industrial Park, Qingdao, China
266061

Mote Marine Laboratory
1600 Ken Thompson Parkway
Sarasota, FL 34236
www.mote.org

National Estuarine Research Reserves Program
www.ocrm.nos.noaa.gov/nerr/welcome.html

National Invasive Species Council
Department of the Interior
Office of the Secretary (OS/SIO/NISC)
1849 C Street, N.W.
Washington, DC 20240
www.invasivespecies.gov/faq/main.shtml

National Research Council
500 Fifth Street NW
Washington, DC 20001
http://www.nationalacademies.org/nrc/

National Science and Technology Council
Office of Science and Technology Policy
Executive Office of the President
Washington, DC 20502
http://www.ostp.gov/NSTC/html/NSTC_Home.html

New Brunswick Department of Agriculture
Fisheries and Aquaculture
440 King Street, Kings Place
P. O. Box 6000
Fredericton, NB E3B 5H1 Canada
www.gnb.ca/0027/index-e.asp

North Atlantic Salmon Conservation Organization
North American Commission
11 Rutland Square
Edinburgh EH1 2AS United Kingdom
www.nasco.org

North American Lake Management Society
P. O. Box 5443
Madison, WI 53705
www.nalms.org

The Oceanic Institute
41-202 Kalanianaole Highway
Waimanalo, HI 96795
www.oceanicinstitute.org

Office International des Epizooties
12 rue de Prony
75017
Paris, France
www.oie.int/eng/en_index.htm

Pacific Coast Shellfish Growers Association
120 State Ave. NE, PMB #142
Olympia, WA 98501
www.pcsga.org

Regional Aquaculture Centers
www.reeusda.gov/pas/aquaculture/csrees_aquaculture_investment/regional/

San Joaquin District - Department of Waste Resources
3374 East Shield Avenue
Fresno, CA 93726
www.dla.water.ca.gov/sjd

The Sound School
60 South Water Street
New Haven, CT 06519
www.SoundSchool.com

South Carolina Marine Resource Act
http://www.scstatehouse.net/code/t50c005.htm

Southeast Asian Fisheries Development Center
Aquaculture Department
17 Times Street, West Triangle, Quezon City
1104 Metro
Manila, Philippines
www.seafdec.org

Food and Agriculture Organization of the United Nations (FAO)
Rome, Italy
www.fao.org

U.S. Marine Shrimp Farming Program
41-202 Kalanianaole Highway
Waimanalo, HI 96795
www.usmsfp.org

U.S. Trout Farmers Association
111 West Washington St.
Suite 1
Charlestown, WV 25414-1529
www.ustfa.org/

University of Nebraska at Lincoln
Lincoln, NE 68588
www.unl.edu

World Aquaculture Society
Louisiana State University
Baton Rouge, LA 70803
www.was.org

The World Aquaculture Society website provides an extensive list of U.S. and international aquaculture organizations, including addresses and/or websites.