The Rationale For a New Initiative in Marine Aquaculture

September 2002

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Foreword

Initiatives in marine aquaculture are not new to the federal government. *Our Nation and the Sea*, the final report of the (Stratton) Commission on Marine Science, Engineering and Resources published in 1969 had a profound influence on both current and contemplated marine activities. One such future activity studied by the Commission was marine aquaculture, popularly known at that time as 'farming the sea.'

In addition to the birth of NOAA, the Stratton Commission Report was responsible for an immediate explosion of interest in the sea and its ecosystems. Excluding all federal and state facilities, the number of marine laboratories in the country increased from 50 in 1963 to 118 by 1973, and soon after almost every one of them was managing at least one project in marine aquaculture.

The new Associate Director of NOAA quickly recognized that this intensive national effort in marine aquaculture was extraordinarily diverse and uncoordinated[1], and he immediately commissioned a study to identify national priorities for its more orderly advancement. A principal recommendation of the study[2], published in 1973 as the *NOAA Aquaculture Survey*, was that, "NOAA should recover full initiative in the establishment of aquaculture goals and policies, and should assume leadership in the required coordination among diffuse federal, state, and agency programs." It also recommended that the national program be directed from the executive level. A position of Aquaculture Program Coordinator was therefore established in the NMFS Office of the Director, and the post was filled within a year.

The first Coordinator was given the immediate responsibility of preparing the NOAA Aquaculture Plan, an annual budget for federal aquaculture, and organizing an interagency committee for coordination. The *NOAA Aquaculture Plan* was published in 1977. The Plan recognized goals and objectives for NOAA, and laid out a planning system. It also outlined the management and control of the NOAA Aquaculture Program through the continuity of the Coordinator, the interagency committee, and several advisory committees, all of which included members from industry.

[1] In 1971 there were 120 marine aquaculture programs dispersed through NMFS, the Office of Sea Grant, the Economic Development Administration, the Office of Economic Opportunity, and the Agency for International Development.

[2] The study was carried out by the Mardela Corporation of San Francisco and involved 12 national workshops.

A parallel commitment to aquaculture was also made by NOAA in its *National Plan for Marine Fisheries*, published in 1976. One of its primary recommendations[3] to meet projected consumer demands for seafood was, "Encourage the development of public and private aquaculture for selected species of fish and shellfish."

NOAA also commissioned the National Research Council (NRC) to undertake a study on the *Constraints and Opportunities of Aquaculture in the United States*. The NRC report, published in 1978, noted that, "aquaculture in the United States lacked coherent support and direction from the federal government. Poor coordination, lack of leadership, and inadequate financial support have traditionally characterized programs relating to aquaculture." The report also recommended designating a national lead agency for aquaculture, but acknowledged that it was still deliberating this important issue when the Food and Agriculture Act of 1977, which designated the Department of Agriculture as the lead, became law. Consequently, specific recommendations for its client were merely:

(i) Issuing guidelines to states for developing coastal zone management plans that recognize the potential of aquaculture;

(ii) Participating in aquaculture activities of the Sea Grant program, which focus on long-term research and development requirements for aquaculture, rather than the short-term three-year problem-solving program currently supported.

The NRC produced another report in 1979 on the *Role of the Department of Agriculture in Aquaculture*. Although the investigative panel was directed to take into account the ongoing programs and legal responsibilities of NOAA, it was also charged to consider primarily the major finfish currently produced in inland waters. In this document, recommendations for NOAA were confined only to aspects of marketing by NMFS.

In 1980, the National Aquaculture Act became law. This Act created the Joint Sub-Committee for Aquaculture (JSA) to coordinate policy initiatives across all federal agencies, and identified the Secretaries of Agriculture, Commerce, and Interior as the Executive Committee, with Agriculture serving as chair.

The combination of these strategic events at the end of the 1970s effectively reduced the role of NOAA in national aquaculture development. For some administrators these legal and administrative frameworks were shortsighted because, as noted by the Stratton Commission, the greatest but long-term potential for future seafood security was in the coastal zone and offshore marine environments. But for other leaders, the diminished responsibility was more suited[4].

Aquaculture Revisited

Despite its historic and significant impact on global technologies (see Appendix III), the aquaculture research program within NMFS throughout the 1980s suffered immeasurable harm as both human resources and facilities were focused in other directions. However, at the beginning of the 1990s, faced with imminent expiration of the appropriations authority of the 1980 National Aquaculture Act, interest in aquaculture by NOAA was once more renewed.

[3] More specifically the plan said (i) The federal government should conduct or sponsor research development, and other programs to provide a sound basis for public and private aquaculture; and (ii) States should establish laws and policies to encourage private aquaculture, maintain suitable environments, and operate hatcheries for stocking waters with selected species.

[4] "NMFS aquaculture efforts will be directed to managing common property resources and endangered species, not for food production." Directive from W.G. Gordon, Assistant Administrator NMFS, to all regional and center directors, 16 November, 1983.

The goal is to prepare and equip the agency with the science and technology of this emerging field

In 1990, the Assistant Administrator[5] of NMFS requested an issue paper on *Aquaculture Policy for the Agency*. The report recommended, "NMFS supports and encourages the development of aquaculture practices which have minimal adverse effects on the Nation's marine species and their environment." Four problem areas were identified (public health, economics, the environment, and fisheries management), strategies were selected and justified, and actions for forward development were recommended.

In 1991, NMFS produced its *Strategic Fisheries Plan* and listed as its eighth goal, "to reduce impediments to U.S. aquaculture," with objectives to:

(i) Determine the potential for aquaculture to enhance recovery of protected species;

(ii) To re-evaluate the NMFS role in aquaculture.

The NMFS Task Force, appointed for the latter, produced its report entitled *The Role of the National Marine Fisheries Service in Marine Aquaculture* in 1994. Its conclusions and recommendations for actions were carefully prioritized, and it reviewed the options for the agency if no actions were taken. It concluded that there were many consequences and risks for NMFS, from the loss of jurisdiction of estuary and nearshore areas, to the loss of lead responsibility for offshore marine aquaculture. More specifically it stated:

"(a) Loss of jurisdiction of estuary and nearshore areas could result from industry pressure to develop private aquaculture in these areas, and pressure associated with seafood safety issues of fish and shellfish raised in nearshore waters. Most safety issues with farmed fish and shellfish involve bacterial pathogens originating from farm runoff and untreated sewage. If another agency is given authority for seafood safety it could assume responsibility for nearby development and factors which affect water quality, thus obtaining *de facto* authority over nearshore areas.

(b) Offshore aquaculture will require leasing sections of water column over the continental shelf. In the absence of NMFS, the Minerals Management Service of the Department of Interior would become the lead federal agency dealing with this issue. This would open the way for the Department of Interior to conduct other activities associated with marine aquaculture.

(c) Other possible risks include the loss of the aquaculture industry, which is an NMFS constituency; the possible loss of biodiversity in marine areas, and possible loss of control over listings under the Endangered Species Act. A final risk to NMFS is the loss of the means to create natural resource-based jobs connected with marine fisheries enhancement and marine aquaculture."

The reality of these risks was made clear in a report carried out in 1992 by the National Research Council called *Marine Aquaculture - opportunities for growth*. The report recognized the leadership role of the USDA and recommended offices and staff for marine aquaculture at a high level within that agency. It also identified a number of specific but smaller roles for NMFS[6] and the National Sea Grant Program. However, without specifying any responsible authority, the report requested Congressional action to "create a legal framework for federal waters to foster appropriate development, to anticipate potential conflicts over proposed uses, to assess potential environmental impacts of marine aquaculture, to develop appropriate mitigation measures for unavoidable impacts, and to assign fair public and private rents and returns on such operations."

Similarly, in 1993, in a report by the Congressional Research Service on *Aquaculture and the Federal Role*, the roles of NMFS were reduced to research

[5] William W. Fox was the Assistant Administrator, and the report was prepared by the Office of Research and Environmental Information with additional assistance.

[6] The NRC report recommended that NMFS be charged with leadership in the management and assessment of stock-enhanced marine fisheries, including (i) evaluating the effectiveness of existing and future programs, (ii) supporting development technologies for producing stocks for enhancement and related aquaculture, and releasing marine stocks, (iii) assessing the impact of various nearshore and offshore practices on the marine environment, and (iv) administering the introduction and transfer of nonindigenous marine species.

and development in marine, estuarine, and anadromous species, and its inspection and financial services. But the report did note that, "although NMFS aquaculture and mariculture efforts declined in the last decade, they are developing new initiatives and are expected to expand their aquaculture program again."

In the field of marine aquaculture, NMFS management has vacillated in its focus. But individual laboratories and staff scientists have maintained a low-level program through extramural funds and correlated studies coordinated with other agency directives to maintain a leading presence in the national and international arenas. Congress has funded the aquaculture program of the USDA more consistently than that of NMFS or other agencies, predominantly because 70% of national production was catfish in inland waters of Southern agricultural states. Throughout the 1990s, the USDA directed some of its funding to marine species through its Marine Shrimp Farming Program. This year it announced the design and construction of a $25 million National Coldwater Marine Aquaculture Center in Orono, Maine.

This document presents the case for a reinvigorated initiative by NMFS in marine aquaculture. The goal is to prepare and equip the agency with the science and technology of this emerging field, which portends to become an integral part of marine resource management in the 21st century. An Executive Summary briefly summarizes the entire initiative and concludes with Recommendations for immediate/short-term and longer-term actions. This is followed by the articulation of the overall Rationale for a new initiative by the agency, and it is supported by more specific information contained in seven Appendices. These concern:

(I) Fish and Shellfish in Commerce;

(II) Economic Benefits of Aquaculture in the United States;

(III) History of Aquaculture in NMFS;

(IV) Government Aquaculture Policy and the Role of NMFS;

(V) Resources of NMFS;

(VI) Constraints to National Development;

(VII) Investments in Aquaculture Development by the Federal Government.

This document is also quantified and qualified in footnotes.

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Executive Summary

Stewardship

The NOAA Fisheries Service is dedicated to protecting and preserving the nation's living marine resources. This is no mean task. The responsibility for stewardship stretches the length of 96,000 miles of coastline and covers 3.4 million square miles of open waters. The consequences impact millions of metric tons of fisheries resources, together with thousands of jobs and a traditional way of life in many coastal and remote communities.

The Fisheries Conservation and Management Act calls for the sustainability of these living resources and provides for their conservation and management hand-in-hand with their utilization for national benefit. Within the purview of the Act, environmentally responsible aquaculture is included firmly as one such use but one which complements and balances the agency's other mandates, including those related to protected species, water and sediment quality, and biodiversity.

The benefits of marine aquaculture[7] in the United States are many. Some are obvious, such as increased food production, more jobs, and earnings from goods and services. Others are more subtle and complement many of NOAA's goals for fisheries sustainability, species recovery, and habitat conservation. For example, the alternative of cultured products can reduce fishing pressure on some overfished stocks, and cultured individuals could supplement species recovery and habitat restoration efforts. Collectively, all research on life cycles, behavior, and maintenance in captivity can provide the necessary scientific understanding for better stewardship.

Aquaculture, and all its technologies, is therefore, a potentially valuable tool for marine resource management. Marine aquaculture in particular has been identified as a way of reinvigorating the fisheries industry. The nation's marine fisheries resources are finite and the global harvest has remained static for more than a decade[8]. Some stocks are below strength, and others are listed for protection. Aquaculture is already being widely used to enhance certain fisheries[9] and directly produce high-value seafood commodities[10]. It is, in fact, the fastest growing food

[7] Marine aquaculture is defined in this document as both husbandry of aquatic animals and plants, and enhancement practices.

[8] World fisheries production is currently about 135 million metric tons. Capture fisheries remains between 90-100 million metric tons. Most growth throughout the last decade has been derived from aquaculture.

[9] In 1998, 26% of Alaska's commercial common property harvest of salmon was produced by the state's enhancement program.

[10] The annual value of U.S. aquaculture production approaches $1 billion for about 500,000 metric tons whole weight.

producing sector in the world[11], providing about 30% of global supplies of fish and shellfish for human consumption. A renewed initiative in marine aquaculture within the agency's mandate for stewardship of the nation's marine resources is therefore both opportune and timely.

Service

The small size of the U.S. marine aquaculture industry is not commensurate with its potential, given that the country has an abundance of natural and intellectual resources ideally suited to aquaculture production. The draft *National Aquaculture Development Plan* (NADP) notes that the United States is a relatively minor producer in terms of world aquaculture production, and many sectors of the aquaculture industry are challenged to compete successfully in the global marketplace. Other nations, including China, Japan, Thailand, the Philippines, and Norway, have made aquaculture a national priority with substantial public investments in research and development[12]. Consequently, cultivated seafood from foreign nations is capturing a growing share of the U.S. seafood market. There is growing concern from stakeholders that competitiveness of the U.S. aquaculture industry is adversely affected by the current federal regulatory framework and lack of support for programs, which are provided to other sectors of agriculture and commerce.

This is not the first time that NMFS has had the opportunity to step up and support a new fisheries industry. In 1976, the agency started cooperation with stakeholders to develop offshore fishing for the 'underutilized' species within the Exclusive Economic Zone (EEZ). The economic benefits were large and made a significant contribution to national prosperity. Twenty-five years later, marine aquaculture now stands on a similar threshold, and exploitation of its benefits and future growth again requires government leadership and NMFS involvement with a range of services.

NMFS is legally and logically placed to underpin the development of national aquaculture, specifically marine aquaculture. NMFS is well-positioned within the context of the agency's strategic plan to solidify relationships with stakeholders in providing assistance associated with the needs of the marine aquaculture industry, among which are fair trade practices, capital investment programs, information, research, and relevant training. The industry is also looking to the agency for sensible regulation and surveillance, and cooperation in monitoring.

The foundation for many of these essential government services are already in place in the agency, or are being financed through the agency. Some of the regional offices have been dealing with the complex legal and regulatory issues to guide the development of sustainable aquaculture operations in the EEZ, and to encourage private investment with economic assistance. This is groundbreaking work.

Science and Technology

Within its authority, NMFS has the twin mandates of management and conservation of marine fisheries resources, both of which depend on the latest research in science and technologies to achieve their goals. Because the levels of aquaculture science and technology are still mostly inadequate for environmentally secure and economically successful activities offshore, considerable research and development in partnership with the industry is still required.

NMFS has a regional infrastructure in place and is already supporting development with pioneering science and technology in its network of fisheries science centers, laboratories, and field stations. It also has the human capacity: experienced scientists, many of whom are world leaders in the aquaculture field. Working in

[11] "Aquaculture, not the Internet, represents the most promising investment opportunity of the 21st Century," Peter Drucker, Economist and Nobel Laureate.

[12] The European Union devotes over $400 million annually to the fisheries sector, which includes $260 million for aquaculture. Canada has just dedicated C$75 million to federal research and development. With capital loans from the Asian Development Bank, even Vietnam is financing aquaculture development and diversification.

partnership with other federal and state agencies, NMFS scientists have an established record of achievement that few other countries can match.

In addition, many habitat and protected resources scientists are included in the NMFS regional and headquarters infrastructure. Many of these specialists have worked with the aquaculture industry and permitting agencies to develop sound culture practices.

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While global production has grown at an annual rate of 10%, the growth of aquaculture in the United States has been only 1% — and mostly in the freshwater environment. This can be changed by refocusing on the potential of the marine environment. A new, well-directed initiative by NMFS will ensure that an aquaculture industry in coastal and offshore federal waters can be sustainable and environmentally compatible; that the natural marine resources are protected and rebuilt with purpose, and that the efforts complement the agency's work in species recovery and habitat conservation. Such leadership is timely.

NMFS clearly needs further Congressional support to implement this broad-based initiative for marine aquaculture and build its foundations in stone

NMFS clearly needs further Congressional support to implement this broad-based initiative for marine aquaculture and build its foundations in stone. New legislation is needed for NOAA to redefine the legal and administrative frameworks for NMFS, in particular its role, responsibilities, partnerships, and cooperative activities, as well as its relationship to other NOAA line agencies. It is particularly needed for development in the EEZ[13] so that productive and environmentally responsible aquaculture can benefit important commercial and recreational fisheries. It then needs Congressional support for the human resources required, and a budget. One yardstick might be dedicating federal funds for development of the national industry and enhancement research in an amount equal to 1% of the annual national trade deficit. Currently this would be $70 million annually. Any appropriation of funding takes time, and therefore, there is an immediate need to prepare a Congressional briefing document on aquaculture and the role of NMFS, complete with budget estimates.

In summary, the new initiative for NMFS will:

- Identify the focal point within the federal government for research, management, and development of marine aquaculture.
- Initiate the Congressional processes to enact appropriate legal and administrative frameworks.
- Initiate the Congressional processes to appropriate significant funding.
- Use the necessary resources in the most sustainable and environmentally compatible way, particularly in the EEZ.
- Preserve and possibly improve coastal and marine habitats and ecosystems.
- Explore the potential of using successful species-specific culture techniques as a management strategy option on recovery of depleted natural fisheries stocks, species recovery, and habitat conservation.

Success will principally allow NMFS to lead, rather than react, to development and management of the marine aquaculture industry, and ensure consistency with NMFS mandates for stewardship of living marine resources.

But it will also provide a range of economic benefits associated with industry growth together with a store of scientific and technological information relevant to the agency's responsibility for stewardship of the nation's marine resources.

[13] NOAA has already drafted offshore aquaculture legislation but it has not been vetted to the new administration. It gives the Secretary of Commerce authority to grant long-term leases for development in the EEZ, subject to specific environmental standards. Such legislation is identified as a key need for the aquaculture industry, and vital for sustainable offshore development.

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Recommendations

I. Recommendations for Immediate and Short-Term Actions

RECOMMENDATION #1

NMFS should commit publicly to strengthen its rational development of marine aquaculture in the nation's coastal and offshore waters and immediately implement specific administrative actions, which can be done without additional legislative authority.

Element 1A. NMFS should immediately fill the vacancy of Aquaculture Coordinator.

NMFS should immediately fill the vacancy of Aquaculture Coordinator and, for expediency, locate the post within the Office of the Assistant Administrator (F). The responsibilities of the Aquaculture Coordinator include working and consulting with relevant NMFS staff, regulatory agencies, and stakeholders, as appropriate, to implement the agency's aquaculture program.

By filling the Aquaculture Coordinator position, NMFS will provide a primary point of contact for the further development and overall implementation of the Marine Aquaculture Initiative, allow for NMFS representation on the Joint Subcommittee on Aquaculture (JSA), and make aquaculture publicly visible as a legitimate function of NMFS.

Filling the Aquaculture Coordinator position will provide a primary point of contact for the further development of the Marine Aquaculture Initiative

Element 1B. Appoint a NMFS Aquaculture Council (replacing the NMFS Aquaculture Task Force) to work with the Aquaculture Coordinator on the administrative and legal frameworks for aquaculture development in the agency.

The NMFS Aquaculture Council would be the agency forum for addressing specific questions relating to the type and level of NMFS involvement in

aquaculture, or for establishing the basis for reviews of key issues. A primary role would be to address the conceptual orientations of aquaculture within the agency, particularly identifying where additional resources may be needed, and what organizational changes may be necessary in headquarters, the regional offices, and the science centers. For example, within NMFS, the council might evaluate the organization and management of the marine aquaculture sector, either through the relatively short-term office of an aquaculture coordinator, or through more permanent and long-term options, such as adding to the functions of an existing program office, or creating a new program or staff office.

NMFS should streamline and simplify the federal process for permitting in the EEZ, and create pre-permitted Aquaculture Development Zones

The council might also evaluate directions for aquaculture research and management priorities. Or it might evaluate the role of the regional offices and science centers with respect to points of contact and support services for stakeholders. These may include, for example, a review of aquaculture permits based on regulatory authorities, research support, and expansion of regulatory authority for aquaculture in the EEZ. Options for the regional offices to provide administrative and constituent services may include regional aquaculture coordinator positions. Meanwhile, options in the fisheries science centers may include cooperative research and development with industry that may be concentrated in a few key laboratories (such as Auke Bay, Galveston, Manchester, and Milford).

The council should also address potential internal conflicts, such as integrating the agency's role in supporting aquaculture development with the regulatory function of the permit review/approval process, and interactions with the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), and Essential Fish Habitat (EFH).

Element 1C. Streamline and simplify the federal process for permitting in the EEZ, and create pre-permitted Aquaculture Development Zones (ADZs).

As a new industry, aquaculture straddles the line between fishing and farming, cuts across significant regional differences, and is placed in a complex jurisdictional context involving the participation of local, state and federal governments.

Some of these concerns will be lessened if marine aquaculture is located in the EEZ. However, the policy and regulatory framework for aquaculture is poorly defined, and most measures in place today were not developed with aquaculture in mind and are often applied in an inconsistent manner. Production from the U.S. aquaculture industry will grow when the state and federal regulatory process is simplified and streamlined. There is an immediate need to:

- Continue with the (difficult) development of a "one-stop shopping" approach to permitting, reducing the time necessary for permit approvals and facilitating the administrative process for applicants.

- Develop framework "aquaculture management plans" to serve as a template to be used throughout the United States for the siting and operating of aquaculture operations.

- Identify Aquaculture Development Zones (ADZs) in the EEZ, which, meeting certain criteria, offer expedited permit approval processes.

Element 1D. Publish the Draft Code of Conduct for Aquaculture Development in the EEZ in the Federal Register as soon as possible.

NMFS requires methodologies for measuring industry compliance and accountability to fulfill its dual mandate of promoting the development of marine aquaculture while maintaining environmental quality. As a steward of the coastal zones of the United States, and in the interest of promoting stewardship in the world's oceans, the agency promotes development of international codes of practice. The agency has in hand a Draft Code of Conduct for Aquaculture Development in the U.S. EEZ that was prepared in partnership with other NOAA agencies and stakeholders. This should be published as soon as possible, reflecting the input of stakeholders. The resultant opportunity for communication on, and eventual publication of, the EEZ Code of Conduct will provide an important springboard for strengthening constituent partnerships with NMFS in marine aquaculture.

The agency has the expertise and intellectual resources to conduct research and help develop guidelines for sound Codes of Conduct, based on the best available science, and to improve the federal regulatory climate for sea farming without compromising environmental protection.

As a steward of the coastal zones of the United States, the agency promotes the development of international codes of practice

Element 1E. Develop a budget initiative to address the scope of activities to be undertaken in support of a national NMFS aquaculture program.

Sufficient funding must be made available to support all program elements at both the national and regional level. A set of budget options corresponding to the options presented in the white paper needs to be developed (in the FY04 Cycle) for management review. The preferred option would then be further developed into a budget initiative.

Some advisory councils, such as the Marine Fisheries Advisory Committee (MAFAC), have already proposed that a NMFS aquaculture program be funded by dedicated federal funds. Some stakeholders have suggested that the funding for development of the national industry might be an amount equal to 1% of the annual national fisheries trade deficit, which, at the current level, would be $71 million/year. This funding would be used to develop the regulatory framework and science necessary for the culture of a wide variety of species that are candidates for enhancement and /or commercial culture beyond salmon. It would also help the development of technology necessary for a robust, environmentally responsible industry.

Element 1F. Encourage aquaculture industry representatives to seek membership on all NMFS/NOAA advisory groups and panels (e.g. Fishery Management Councils, MAFAC, and Marine Protected Area (MPA) advisory groups, etc.).

The aquaculture industry is currently under-represented on all fisheries advisory groups and panels even though they are dependent on many of the decisions these bodies make. NMFS should support the nomination/membership of aquaculture industry representatives as vacancies occur on such advisory bodies as MAFAC and the MPA advisory group, which is being developed at this time, as well as Fishery Management Councils and their advisory committees.

Element 1G. NMFS should prepare a Congressional Briefing Paper, together with a budget, on aquaculture in the United States and the roles of NOAA and NMFS.

It is important that NMFS initiate the process of seeking administration support for a broad-based aquaculture initiative, and for new legislation where needed, by preparing a Congressional briefing paper. The paper should define the roles, responsibilities, partnerships, and cooperative activities of all line agencies and offices relevant to marine aquaculture development. New legislation may be needed for aquaculture development in the EEZ.

NOAA has developed draft offshore legislation, but this initiative has not been vetted by the new administration. This legislation would give the Secretary of Commerce authority to grant long-term leases in the EEZ for aquaculture, and require the development of environmental standards. Such legislation has been identified as a key need by the aquaculture industry, and is necessary for responsible development. Legislative changes should also include aquaculture as an area eligible for expenditure of existing Capital Construction Funds (CCF).

NMFS should enhance its capabilities to advance aquaculture technologies with a focus on production systems for new species and new practices

II. Recommended Activities for the Longer Term

RECOMMENDATION #2

NMFS should enhance its capabilities to advance aquaculture technologies with a focus on production systems for new species and new practices, for rebuilding overexploited stocks and endangered marine species, and improving environmental technologies and practices.

The agency has more than 100 years of achievement in aquaculture research and development, a network of scientific laboratories, field stations with basic facilities, and a cadre of staff experienced in most aspects of the field. Expansion of scientific and technical skills will not only help develop the industry directly but provide the agency with the best information for sensible regulation and oversight.

Element 2A. Develop economically viable and sustainable husbandry systems for the culture of marine fish, shellfish, and seaweeds.

Stewardship entails the building of sustainable fisheries, recovering protected species, and sustaining the health of the coasts. Research and development by NMFS in marine fish culture can complement other NMFS strategic goals. For example, marine farming technologies can provide employment in economically-depressed coastal communities; seafood for domestic consumption and exports, and more subtly ease the pressure on overfished stocks and areas by providing alternative products. Cultured products can also be used to rebuild depleted stocks or captive broodstocks can be used for maintaining protected species, and contribute to the health of coastal ecosystems. However, the number of species currently under investigation is small and the effort is disparate. This has to be increased.

Element 2B. Improve the technology for marine stock enhancement.

NMFS should develop effective enhancement strategies for aquatic species to help in the recovery of wild stock fisheries and endangered species. Aquaculture technologies can provide information on the life history, physiology, and behavior of marine species, which will expand the available information base upon which

to evaluate management strategies for fish and shellfish resources in the EEZ, and throughout their range.

Aquaculture, as a tool to achieve rebuilding goals, can be developed further as stocks are over exploited or diminished, or for species which are threatened or endangered. Releases of cultured animals can help rebuild wild stocks for the benefit of both commercial and recreational fisheries. Enhancement of endangered or threatened wild stocks through propagation can result in their restoration, conservation and eventual de-listing. But the technology is poorly developed. With dedicated funding, NMFS can conduct the necessary science for evaluating the unanswered potential that enhancement/aquaculture may hold as a contributing management strategy in rebuilding overfished stocks and restoring endangered species.

NMFS should move to stimulate domestic production of U.S. aquaculture products in support of the DOC Aquaculture Policy

RECOMMENDATION #3

NMFS should move to stimulate domestic production of U.S. aquaculture products in support of the DOC Aquaculture Policy.

The DOC Aquaculture Policy of 1999 lists as one of its chief objectives the expansion of the U.S. aquaculture industry from its present annual production value of $1 billion to $5 billion by 2025. For marine aquaculture, this can only be achieved by expansion into the EEZ where NMFS has regulatory authority. Doubling the country's aquaculture production from 400,000 to 800,000 metric tons by 2025 will naturally increase employment and the related goods and services which support the aquaculture industry. Currently, the national aquaculture industry employs between 180,000 to 200,000 persons and exports about $500 million in goods and services for a sector with gross farm production of 380,000 to 400,000 mt.

Table 1. Summary of Immediate/Short-Term Actions within 2002

RECOMMENDATION #1 NMFS should commit publicly to strengthen its rational development of marine aquaculture in the nation's coastal and offshore waters and implement specific administrative actions which can be done without additional legislative authority.
Element 1A. NMFS should immediately fill the vacancy of Aquaculture Coordinator.
Element 1B. Appoint a NMFS Aquaculture Council (replacing the NMFS Aquaculture Task Force) to work with the Aquaculture Coordinator on the administrative and legal frameworks for aquaculture development in the agency.
Element 1C. Streamline and simplify the federal process for permitting in the EEZ, and create pre-permitted Aquaculture Development Zones (ADZs).
Element 1D. Publish the Draft Code of Conduct for Aquaculture Development in the EEZ in the Federal Register as soon as possible.
Element 1E. Develop a budget initiative to address the scope of activities to be undertaken in support of a national NMFS aquaculture program.
Element 1F. Encourage aquaculture industry representatives to seek membership on all NMFS/NOAA advisory groups and panels (e.g. Management Councils, MAFAC, MPA advisory groups, etc.).
Element 1G. Prepare a Congressional Briefing Paper, together with a budget, on aquaculture in the U.S. and the roles of NOAA and NMFS.

NMFS should encourage private investment and establish a level playing field for fair trade

Element 3A. Encourage private investment.

NMFS has limited financial resources to encourage a shared strategy of private/federal investment in marine aquaculture. These resources include economic assistance to growers through Fisheries Finance Program loans, the Saltonstall-Kennedy grant program, and technical assistance to the Small Business Innovation Research Program. Expansion of these programs can help lay the foundation for a marine aquaculture industry. However, with the extension of current legal and regulatory authority through new legislation, the agency may be able to use the CCF program to include aquaculture enterprises interested in investing in production operations in U.S. waters.

In addition to partnering with private enterprises to locate activities in the EEZ that minimize environmental impacts, the agency can help provide needed managerial and technical information to enable stakeholders in the aquaculture industry to support a potential system of private ownership, and encourage private investment in offshore development. The need is to give clear title to ocean sites and livestock to help ensure rapid and significant gains and access to private capital at reasonable costs. For aquaculture to flourish in the coastal zone and EEZ, and to ensure long-term private investment, the farmer must be guaranteed either a long-term lease, or outright ownership of the cultured species.

Element 3B. Establish a level playing field for fair trade.

NMFS should actively intervene on behalf of producers in the matter of unfair trade practices at both international and interstate levels. In addition to their negative impact on the competitiveness of the U.S. industry — and on the seafood trade deficit — these practices further weaken parts of the national aquaculture industry, making them vulnerable to foreign corporations.

The agency should promote actions that guard against imports with prices skewed by subsidies and other fiscal assistance, as well as imports produced under less stringent or no environmental regulations. There is also a need to identify wild-caught and cultured species to avoid issues of size limitations, possession, and to streamline and simplify interstate movement of seafood to reduce cost to the producers and distributors.

Table 2. Summary of Long-Term Actions

RECOMMENDATION #2 NMFS should enhance its capabilities to advance aquaculture technologies with a focus on production systems for new species and new practices for rebuilding over-exploited stocks and endangered marine species, and improving environmental technologies and practices.
Element 2A. Develop economically viable and sustainable husbandry systems for the culture of marine fish, shellfish, and seaweeds.
Element 2B. Improve the technology for marine stock enhancement.
RECOMMENDATION #3 NMFS should move to stimulate domestic production of U.S. aquaculture products in support of the DOC Aquaculture Policy.
Element 3A. Encourage private investment.
Element 3B. Establish a level playing field for fair trade.

The Rationale for a New Initiative in Marine Aquaculture

Contents

Introduction

The National Marine Fisheries Service (NMFS) in the National Oceanic and Atmospheric Administration (NOAA) is dedicated to protecting and preserving the nation's living marine resources. This is no mean task. The responsibility for stewardship stretches the length of 96,000 miles of coastline and covers 3.4 million square miles of open waters. And the consequences impact an important source of food for the nation, together with thousands of jobs and a traditional way of life in many coastal and remote communities.

The Magnuson-Stevens Fishery Conservation and Management Act Public Law 94-265 calls for the sustainability of these living resources and provides for their conservation and management hand-in-hand with their utilization for national benefit. Within the purview of the Act, environmentally responsible marine aquaculture[1] is included firmly as one such use.

Many fisheries scientists and managers are now beginning to recognize that fisheries management and aquaculture development are complementary, and are essential joint elements of a much-needed strategy for creating sustainable fisheries for national seafood security. Nationally, they should therefore be developed in parallel and not as independent sub-sectors. Compared with development in other countries, the potential for marine aquaculture in the United States has been overlooked, and recognition and prioritization within NOAA and NMFS is well behind the prioritization of fisheries management.

The need is for the re-invigoration of the role of NMFS in marine aquaculture so that the benefits can be integrated more effectively into the agency's responsibilities for stewardship of the nation's living marine resources. Moreover, the proposed approaches will more effectively assist the Department of Commerce (DOC) and NOAA in attaining their policy objectives for sustainable fisheries and responsible aquaculture. Only NMFS has the legislative responsibility and the basic resources to put the solution into practice.

[1] Marine aquaculture is defined in this document as both husbandry of aquatic animals and plants, and enhancement practices.

The Rationale for Marine Aquaculture within NMFS

The benefits of marine aquaculture are many. Some are obvious economic benefits, such as increased food production, more jobs, and earnings from goods and services. But others are more subtle and complement many of NOAA's goals for sustainable fisheries. For example, the alternative of cultured products can alleviate fishing pressure on some overfished stocks. Research on life cycles, behavior, and maintenance in captivity can provide the necessary scientific understanding for better stewardship. And, ecosystems can benefit from extensive polyculture and enhancement systems. Aquaculture, and all its technologies, is therefore a potentially valuable tool for fisheries management.

This is not the first time that NMFS has worked to develop a new fisheries industry. In 1976, the agency cooperated closely with stakeholders to develop offshore fishing for the 'underutilized' species. The economic benefits were large and made a significant contribution to national prosperity. There is now another opportunity for NMFS to help develop marine aquaculture.

A re-invigorated role for NMFS in marine aquaculture is both opportune and timely. The harvest of wild marine resources is finite. Global capture fisheries have remained static between 90 and 100 million metric tons for more than a decade[2] (Figure 1), and for some populations limits are being reached. Many stocks are below strength, and others listed for protection. Marine aquaculture is an effective technology which can integrate closely in several fisheries management strategies. It is already being used to enhance certain marine fisheries[3], and it is an alternative source of high-value seafood commodities[4] for domestic and international markets to alleviate the demand on wild stocks.

Success will guarantee that the developing aquaculture industry in coastal and offshore federal waters is sustainable and environmentally compatible. Success will also make certain that the natural marine resources are protected and rebuilt with purpose. It is timely in that other federal agencies are preparing to fill an administrative vacuum.

Background

The American People are conservative consumers of seafood[5] but collectively they create a powerful market. Their insatiable demand continues to have the most significant influence on fisheries commerce, both nationally and globally, and a concomitant influence on a variety of natural resources. With their enormous purchasing power[6], American seafood consumers comprise a well-targeted, high-value international market. This has resulted each year in an expanding imbalance in fisheries trade (see Appendix I).

The growing imbalance in seafood trade is of major concern to DOC, NOAA, and NMFS. DOC has set specific 25-year goals to offset the annual $7 billion imbalance. It places the highest priority on ending this burgeoning deficit, and calls for increased domestic production of fish and shellfish in sustainable and environmentally compatible ways.

The option of aquaculture can be directly rewarding. Most of the annual increase in global production of fisheries products for the last decade has been derived by aquaculture industries. About 30% of the global supply of food fish is now farmed[7]. In a little more than a decade, many countries[8] have built their domestic aquaculture industries with money from the pockets of the American consumer. Foreign governments have not only benefited from the valuable export earnings, but also achieved national policies for food security by using aquaculture technologies to raise products for domestic consumption.

[2] World fisheries production is currently about 135 million metric tons. Capture fisheries remains between 90-100 million metric tons. Most growth throughout the last decade has been derived from aquaculture.

[3] In 1998, 26% of Alaska's commercial common property harvest of salmon was produced by the state's enhancement program.

[4] The annual value of U.S. aquaculture production approaches $1 billion for about 500,000 metric tons whole weight.

[5] Per capita consumption is 20.9 kg of fish and shellfish based on the estimated live-weight equivalent of available edible products. This is above the global average but well behind the people of east Asia.

[6] American seafood consumers spend an estimated $54.4 billion annually for fishery products. This is an increase of 25% in 5 years.

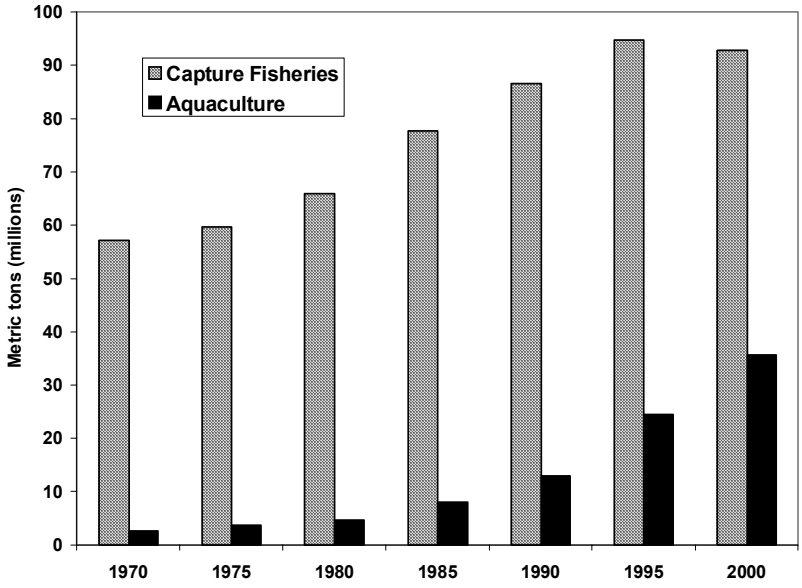
[7] Global aquaculture now produces over 31 million metric tons of farm products annually, valued at some $48 billion. Capture fisheries consistently produce about 80 million metric tons of fisheries products for human consumption.

[8] Salmonid production increased from 1,500 to 260,000 metric tons between 1985 and 2001 with current exports of $973 million going to Japan and the United States. The marine shrimp industry in Ecuador has tripled since 1986. After oil, farmed shrimp is one of the country's prime exports.

Aquaculture, particularly raising high-value marine products, is an appropriate solution for the United States. It has many economic benefits in addition to seafood production (see Appendix II), such as increased employment in coastal fishing communities, and increased earnings in goods and services. But its ability to offer consumers the increased choice of fresh, high-quality, homegrown products on a regular basis can be an effective driving force to achieve the fundamental goal of increasing seafood consumption. This is the common denominator underlying economic growth of the national fisheries sector and putting an end to the upward trend in the annual imbalance in fisheries trade. If organized and managed efficiently — with the right policies to achieve rapid results — the U.S. government can use the potential purchasing power of the American seafood consumer to support economic growth of its own aquaculture industry[9], and contribute further to national food security.

Aquaculture can also be indirectly rewarding, and produce many benefits which would be reflected throughout the fisheries sector. Indirect benefits include the reduction in fishing pressure on many wild stocks, and assistance in rebuilding their populations.

Figure 1. Global Harvest of Aquatic Animals (Source FAO)



Aquaculture — A Technology Familiar to the Government

Aquaculture is familiar technology in the United States due in great part to the federal government (see Appendix III). Today, the national sector is divided into two distinct parts, both of which are economically beneficial. One produces food for human consumption, either directly through aquatic farming or indirectly through enhancement of valuable fish and shellfish stocks. The other produces a range of commercial non-food products, such as baitfish, ornamental fish, live-food organisms, leathers, jewelry, craft materials, medicines, drugs, and research animals; and non-commercial products, such as aquatic animals and plants for conservation purposes. Both parts contribute significantly to national employment and valuable goods and services in the economy. The priority of private investors in U.S. aquaculture today is profitable production of seafood for the domestic market. But perhaps future collective revenues of non-food products will surpass those of food production.

The United States is now in eighth place on the list of leading producers. Annual national production by farming in 2000 reached almost 430,000 metric tons, whole weight (Figure 2), with a value of $1 billion (Figure 3), of which about one-third is for marine species[10]. Added to this is the harvest of many commercially and recreationally caught fish originating from culture-based stock enhancement programs, primarily for Pacific salmon species[11]. But together these resources cannot satisfy domestic demand as the growing import of foreign aquaculture products demonstrates.

The Climate for Aquaculture Development in DOC

DOC views national aquaculture as a *'cross-cutting issue,'* requiring the attention of NOAA and most of its other agencies, and advocates a strong policy for its development (see Appendix IV). DOC policy is reflected in NOAA policy and the strategies proposed for its three line agencies responsible for certain aquaculture-

[9] Within the last 5 years, Italy has increased domestic seafood consumption from 22 kg to 27 kg per capita mostly by available domestic aquaculture products (clams, sea bass, and sea bream).

[10] 2000 data published by FAO show that fish production yields 339,992 metric tons, crustaceans 10,364 metric tons, and mollusks 77,906 metric tons. Fish production is dominated by freshwater catfish and trout. Marine fish production is between 20,000-30,000 metric tons. Similarly a large proportion of the crustaceans are freshwater crawfish.

[11] About 94% of all pink salmon caught in Prince William Sound (Alaska) in 1997 were artificially propagated. For all salmon harvested in common property resources throughout Alaska that year, 22% of the coho, 30% of the pink, and 65% of the chum salmon originated in hatcheries.

[12] JSA provides a forum for coordinating policy initiatives across all federal agencies with an interest in aquaculture. The secretaries of Agriculture, Commerce, and Interior make up the Executive Committee. Members include the chiefs of the Army Corps of Engineers, Environmental Protection Agency, Agency for International Development, Department of Energy, Department of Health and Human Services, Farm Credit Association, National Science Foundation, Small Business Administration, and Tennessee Valley Authority.

[13] The nation has 28 coastal states and 5 island territories which yield 96,000 miles of oceanic and Great Lakes coastline. The EEZ extends over some 3.4 million square miles. By far, the largest part of the EEZ adjoins the state of Alaska and its many islands, and U.S. states and island territories in the Pacific and Caribbean.

related activities: NMFS, the National Sea Grant College Program (NSGCP), and the National Ocean Service (NOS). Therefore, within NOAA, there is a blending of activities and services across the board, and aided by the National Ocean Data Center (NODC), which hosts the NOAA/DOC Aquaculture Information Center in the NOAA Library.

The National Aquaculture Act of 1980 recognized that the principal responsibility for national development lay with the private sector. Therefore, to increase overall effectiveness of federal research, transfer, and assistance programs in support of the private sector the Act created the Joint Subcommittee for Aquaculture (JSA)[12]. NOAA represents DOC on the JSA.

In 1983, JSA published a National Aquaculture Plan, which recently (2000) has been updated. A review of all the current government policy statements and the National Aquaculture Development Plan 2000 reveals considerable authorization of aquaculture activities within the federal government but without appropriation of funds for these activities.

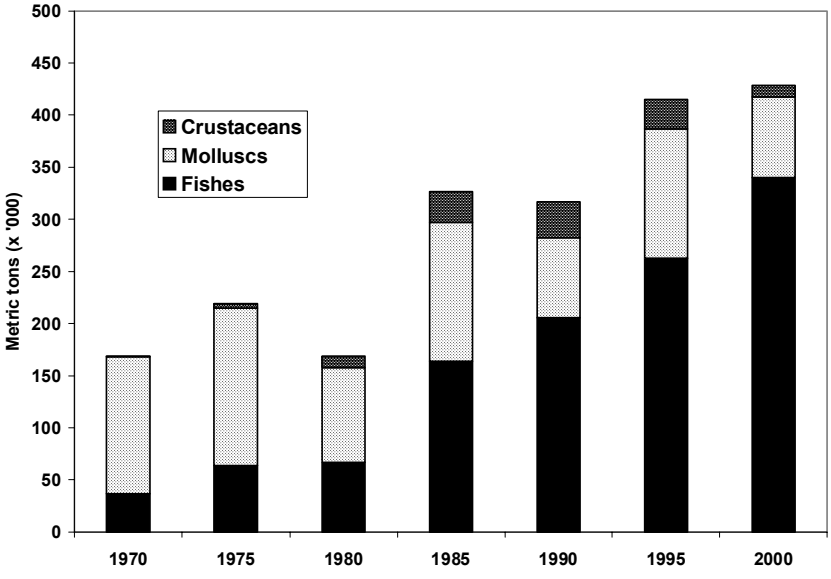
NMFS and National Aquaculture Development

With its broad mandate for stewardship of the nation's marine and coastal living resources, NOAA recommends that aquaculture development and environmental protection proceed hand-in-hand to meet public needs. The greatest potential for increased aquaculture production lies in the nation's coastal and offshore waters[13], an environment which is particularly sensitive. Therefore, in addition to the technical challenges of working in this difficult arena, there are political, environmental, and socio-economic impediments which must be addressed both by a re-examination of regulatory policies, and by research. Fortunately, NOAA has the experience and expertise to address most of the key issues.

The primary focus for aquaculture in DOC is NMFS and the NSGCP. Recently, NOS reviewed the regulatory framework for aquaculture as part of the Coastal Zone Management Act.

The current statutory authorities give NMFS a dual role in aquaculture development. It is both a promoter through finance and research support, and a participant in the regulatory review process to ensure that development proceeds in an environmentally responsible manner. Already NMFS carries out many aquaculture policy and planning functions. It serves on task forces working on aquaculture issues within DOC and NOAA, and interacts with the regional fishery management councils, the interstate marine fisheries commissions, and individual states on aquaculture issues as they relate to shared responsibilities addressing the stewardship of living marine resources, sustainable fisheries, healthy coasts, and protected species. The extent of this involvement, which has greatly increased over the last decade, varies among and within NMFS geographical regions.

Figure 2. U.S. Aquaculture Production by Major Group (Source FAO)

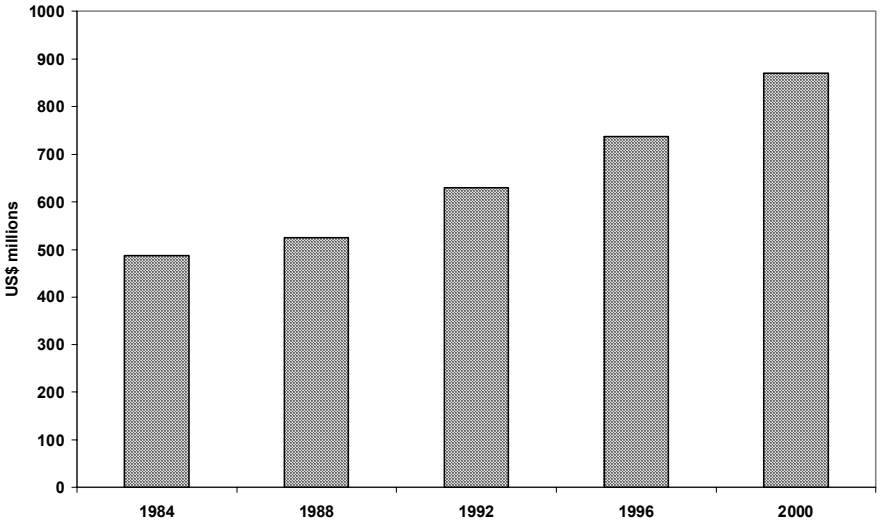


NMFS has considerable resources in place on a regional basis (see Appendix V) which can carry out its responsible financial and regulatory functions, and to conduct both

basic and applied research[14]. However, the funding for these activities has not kept pace with the mandates.

NMFS cooperates in aquaculture development through state-federal and industry grant programs[15], provides economic assistance to the aquaculture industry through the Fisheries Finance Assistance Program, and participates in the regulatory review of permit applications for the siting of offshore aquaculture.

Figure 3. Value of U.S. Aquaculture Production (Source FAO)



NMFS has established a credible history in aquaculture research on difficult issues of technology development requiring long-term attention. It helped create three successful sub-sectors[16] with both domestic and international benefits. It has the scientific expertise[17] to assess the appropriate role of aquaculture and its potential impacts on wild stocks, habitat quality, and protected species, making it capable of fulfilling its responsibilities for marine stewardship. In addition, it might provide the basic science needed to help establish clear policies for permitting aquaculture development in the country, thereby complementing its responsibilities as a regulatory authority. However, these activities currently occur at a low level of activity due to budget limitations.

This background in aquaculture has made NMFS the focal point for international cooperation, and scientific and technological exchange. NMFS delegates serve on aquaculture subcommittees for the Food and Agriculture Organization (FAO) Committee on Fisheries, and the Asia-Pacific Economic Council (APEC). NMFS aquaculture experts have chaired and have been active participants in the annual aquaculture meetings of the United States-Japan Cooperative Program for Natural Resources (UJNR).

A more recent domestic role for NMFS in the development of national aquaculture has been outreach. To address research and development prioritites, outreach to NMFS constituents and stakeholders is accommodated to varying degrees by the five regional centers in the normal course of their programs. The response by the constituents in the aquaculture sector has been positive, but this could change quickly if these opportunities are squandered.

The Role of NMFS in Overcoming the Constraints to National Development

Despite the successful economic growth of the national aquaculture industry, various reviews reveal that there are many perceived and real issues of the sector which concern both the industry itself and the American public (see Appendix VI). These areas of uncertainty and risk have become major impediments to sustainable development of the national industry. Because they concern both freshwater and marine production, they cannot be addressed by NMFS alone, but by the involved government agencies working in partnership.

[14] NMFS has five regional fisheries science centers (Alaska, Northwest, Northeast, Southwest, Southeast) all of which have one or more satellite research laboratories and stations. The three principal stations for large-scale applied research in marine aquaculture are Manchester, WA, Milford, CT, and Galveston, TX. The different fisheries science centers carry out more fundamental research on marine aquaculture to varying degrees.

[15] The Saltonstall-Kennedy Grant Program is most well known for supporting aquaculture-related projects, but in recent years the funding has declined. There were only 17 aquaculture-related projects in FY2000 sharing $0.6 million of the $4 million available for all projects. However, S-K funding for FY2002 is projected to be $11 million. The Northeast Fishing Industry Grants program awarded $42 million for aquaculture projects between 1994-95. The Columbia River Fisheries Development Program awarded $176 million to state governments for the protection of salmon and steelhead resources from 1970-1996.

[16] The three sub-sectors are the farming of saltwater reared salmonids in net-pens in the Northwest, the revitalization of the oyster industry in the Northeast, and marine shrimp propagation in the Southeast.

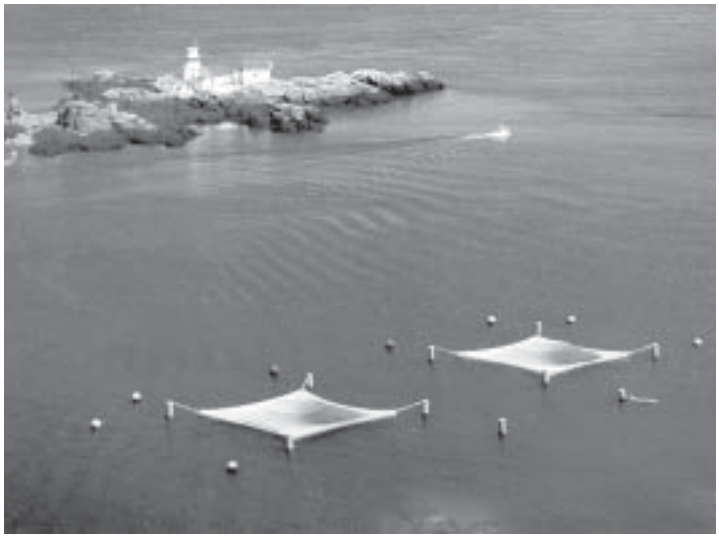
[17] NMFS has well over 100 staff scientists and engineers throughout its facilities working on aspects of marine aquaculture and enhancement. Many have practical experience working in aquaculture's private sector.

However, NOAA and NMFS have the responsibility to promote the development of robust and environmentally sound marine aquaculture in coastal and offshore waters. According to the NOAA Fisheries Strategic Plan, in partnership with its sister agencies, NMFS will address impediments to the development of a domestic marine aquaculture industry and the necessary environmental safeguards associated with such development.

Actions needed by NOAA and NMFS to overcome key constraints for marine development fall into two areas: those which will improve the American business environment, and those which will protect the natural environment.

A. Improving the Business Environment

(i) Create the Right Legal Framework for Marine Aquaculture



Since its inception in the 1970s, the national aquaculture industry has been constrained by laws enacted to manage wild-stock fisheries or natural resources without considerations for its own activities and needs. Moreover, as a multi-purpose industry without a single identity, it has been constrained by the jurisdiction of several agencies. Consequently, excessive regulation[18] has fostered a singular lack of trust in these agencies by potential entrepreneurs and investors.

New legislation is required by NOAA to define the roles, responsibilities, partnerships, and cooperative activities of NMFS, and its relationship to other NOAA line agencies, for all marine aquaculture. It should also create an identifiable administrative office[19]. New and creative legislation, which emphasizes organizational and managerial responsibilities for aquaculture development — especially for activities in the EEZ — is needed not only to establish a productive and environmentally responsible aquaculture industry, but also to benefit the important recreational and commercial fisheries of the country.

NOAA has also developed draft offshore legislation, but this initiative has not been vetted to the new administration. Such legislation would give the Secretary of Commerce authority to grant long-term leases in the EEZ for aquaculture, and require the development of environmental standards. This has been identified as a key need by the aquaculture industry, and is necessary to have offshore aquaculture development.

(ii) Create the Right Administrative Framework for Marine Aquaculture

Without its own legal framework, modern aquaculture has been forced by successive state and federal governments into many existing frameworks, according to their own perception. Without clear identity, the national sector has been administrated by an inter-agency committee, with each agency exercising its own functions and imposing regulations independently.

The government needs the aquaculture industry to contribute to the GDP through annual increases in product sales, employment, and goods and services. In return, the aquaculture industry needs government leadership through an appropriate national infrastructure, with one agency designated as the responsible authority to ensure its efficient organization and management. If one responsible national authority is not possible, then NMFS should be the designated authority for administration of all aquaculture, not only that in the EEZ.

[18] Requirements for a saltwater site in Washington include a lease for the use of aquatic lands (Department of Natural Resources), a Substantial Development Permit (local county), a Hydraulics Permit (Department of Fish and Wildlife), an NPDES permit (Department of Ecology), a navigational hazards permit (Corps of Engineers), and a SEPA review to determine if an EIS is required. The most difficult is the county permit because of the local politics.

[19] The only recognition of aquaculture in the administration is the position of NMFS Aquaculture Coordinator, which is currently vacant and a replacement has not been named.

The national aquaculture industry interfaces with the regulatory authorities largely at the state level. The lack of an administrative framework at the federal level is reflected by the states in their individual policies and regulations. The different regulatory climates of the states has been responsible for growth and development in the Southeastern region, but discouraging investment and opportunity along the coasts[20]. Differences are most apparent in the permitting process, which is long and costly[21]. Southern states, because of minimal land-use conflicts and economic benefits of aquaculture from low-lying areas, have streamlined the process for the regulations within their authority. The coastal states have not, mainly due to water-use conflicts with fishing and recreational industries.

NMFS should work with the coastal states and the industry to create an efficient and transparent permitting process for marine projects, preferably a single permit, and be the designated authority to coordinate the process. The permit might be tied to conditions for best management practices developed with the help of NMFS scientists.

(iii) Increase Available Capital for Development

Without a consolidated federal power base, the aquaculture industry has been unable to persuade the federal government to share the burden of developing new technology, particularly in marine and coastal areas with their added burdens of complexity. Fiscal incentives have been noticeably absent from aquaculture-related legislation, and every National Aquaculture Development Plan has been approved without a budget. This is contrary to the common fisheries policies of many countries, especially the members of the European Union[22], and the USDA, which supports a range of agriculture enterprises with credit and business schemes[23]. A few aquaculture enterprises have received research support through the USDA.

Grants, after agency salaries, constitute the largest line item in the annual budget of NMFS[24]. Therefore, indirect support to aquaculture research and development is already an important component within a variety of NMFS programs. Accordingly, important advances in NMFS activities in relation to oversight and administration of grant programs may be achieved in two primary ways. First, a compilation of current and historical research and development accomplishments in aquaculture derived from NMFS grant programs should be cataloged as a convenient information base for the public. The NMFS Grants Council is currently taking steps to establish an electronic grants database which will help achieve this objective. However, the degree to which this database may accommodate the need (especially regarding grants awarded before 1990) is questionable in the absence of increased dedicated resources and funding support. Second, an important advance in these aquaculture grant-related programs could be achieved by identification of research and development funding priorities across the scope of applicable NMFS grant programs. Specifically, in collaboration with NMFS constituents, emphasis could be given to those priorities which strengthen bridges between agency expertise and external research capabilities to expand the national resource base in line with the goals of the NOAA Fisheries Strategic Plan.

NMFS science centers can provide longer-term, systems-centered research, which is difficult or impossible to undertake with short-term grants to research organizations. A long-term focus on the development of cost-effective and environmentally responsible marine technologies can best be achieved with stable long-term funding, an investment in pilot-scale infrastructure, and dedicated scientific leadership. Therefore, particular attention should be given to complementing the longer-term research capabilities of NMFS aquaculture-related programs with shorter-term or pilot collaborations with state, university, and private researchers through grants and appropriate cooperative agreements.

Finally, the potential of a national aquaculture industry will not be fulfilled without better access to capital for equity, long-term debt, research and development/

[20] In a national survey, the analysis showed all 12 states in the Southern Region had *very low* or *low* stringency levels with regard to aquaculture regulations, with the exceptions of Georgia and Oklahoma, which had *average* levels. Of the 23 coastal states, only 5 had *very low* or *low* stringency levels; 11 states had *average*, *high*, or *very high* levels, and 7 did not reply, including Alaska and Washington.

[21] The process for a net-pen salmon farming permit in Washington has been known to take 5 years and cost $500,000, of which two-thirds was for legal fees for successful appeals.

[22] Between 1989 and the end of 1999, the EU ploughed ECU 16 thousand million of structural funds into 'zones dependent on fisheries and marine fish culture'. The funds were distributed among 13 countries, of which Greece (4.5 thousand million), Portugal (2.8) and Spain (2.6) had the most. During the same period, aquaculture production from the Union doubled from 620,000 metric tons to over 1.2 million metric tons.

[23] The government has a long history of supporting a range of agriculture enterprises through the Farm Credit Administration and the Small Business Administration. Several aquaculture enterprises have received research support through the Small Business Innovative Research program.

[24] Currently grants comprise about 33% of the total agency budget.

[25] Currently, NMFS has two capital schemes. The Fisheries Finance Program provides long-term debt financing through loans provided that the vessels or equipment do not create new harvesting capacity. Some long-term aquaculture-related loans have been made totaling $30.5 million. The Capital Construction Fund provides fiscal incentives, again for purchasing vessels.

application, and other commercial purposes (see Appendix VII). If NMFS is serious about fostering the development of this potential in coastal and offshore waters it cannot ignore the capital needs[25]. Therefore a priority for NMFS throughout the next decade should be to do more to supplement capital access for entrepreneurs of marine applications.

(iv) Unify the National Seafood Business

The two industries which produce domestic seafood — harvesting and farming — are currently polarized. Post-harvest processors diplomatically remain neutral. However, this lack of cooperation between producers is a national impediment to the growth of the national seafood industry[26]. It negatively impacts their separate industries and fuels the vacuum on the domestic market, opening it wider to foreign imports.

It is evident from the growth of seafood production in many countries that successful development depends on close cooperation between fishers and farmers, nurtured by strong government leadership and appropriate development frameworks[27]. NMFS should provide the necessary leadership for its constituents, fishers, and fish and shellfish farmers, to recognize that they are partners, both producing seafood and competing fairly for the domestic market while keeping out foreign competition. NMFS should promote economic growth of the fisheries and aquaculture sectors by targeting domestic seafood consumption with promotional schemes on marketing products and reducing waste.

(v) Construct a Level Playing Field for Fair Trade

The seafood deficit is widened each year by the unfair advantage of foreign producers. Most seafood products enter the United States without duty, but national exports are frequently subjected to tariff or non-tariff barriers.

The price of imported seafood has been skewed by subsidies and other fiscal incentives. At times, seafood has been dumped at less than production cost[28]. In addition to their impact on the seafood trade deficit, these practices further weakened parts of the national aquaculture industry, making them vulnerable to foreign corporations.

Both fishermen and farmers are increasingly constrained by stringent environmental regulations, including new regulations regarding animal welfare. Compliance and monitoring add significantly to domestic seafood production costs, together with high legal fees associated with the regulatory process. Foreign producers are not regulated, and do not have to apply the same standards.

Within the United States there are also constraints on interstate trade, which add to the costs for American seafood producers. These include the regulation of live fish movement between states[29], which requires permits and fees, and different standards of size and harvest limitations.

NMFS should actively intervene on behalf of producers in the matter of unfair trade practices at both the international and interstate level, and help instigate legislation which helps distinguish between fish as a public resource and fish as farm livestock.

(vi) Increase Management and Research Outreach

An increased emphasis[30] on both management and research outreach is needed if NMFS is to achieve NOAA's strategic objective to promote the development of robust and environmentally sound aquaculture.

[26] The most damaging conflict is between Pacific salmon fishermen and Atlantic salmon farmers. Alaska bans fish farming, *per se,* although it depends on aquaculture technologies for producing a large part of its salmon resources. Chile, with an environment similar but far smaller than Alaska, has built up a salmon farming industry worth about $1 billion in only 15 years. The salmon farming industry in British Columbia, Canada is worth about C$400 million.

[27] The Fisheries Cooperative Associations play a crucial role in Japan in successful fisheries and aquaculture development as the same families are involved in both activities. The members now have control over common property and some cooperatives have been given ownership rights to resources and demarcated rights of tenure to aquatic lands.

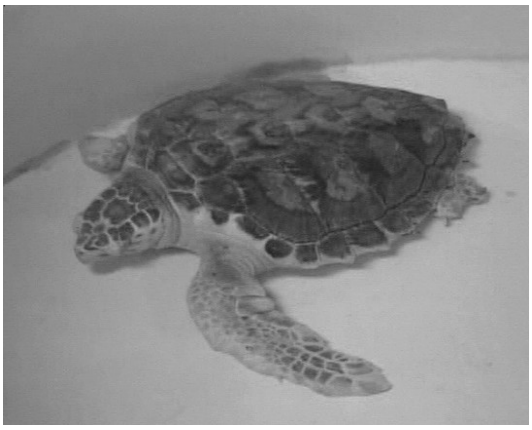
[28] The Norwegian government subsidizes its salmon industry through a variety of regional development loans and grants, regional capital tax incentives, federal payroll taxes, and advanced depreciation on assets. Both Chile and Norway have been accused of dumping farmed Atlantic salmon.

[29] Possession or sale of striped bass in many Eastern states is illegal, but farmed production of striped bass was almost 5,000 metric tons in 1999.

[30] NMFS is generally observant of this need. In 2000 NMFS conducted 6 regional stakeholder meetings on the development of aquaculture in the EEZ. Their inputs were incorporated into a draft Code of Conduct.

With regard to management, NMFS should consult with the regional fishery management councils, interstate commissions, and individual state fishery management agencies to identify, on a species basis, the voids in data and information relative to commercial aquaculture and stock enhancement. Where appropriate, the concerns and/or management priorities should be worked or reworked into fishery management plans. Close coordination with state fishery management agencies is especially critical. Together with NMFS, these agencies collectively share inter-jurisdictional legislative responsibilities for stewardship of living marine resources throughout their range. In this vein, intensified collaboration and teamwork responding to aquaculture/fishery management strategies would emphasize NMFS mandates in sustainable fisheries, healthy coasts, and protected resources.

Management-related outreach and collaboration should be aired for public and congressional comment. Support should be translated by NMFS, as appropriate, into its current programs and budget initiatives. Creation of aquaculture coordinator field positions would ensure the dedicated resources needed for this collaboration and for responding to constituent needs in the area of aquaculture and its integration with marine fishery management.



Regarding research, the unique expertise of NMFS personnel in aquaculture should be acknowledged, nurtured, and communicated above present levels to colleagues in the industry, universities, and the private institutions. The short- and long-term capabilities of NMFS facilities should be defined. Partners and stakeholders should help identify priorities. An expanded role for NMFS in aquaculture research has significant potential, particularly in the areas of aquaculture systems design, rearing studies on candidate species, and longer-term life-history investigations. Where appropriate, public and congressional support must be articulated and translated into current programs and out-year budget initiatives.

B. Protecting the Natural Environment

The diversity of natural ecosystems has made risk to the environment the paramount constraint to aquaculture development. Because marine aquaculture is a new technology, and production is still comparatively small (Figure 4), the lack of scientific information has fueled considerable conjecture about its effects, some of which are genuine risks, some of which are only perceived problems, and some of which are deliberately false. For the most part, the industry has had to cope with all of the ramifications of the environmental constraint on its own. Only recently has NMFS come forward to review the scientific facts and analyze the risks in detail and, using the results, help sub-sectors develop their best management practices[31].

The physical, chemical, and biological impacts of aquaculture on the natural habitat constitute the environment risk[32]. *Inter alia*, the physical impact concerns issues such as the siting of structures and their obstructive damage; the chemical impact concerns issues such as waste nutrients and heavy metals in the sediments and water; and the biological impact concerns issues such as changes to the natural flora and fauna, genetic interactions, exotic species introduction, and disease transfer.

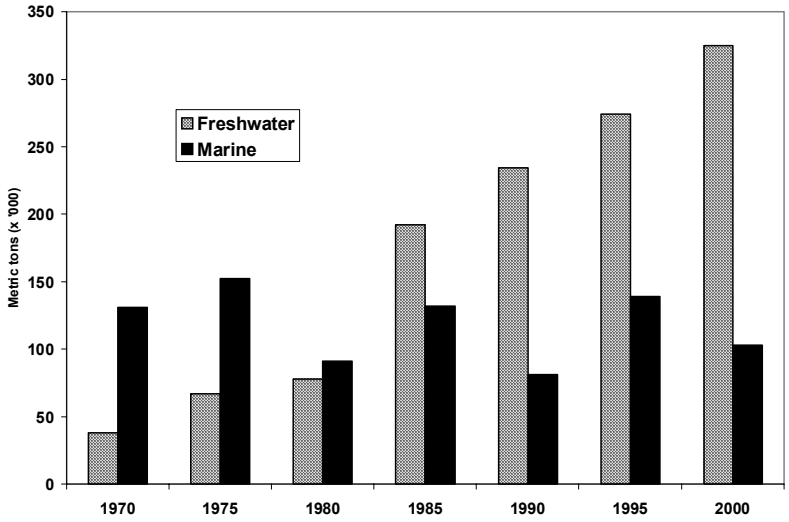
NMFS recognizes that stewardship of the nation's living marine resources is a challenge. Maintaining the health and improving the productivity of these resources is the goal, but many species are already under stress by human intervention, either over-exploitation through harvesting, or habitat degradation by other resource-based industries.

NMFS should balance its environmental mandates with the anticipated needs of industry and regulatory agencies. This is more difficult with aquaculture than harvesting. Policy, management, and research must reflect the diversity of coastal

[31] Following a scientific literature review, NMFS is working with the Washington Fish Growers Association to develop Best Management Practices for net-pen salmon farming in the Pacific Northwest.

[32] Conversely, there are also environmental benefits which should be credited. Many marine aquaculture structures act as aggregating devices, and organic wastes are being utilized by other productive organisms. Hence, considerable research (particularly in Japan) is being carried out on integrated schemes with the emphasis on polyculture of inter-dependent species, rather than intensive monoculture.

Figure 4. U.S. Aquaculture Production by Environment (Source FAO)



aquaculture and its potential interactions with a range of marine ecosystems. But the difficulties must be overcome. Aquaculture production can relieve some of the fishing pressure on fish stocks, and its technologies can contribute to their recovery[33] through enhancement and conservation.

The Fisheries Strategic Plan proposes to develop and implement environmentally sound aquaculture technologies and practices in concert with industry and other agencies. Such partnerships are already underway and should be expanded. NMFS has an established record of cooperating with industry to ensure environmental compliance, especially where listed species and marine mammals are concerned. This role should be strengthened. But fisheries managers and research scientists could do more to work with industry to develop management practices that minimize the physical, chemical, and biological impacts of aquaculture operations on the habitat, and to develop alternatives, such as the design and engineering of closed systems. In this regard, NMFS is already leading the way with the preparation of a draft *Code of Conduct for Aquaculture Development in the EEZ*. This should be finalized and implemented.

Monitoring the environment is an important, but costly, aspect of any aquaculture operation. It also gives an advantage to foreign producers. Meaningful monitoring is long term. Therefore, it is necessary for NMFS to work with industry to identify the minimum number of key parameters and share the cost of monitoring more complex programs.

NMFS has considerable experience with stock enhancement, and the techniques for assisting the recovery of populations. NMFS should continue to emphasize enhancement opportunities, but work to balance culture regimes that maximize economic benefits while minimizing ecosystem stress.

NMFS has much to offer regarding the effects of culture operations on biodiversity, particularly with monitoring. Anticipating the impact on the ecosystem is an important aspect of its sustainability. This might include understanding the energetics behind the industrial fisheries as providers of animal feeds, and the interactions of aquaculture operations with marine mammals and ESA-listed species. NMFS should continue to play a proactive role in these areas, which have vital economic and ecological consequences.

[33] For 10 years, NMFS has been working with the Idaho Department of Fish and Game to rehabilitate the ESA-listed Redfish Lake sockeye salmon through a captive broodstock program. In 2001, the returns numbered over 250 fish.

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Appendix I
Fish and Shellfish in Commerce

1. Domestic Consumption of Seafood

Each year, every American consumes 20.9 kg of fish and shellfish[1], based on the estimated live weight equivalent of available edible products. This figure is well above the global average, but well behind the people of East Asia[2]. At the moment, it is similar to that of most European countries, but with the capital investment in aquaculture by the European Union this is likely to change. Italy increased domestic consumption from 22 kg to 27 kg in the last five years, mostly by available homegrown marine products[3].

American seafood consumers now spend an estimated $54.4 billion per annum for fishery products[4]. This is an increase of 25% in just five years. A little over two-thirds of these expenditures are at food service establishments, such as restaurants, caterers, and home-deliveries, which provide only high-end products. Apart from a small portion spent on industrial products, the rest is retail sales for home consumption, which are mostly fresh and frozen marine fish and shellfish ready processed.

Supermarket chains now control the retail seafood market, having accelerated the decline of the traditional fishmonger by dominating the supply chain. Unlike the small retailer, who operated successfully around seasonal supplies from domestic fishermen, supermarket chains require large volumes of product regularly available. As long as the quality of the seafood is good, the source or supplier is not important to the brokers and buyers. This also suits the seafood consumer. Market surveys[5] reveal the consumer is mostly influenced by price and convenience. The origin of the products, whether domestic or imported, or harvested or cultured, is not a deciding factor. They also reveal that consumer perception of seafood quality is based more on freshness and taste, and less on harvesting being more natural than farming, or that the catch is wild.

[1] Fisheries of the United States, 2000. U.S. Department of Commerce.

[2] The global (1995-1997) average was 15.7 kg, based on live-weight equivalents. The U.S. consumption is similar to France (28.4 kg), Italy (22.0 kg), and the United Kingdom (20.1 kg) but distanced by major fishing nations such as Japan (69 kg), Norway (50.1 kg), and Spain (40.5 kg).

[3] Eurofish, October 2001.

[4] Fisheries of the United States, 2000. U.S. Department of Commerce.

[5] See AquaVision 1998. Report from the Second Nutreco Aquaculture Business Conference, Stavangar, Norway 13-15 May, 1998. Nutreco Aquaculture, PO Box 319, Stavangar, Norway.

2. The Imbalance in Seafood Trade

With their enormous purchasing power, American seafood consumers are a well-targeted, highly valued international market. Unfortunately, despite small but steady annual growth, domestic resources remain inadequate. The national supply[6] of edible fishery products in 2000 was 4.6 million metric tons, but 1.8 million metric tons were imported at a cost of $10.1 billion. Although this was offset to some degree by increased exports[7], the annual trade deficit in edible seafood products widened by 14.5% to a record-breaking $7.1 billion.

A large part of these seafood imports are now high-value aquaculture products, such as marine shrimp, shellfish, and seawater-raised salmon, and the trend is predicted to continue[8]. Countries like Canada, China, Ecuador, New Zealand, Norway, Taiwan, and Thailand, and many others like them, have developed their aquaculture sectors specifically targeting the rich markets of the United States, Japan, and the European Union, the big three global markets for seafood. In some cases, aquaculture products have become among their top export commodities. Moreover, almost every one of these countries has achieved their success in less than two decades[9] through focused government leadership and development policies which have attracted international investment.

[6] Defined as domestic landings plus imports, round weight equivalent, minus exports.

[7] The United States exports almost $3 billion of seafood annually, mostly to Japan (39%), Canada (23%), and the EU (14%).

[8] USDA projects imports in 2001 of farmed shrimp, with a value of about $3.5 billion; Atlantic salmon (about $770 million); tilapia (about $120 million); mussels (about $40 million), and even ornamental fish (about $45 million). From Aquaculture Outlook, 2001, LDP-AQS-14, USDA, Washington D.C.

[9] Salmonid production in Chile was about 1,500 metric tons in 1985. In 2001 it is over 260,000 metric tons with an export value of $973 million (Fish Farming International 28:7) going mainly to Japan and the United States. Shrimp production in Ecuador has tripled since 1986.

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Appendix II

The Economic Benefits of Aquaculture in the United States

The aquaculture sector in the United States is divided into two distinct parts. One produces food for human consumption, either directly through aquatic farming or indirectly through enhancement of valuable fish and shellfish stocks. The other produces a range of commercial non-food products, such as baitfish, ornamental fish, live-food organisms, leathers, jewelry, craft materials, medicines, drugs, and research animals; and non-commercial products, such as aquatic animals and plants for conservation purposes. Both parts contribute significantly to national employment and valuable goods and services in the economy. The priority of private investors in U.S. aquaculture today is profitable production of seafood for the domestic market, but perhaps in the future, the collective revenues of non-food products will surpass those of food production.

1. The Production of Food by Aquatic Farming

The live-weight equivalent of farm products in the United States rose to a record 478,679 metric tons in 1999 (mostly from freshwater aquaculture), after fluctuating between 350,000 and 450,000 for more than a decade[1]. At the same time, the annual market value of these products has almost doubled, and is rapidly approaching $1 billion[2]. Today, the United States is eighth among leading aquaculture producers worldwide. Ten years ago it was sixth.

Global aquaculture now produces more than 31 million metric tons of farm products (fish, crustaceans, and mollusks) annually, with a value of some $48 billion. It also produces a further 8 million metric tons of highly marketable seaweeds, valued at $6 billion. In a little more than a decade, the global production of farmed products, excluding seaweeds, has risen by over 150%, with marine fish and shellfish the fastest-growing segment. In contrast, the world's capture fisheries declined by 3%.

Asian countries dominate world aquaculture, with China producing 67% of the global total. But this is only 47% of the global value, as production in China is dominated by the large quantities of cheap freshwater fish, such as the carps,

[1] Aquaculture production: quantities, 1971-1999. Fishstat Plus, FAO of the United Nations, Rome.

[2] Aquaculture production: values, 1971-1999. Fishstat Plus, FAO of the United Nations, Rome.

which provide most of the animal protein for the people. With the exception of Japan, most of the other leading countries, such as India, Thailand, and Vietnam, target production of high-value marine products[3] to earn foreign exchange. Only the United States (8th) and Norway (10th) currently compete in the top 10.

Within the United States, aquaculture is the fastest growing food-producing sector. Farm production, in terms of live-weight equivalent, is dominated by catfish (57%), followed at some distance by rainbow trout (6%), crawfish (4%), and tilapia (2%). These are all freshwater species. Marine species contribute 31%, led by cupped oysters (18%), hard clams (6%), and Atlantic salmon (4%). Together, all these farming technologies contribute about 12% to the total edible fish and shellfish landings in the country.

Aquatic farm products are also exported. About 6,600 metric tons of Atlantic salmon, rainbow trout, tilapia, and catfish were exported in 1999, with a value of $29.3 million[4]. Large quantities of farmed mollusks were also exported, but the volume cannot be separated out of the national total.

2. Fisheries Enhancement for Food Production and Conservation

The United States is the largest and most successful practitioner of fish enhancement in the world. Principally, this is because of a century of study with Pacific salmon by the federal government and the states of the Pacific Northwest[5], and particularly favorable conditions in Alaska where artificial propagation now contributes 34% of all the salmon harvested[6]. With public, Tribal, and non-profit (Alaska) propagation sites[7] scattered along the length of the four coastal states, fisheries enhancement contributes significantly to the domestic landings of Pacific salmon, currently 285,147 metric tons valued at $270 million (NMFS 2001), and a large coastal recreational fishery.

Public and private hatcheries are also responsible for the enhancement of most of the country's inland waters with sport or game fish. There are some 215 such facilities throughout the country[8], with the majority operated by federal, state, and Tribal agencies. The Fish and Wildlife Service alone operates 70 hatcheries and releases annually some 170 million fish[9]. Many other countries have large and dependable culture-based fisheries in their marine and coastal waters, not only for Pacific salmon but also for sports fish. For example, Japan relies on hatcheries and enhancement practices for all of its harvest of Yesso scallop[10], 50% of the Kuruma prawn catch, 75% of red sea bream, and 40% of Japanese flounders. Iran uses hatcheries to sustain its sturgeon (caviar) fisheries in the Caspian Sea[11]. Other nations now marketing products from some of their culture-based fisheries include Norway (with cod), Australia (barramundi), Malaysia and Thailand (blood cockle), the Philippines (clams), and China (scallops, clams, and cockles, among others).

In the United States, the potential of the culture-based marine fisheries (other than salmon) is still somewhere between advanced research and development and offshore pilot farms. Cooperative projects between the public and private sectors are pioneering practices for red drum (in Florida, South Carolina, and Texas), Pacific threadfin, mullet, and snapper (in Hawaii), red snapper (Alabama, Florida, and Mississippi), white seabass (California), summer flounder (North Carolina), cod (Maine), lingcod (Washington), snook (Florida), and winter flounder (New Hampshire). However, these are mostly in the research phase.

Most of the world's oyster fisheries have been enhanced for centuries, first by continuously improved husbandry and more recently by artificial propagation in hatcheries and seeding. The last 50 years have seen oyster culture technology successfully applied to many other commercial species of mollusks, including clams, cockles, abalone, and mussels. Currently, the live-weight equivalent of global mollusk culture is just over 10 million metric tons annually, and represents

[3] Production in Asian countries focuses on groupers, snappers, seabreams, shrimps and prawns, and many mollusks.

[4] 2000 Annual Report of the U.S. Seafood Industry, by H.M. Johnson & Associates, Jacksonville, OR.

[5] The Columbia River Basin program is authorized and funded through the 1938 Mitchell Act, which was established to mitigate, in perpetuity, for habitat and salmon runs lost through the construction of hydro-electric projects. The 25 major hatcheries release annually over 120 million smolts and contribute between 50%-70% of all adults caught in the coastal fisheries.

[6] M. McNair (Alaska salmon enhancement report 2000: annual report. Alaska Department of Fish and Game, Juneau, AK, 34p.) reported that 93.6% of all pink salmon caught in Prince William Sound in 1997 were artificially propagated, and that for all salmon harvested in common property resources throughout Alaska that year, 22% of the coho salmon, 30% of the pink salmon, and 65% of the chum salmon originated in hatcheries.

[7] In addition to hatcheries, net-pens, acclimation sites, rearing ponds, and remote egg-incubators are all used. The State of Washington operates the largest production system, with 24 complexes (groups of hatcheries) with more than 90 rearing facilities. The State of Oregon operates 34 hatcheries and 15 other rearing facilities.

[8] Census of Aquaculture 1998. USDA.

[9] Each year, USFWS distributes juvenile fish and fish eggs of 18 coldwater species (mostly salmonids), 14 coolwater species (mostly walleye and northern pike), and 31 warmwater species (mostly striped bass, largemouth bass, bluegill, channel catfish, and American shad).

[10] In 1970, the scallop fishery in Hokkaido was still totally depleted. Today, production is over 216,000 metric tons with a value of US$324 million (FAO Fishstat Plus 2000).

[11] Iran releases about 20 million juveniles from its hatcheries annually to sustain the sturgeon fishery. In spite of uncontrolled poaching by its neighbors, and pollution from mineral exploration, the fishery provides export earnings from caviar second only to oil.

about 70% of the world harvest. Oysters make up about 37%, clams 27%, and mussels 14.5%.

Annual production of mollusks in the United States, from all sources, is currently 119,377 metric tons live weight, with a value of about $100 million. Despite increased enhancement programs throughout all of the coastal states[12], mollusk production has not regained the peak of 151,000 metric tons it saw in 1975. This is due predominantly to the loss of suitable coastal habitat and disease.

Enhancement and improved husbandry practices are also responsible for the freshwater crawfish industry in the Southern states. Current production of the red swamp crawfish is almost 20,000 metric tons annually, with a value of $28 million.

Finally, enhancement practices are also being applied for the conservation of fish and shellfish populations. The marine fisheries resources of the United States reached maximum production levels two decades ago. Modern catch trends show a high incidence of fully exploited fish stocks, and stocks which are either overexploited, depleted, or recovering. Fisheries managers find that enhancement is an effective solution for replenishment and recovery, and may be the only option for some ESA-listed species. Perhaps the most successful project has been federal fisheries scientists' rescue and rehabilitation of the Redfish Lake sockeye salmon from the verge of extinction[13]. Another is the cooperative project by the United States and Mexico to save the Kemp's Ridley sea turtle.

3. Other Economy-Wide Impacts

By the year 2025, the DOC's aquaculture policy[14] calls for almost a six-fold increase in the value of domestic aquaculture production, a three-fold increase in employment, and a five-fold increase in the value of goods and services.

In 1992, aquatic farming production in the United States was 413,531 metric tons live weight equivalent. According to Dicks et al. (1996), the industry that year generated approximately $5.6 billion in GDP and over 181,000 jobs[15]. Although national production has increased by some 16% since then — with intense price competition among the suppliers, including commercial harvesters and importers — the national employment profile is not likely to have changed significantly.

The United States has a complex[16] aquaculture sector, with a critical mass of primary producers for a large number of species. The Census of Aquaculture (USDA 1997) recorded a total of 4,028 farms[17] in the United States in 1996, of which 54% were involved with food fish, 21% with crustaceans, and 13% with mollusks. The rest produced ornamental fish, baitfish, sport or game fish, or other aquatic animal products.

While the average employment on a farm[18] is almost exactly 4 persons, sub-sector labor profiles differ by species and technology. Employment on a typical net-pen farm producing salmon in the United States is 6-7 positions, similar to that of Canada and Norway[19]. Furthermore, the estimated wages of both a production and downstream employee in the salmon industry are above average for the collective agriculture sector in the United States.

Dicks et al. (1996), in their study of the U.S. aquaculture sector in 1992, calculated that the value of total industry output from fish farming activities[20] was slightly more than 3.5 times the value of the actual production. That is, each dollar spent to produce an aquaculture product generates an additional $2.50 of goods and services in the economy. Because of the incompleteness of the database, the authors believe these aggregate multipliers are conservative. The value of aquaculture production in 1992 was $629.5 million; in 1999 it was $833.5 million. The total income generated by the aquaculture production activities must now be close to $2.5 billion.

[12] The use of hatchery technology is widespread in the West Coast industry, of moderate significance in the Northeast, and just becoming established in the Gulf and South Atlantic states. Hatcheries are believed to be the future of the oyster industry. J.J. Manzi, 1990, Marine farming and enhancement, NOAA/NMFS Technical Report 85, Washington D.C.

[13] In 1990, fisheries scientists from the National Marine Fisheries Service and the Idaho Department of Fish and Game started a captive broodstock program for the 16 fish which returned that year. In 2001 the returns numbered over 250 fish.

[14] Announced in August 1999, the policy targets aquaculture production valued at $5 billion, 600,000 jobs, and $2.5 billion in goods and services by the year 2025. Among the total of 7 objectives, it also calls for enhancement of depleted stocks and a Code of Conduct for Aquaculture in federal (EEZ) waters.

[15] According to M.R. Dicks et al. (1996), production activities accounted for 8% of the income and 16,500 jobs; the upstream activities (purchases of equipment, supplies, feed, seed, fertilizer, labor, and financing) for 23% of the income and 40,500 jobs; and downstream activities (transport, storage, processing, manufacture, distribution, and sales) for 69% of the income and 125,000 jobs.

[16] A complex sector is one which produces large quantities (over 10,000 metric tons) of a broad range of species, in all environments, and with a variety of technical practices. C.E. Nash, 1992, Employment and manpower in aquaculture, FAO, Rome.

[17] The USDA defines a farm as a place (commercial or non-commercial) from which $1,000 of products are sold annually. It can be any location where primary production takes place, such as a hatchery, nursery, or grow-out operation. USDA, 2000, Census of aquaculture 1998, AC97-SP3, Washington D.C.

[18] Using employment data from M.R. Dicks et al. (1996) and farm data from USDA (2000).

[19] From NOAA Technical Memorandum NMFS-NWFSC-49, 2001, The net-pen salmon farming industry in the Pacific Northwest.

[20] Shellfish farms were not included in the study.

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Appendix III
The History of Aquaculture in NMFS

1. Early Marine Hatcheries

Application of culture methods for marine fish developed in Europe and the United States during the second half of the 19th century were believed to be a way to augment and replenish natural fisheries stocks[1]. In 1871, Spencer Fullerton Baird, leader of the newly formed U.S. Commission of Fish and Fisheries, reported to Congress reasons for declining stocks and recommended fish culture as a solution. His ideas were accepted, and a research vessel[2] was built for the Commission, followed by shore-based marine fish hatcheries. Although highly effective in producing and releasing newly hatched fry, the lack of evidence of increased harvests ended their efforts in the 1940s.

As the enhancement approach was abandoned, the emphasis during the years after World War II shifted to aquatic farming. Federal laboratories led by the Bureau of Commercial Fisheries (now NMFS) conducted pioneering research in culture, first with mollusks (at Milford, CT), and then with salmonids (at Manchester, WA and Little Port Walter, AK), and marine shrimp (at Galveston, TX). Although these pioneering efforts were major contributors to new industries worldwide, federal research for aquaculture was drastically reduced in the 1980s, leaving development to the private sector. Only declining natural stocks, and the unrealized potential for U.S. aquaculture products on global markets, re-established some low-level research by NMFS in the mid-1990s. Also, with the availability of new fish-marking techniques, there was a re-awakening of aquaculture-based stock enhancement by groups outside NMFS. Some early well-designed experiments were shown to increase stocks without displacing wild fish.

2. Pacific Coast Salmonid Hatcheries

Although efforts to enhance the marine fisheries were stopped in the middle of the 20th century, this was not true for the more successful efforts with the anadromous salmonids. NMFS still funds the operation of 18 hatcheries[3] in the Columbia River Basin as mandated by the Mitchell Act of 1938, and amended in 1946. The Mitchell

[1] Hatcheries in Norway first produced and released billions of hatched codfish eggs to enhance the natural stocks, followed by the British who propagated and released codfish and then flatfish species in large numbers in the North Sea.

[2] *RV Fish Hawk* was built for the Commission in 1880 to be a mobile hatchery for shad, striped bass, mackerel, and herring. In 1883, a federal government fish hatchery was built in Woods Hole, MA, followed by others in Gloucester, MA in 1890, and in Boothbay Harbor, ME in 1904.

[3] The 18 Mitchell Act hatcheries are actually operated by the Oregon Department of Fish and Wildlife (ODFW), the Washington Department of Fish and Wildlife (WDFW), and USFWS.

Act was passed to mitigate, in perpetuity, habitat and salmon runs lost due to federal water-related projects within the Columbia River Basin, primarily the large main-stem hydroelectric projects. This program is the largest federally funded marine fisheries enhancement program in the United States, releasing each year between 70-75 million juvenile coho, fall chinook, spring chinook, sockeye, and winter and summer steelhead. Previously the number was 100-120 million[4].

The listing of a number of stocks of salmon in the Basin by NMFS under the Endangered Species Act (ESA) has had a negative impact on the Pacific salmon fisheries, but fish from Mitchell Act hatcheries are still instrumental in providing fish to coastal commercial and recreational fisheries, as well as commercial, recreational, and Tribal fisheries within the Columbia River Basin. With record hatchery returns to the Basin in 2001, the result of good ocean rearing conditions, Mitchell Act fish still make significant contributions to these fisheries. Record numbers of surplus fish are being provided for Tribal use, and processed and distributed through a number of food-share programs in the Pacific Northwest.

The annual allocation of funding[5] is presently inadequate to meet rising production costs. This has resulted in several hatcheries taken out of production, and reduced releases at others. These NMFS pass-through funds are allocated to the 3 operational agencies based on production priorities planned in conjunction with the states and Tribes. NMFS, therefore, maintains considerable active involvement in the program, and reflects the mandates established by Federal Court decisions and implications of listings under the ESA.

3. Current Activities

A considerable volume of research at NMFS (mostly funded by reimbursable contracts from BPA) continues to work with the Pacific Coast salmonid hatcheries and conservation of listed Pacific salmon stocks. The agency is now implementing reforms in the Mitchell Act hatchery program to reduce potential impacts of cultured fish on natural stocks by releasing more naturally behaving smolts. Some of the hatcheries are being totally redirected to a conservation role as funds become available .

In Alaska, since depressed fisheries led to the start of Regional Aquaculture Associations for salmon enhancement, research by NMFS scientists at the Auke Bay Laboratory (Little Port Walter Station) continues to contribute to a hatchery program which now provides 30% of the annual salmon harvest in the state. In addition, the agency is carrying out a production-level aquaculture project in southeast Alaska, under the auspices of the United States/Canada Pacific Salmon Treaty, to enhance trans-boundary runs of sockeye salmon stocks. The project is operated jointly with Canada[6].

Within the last decade, research by NMFS scientists has focused on commercially important marine fish species, cultured both for enhancement of natural populations and directly for food. More detailed information about these marine programs and the NMFS resources for aquaculture in the regions is provided in Appendix V.

[4] Several billion juvenile Pacific salmonids are released annually from the 200 hatcheries and net-pen systems in Alaska, California, Idaho, Oregon, and Washington for various purposes. Most are operated by state agencies, Tribal groups, the USFWS, and by regional aquaculture associations in Alaska.

[5] Funding in FY 2002 for operation and maintenance of Mitchell Act hatcheries was over $12.7 million.

[6] NMFS is using pass-through funding of $300,000-$400,000 annually to support the program. The U.S. portion of the project is carried out by the Alaska Department of Fish and Game.

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Appendix IV
Government Aquaculture Policy And the Role of NMFS

1. Statutory Authorities

The National Aquaculture Act of 1980, as amended (16 U.S.C. 2801 *et seq.*), proclaims that private development of a U.S. aquaculture industry is *'in the national interest'* due to its potential for (i) reducing the trade deficit, (ii) augmenting commercial and recreational fisheries, and (iii) meeting future food needs. The Act established the Joint Subcommittee on Aquaculture (JSA) as a coordination group for federal government activities relating to aquaculture, and charged the JSA with the development of a National Aquaculture Development Plan. Amendments to the act in 1985 designated the Secretary of Agriculture as the permanent chair of the JSA. The secretaries of Agriculture, Commerce, and Interior make up the Executive Committee.

Authorizing legislation for NOAA aquaculture policy is listed in Table IV-1. Of particular relevance for NMFS are the Magnuson-Stevens Fishery Conservation and Management Act, the Marine Mammal Protection Act, the Endangered Species Act, and the Fish and Wildlife Coordination Act. Although these laws do not explicitly address aquaculture, they provide the legal basis for NMFS to review aquaculture development from the perspective of potential impacts on wild stocks, essential fish habitat, marine mammals, and endangered species.

Under these statutory authorities, NMFS has a dual role. It is both a promoter of aquaculture development and a participant in the regulatory review process to ensure that development proceeds in an environmentally responsible manner.

2. Policy and Planning Initiatives

Policy and planning for implementing the National Aquaculture Act has proceeded on several levels (see Table IV-2). In addition to the JSA, there are task forces working on aquaculture issues within DOC, NOAA, and NMFS. NMFS participates in each of these initiatives. NMFS also interacts with the Regional Fishery Management Councils, the interstate marine fisheries commissions, and individual

Table IV-1. Authorizing Legislation for NOAA Aquaculture Policy	
Agriculture and Food Act of 1980 Anadromous Fish Conservation Act Clean Water Act Coastal Zone Management Act, 1990 and 1996 Amendments Columbia River Basin Fishery Development Program Commercial Fisheries Research and Development Act Endangered Species Act Fish and Wildlife Act of 1956 Fish and Wildlife Coordination Act Interjurisdictional Fisheries Act Magnuson-Stevens Fishery Conservation and Management Act	Marine Mammal Protection Act Marine Protection, Research and Sanctuaries Act National Sea Grant College Program Act National Aquaculture Improvement Act of 1985 National Environmental Policy Act National Aquaculture Act of 1980 Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 Rivers and Harbors Act of 1899 Saltonstall-Kennedy Act Title XI, Merchant Marine Act of 1936, as amended Water Resources Development Act

Source: NOAA Aquaculture Policy, Attachment 1 (February 1998)

states on aquaculture issues as they relate to shared responsibilities addressing the stewardship of living marine resources, sustainable fisheries, healthy coasts, and protected species. The extent of this involvement, which has greatly increased over the last decade, varies among and within NMFS geographical regions.

(i) Joint Subcommittee on Aquaculture (JSA)

The JSA provides a forum for coordinating policy initiatives across all federal agencies with an interest in aquaculture. The JSA has produced a draft update of its National Aquaculture Development Plan, with input from federal agencies and stakeholders, and developed a draft implementation plan specifying actions for each federal agency. The plan's vision is *'to develop a highly competitive, sustainable aquaculture industry in the United States to meet consumer demand for cultivated aquatic foods and products that are of high quality, safe, competitively priced, and nutritious and are produced in an environmentally responsible manner with maximum opportunity for profitability in all sectors of the industry.'* The plan addresses 12 major issues (see Table IV-2)[1].

NOAA (OAR and NMFS) represents DOC on the JSA. The NMFS Aquaculture Coordinator[2] has represented DOC on the Executive Committee. Other NMFS representatives[3] provide leadership for the JSA task forces and working groups.

(ii) Department of Commerce

DOC has established an Aquaculture Task Force, supported by NOAA's Office of Sustainable Development and Intergovernmental Affairs. In addition to NOAA participants (including NMFS), the task force includes representatives from the Minority Business Development Administration (MBDA), the Economic Development Administration (EDA), the International Trade Administration (ITA), and the National Institute for Standards and Technology (NIST). A major achievement of the task force was the drafting of a Department of Commerce Aquaculture Policy, which was approved in August 1999. The policy sets specific objectives by the year 2025 (see Table IV-2)[4].

The DOC Strategic Plan for 1997-2002 (September 1997) advocates the growth in a U.S. marine aquaculture industry to help restore depleted populations under its *'build sustainable fisheries'* goal. In addition, the plan calls for a *'percentage reduction in the time and cost of permitting environmentally sound aquaculture ventures,'* and supports NOAA research and technical assistance in aquaculture.

[1] JSA's approach to addressing specific aquaculture issues in a coordinated manner across federal agencies is to establish a task force or working group of agency representatives, experts, and stakeholders, as appropriate, to develop solutions and recommendations.

[2] The position of NMFS Aquaculture Coordinator is currently vacant and a replacement has not yet been named.

[3] NMFS personnel from Industry and Trade, and SF/Pascagoula currently serve as chair and vice-chair (respectively) of the Working Group on Aquacultural Statistics and Economics, and Aquatic Animal Health Task Force. Previously, NMFS aquaculture coordinator served as vice-chair of the Aquaculture Effluents Task Force, and SEC personnel chaired the Shrimp Virus Working Group.

[4] Companion policy guidelines are currently in draft form.

Table IV-2. Summary of Major Aquaculture Policy and Planning Initiatives	
Joint Subcommittee on Aquaculture	Established under the National Aquaculture Act of 1980, as amended (16 U.S.C. 2801 *et seq*.) to provide coordination among federal agencies in promoting private development of U.S. aquaculture industry. Department of Agriculture is the permanent chair. Agriculture, Commerce, Interior make up the Executive Committee. JSA has produced a National Aquaculture Development Plan addressing 12 major issues: research and technology development; technology transfer; education, extension, and training; information systems; sustainability and environmental compatibility; aquatic animal health; product quality, safety, and variety; federal regulatory framework; marketing and international trade; statistics and economics; financial services and incentives; coordination and partnerships. NOAA (NMFS and OAR) represents Commerce on the JSA; NMFS aquaculture coordinator (currently vacant) represents Commerce on the Executive Committee. NMFS also provides leadership for task force and working group activities.
Department of Commerce	DOC Aquaculture Policy (approved August 1999) sets specific objectives by 2025: to increase the value of domestic aquaculture production to $5 billion; to increase the number of jobs in aquaculture to 600,000; to develop aquaculture technologies and methods to improve production and safeguard the environment; to develop a code of conduct for responsible aquaculture by 2002 and have 100 percent compliance in federal waters; to double the value of non-food products and services produced by aquaculture; to enhance depleted wild fish stocks; to increase exports of U.S. aquaculture goods and services to $2.5 billion. DOC Strategic Plan for 1997-2002 (September 1997) includes a '*build sustainable fisheries'* goal that includes the application of solutions such as growth in a U.S. aquaculture industry to help restore depleted populations. DOC Aquaculture Task Force includes representatives from NOAA, MBDA, EDA, ITA, NIST.
National Oceanic and Atmospheric Administration	NOAA Aquaculture Policy (February 1998) describes roles of NMFS, OAR, and NOS and outlines programs to meet the needs for aquaculture development and environmental protection through research, development and technology transfer; financial assistance to business; environmental safeguards; and coordination. NOAA Strategic Plan (May 1996) calls for *'accelerating the growth of U.S. marine aquaculture'* (Objective 5). NOAA Aquaculture Task Force includes representatives from NMFS, OAR, NOS, others.
National Marine Fisheries Service	NOAA Fisheries Strategic Plan (May 1997) includes an objective to '*promote the development of robust and environmentally sound aquaculture'* and sets 5 performance measures: promote the commercial rearing of at least 7 new species; reduce the time and cost of permitting environmentally sound aquaculture ventures; provide financial assistance for environmentally sound aquaculture ventures; identify areas in coastal waters and the EEZ suitable for environmentally sound aquaculture development; develop and implement environmentally sound aquaculture technologies and practices. NMFS Aquaculture Task Force includes representatives from throughout the agency (including regions).
Regional Fishery Management Councils	Northeast Council established an Aquaculture Committee (1995), amended the Sea Scallop FMP to allow experimental aquaculture project, and drafted an aquaculture policy (1998) to facilitate permitting in the EEZ. Southeast Council amended Coral FMP to establish a live rock aquaculture permit system for the South Atlantic EEZ (1995). Gulf of Mexico Council adopted a Mariculture Policy as part of its Essential Fish Habitat Amendment.
Interstate Marine Fisheries Commissions	ASMFC identifies aquaculture issues as important components of fishery management plans for Atlantic sturgeon, Atlantic striped bass, and summer flounder and is developing aquaculture guidelines for member states. ASMFC and the Gulf States Marine Fisheries Commission conducted inventories on aquaculture activities and related laws and regulations in member states.

The DOC has also developed draft legislation that would authorize leasing of areas of the EEZ for offshore aquaculture development. The current Administration has not yet taken a position on this draft legislation.

(iii) NOAA

NOAA has established an Aquaculture Task Force, which, like the DOC Task Force, is coordinated by the Office of Sustainable Development and Intergovernmental Affairs. The task force was instrumental in developing a NOAA Aquaculture Policy, which was approved in February 1998 (see Table IV-2). NOAA has also included aquaculture in its strategic plan. The *NOAA Strategic Plan: A Vision for 2005* (May 1996) calls for *'accelerating the growth of U.S. marine aquaculture.'*

NMFS has specific aquaculture responsibilities under the NOAA Fisheries Strategic Plan

(iv) NMFS

NMFS participates in broader-based aquaculture efforts that are organized and coordinated by JSA and task forces established within DOC and NOAA. Within NMFS, a task force has also been established to coordinate efforts within the agency, but no formal NMFS aquaculture policy has been developed to date.

NMFS has specific aquaculture responsibilities under the NOAA Fisheries Strategic Plan (May 1997). The plan includes an objective to *'promote the development of robust and environmentally sound aquaculture,'* and articulates 5 performance measures[5] through 2002 (Table IV-2).

NMFS is also pursuing aquaculture initiatives under its Implementation Plan for the Code of Conduct for Responsible Fisheries, which includes marine aquaculture. The Implementation Plan reiterates the 5 performance measures in the NOAA Fisheries Strategic Plan, which states that *'the NMFS strategy will be implemented in cooperation with other U.S. agencies,'* and specifically mentions the role of the JSA in planning and coordination. As part of this effort, NMFS held a series of public meetings in late 2000 to solicit input on a Code of Conduct for aquaculture in the EEZ[6].

(v) The Fishery Management Councils

Fishery Management Council (FMC) aquaculture-related activities, in general, have been restricted to the New England and Southeast regions.

The New England Council established an Aquaculture Committee during 1995 and, under contractual arrangement, completed and approved a special report on that its role in aquaculture policy and management strategy. That report concluded that aquaculture is a component of the New England fishery, of which the Council has a responsibility and a legal authority to manage. Later that year, the Council developed Amendment #6 to the Atlantic Sea Scallop Fishery Management Plan (FMP), which allowed an experiment involving sea scallop research, enhancement, and aquaculture in the EEZ. In 1998, the Council also drafted an aquaculture policy in conjunction with NMFS, the fishing industry, and other resource management interests. The policy called for measures to facilitate an aquaculture permitting process in federal waters.

In the Southeast, the Council's 1995 amendment to the Coral FMP established a live-rock aquaculture permit system[7] for the South Atlantic EEZ. The associated federal regulations require a permit for possession of live-rock and related coral

[5] Strategies for achieving the performance measures include the study of new candidate species, simplifying permitting and regulatory processes, addressing user conflicts, providing loans through the Fisheries Finance Program, determining site requirements for aquaculture in the EEZ, and technology transfer.

[6] A report based on stakeholder input was completed in July 2001, together with a draft Code of Conduct for circulation.

[7] For persons taking or possessing cultured live rock in the Gulf or South Atlantic EEZ, a federal cultured live-rock permit is required for each specific harvest site. Such a permit, or copy, must be on board a vessel depositing or possessing material on a cultured live rock site, or harvesting, or possessing live rock from a cultured live rock site.

aquaculture operations in the EEZ, and prohibit octocoral harvest north of Cape Canaveral, FL. The Council issued 29 aquaculture permit transactions in FY2001.

The Gulf of Mexico Fishery Management Council adopted a mariculture policy as part of its Essential Fish Habitat Amendment. The policy encourages environmentally responsible mariculture and associated guidelines pertaining to exotic species, habitat, siting, research and monitoring, water quality, and disease control.

Aquaculture issues have been identified as important components of several state-federal fishery management plans

(vi) The Regional Fisheries Commissions

Aquaculture issues have been identified as important components of several state-federal (inter-jurisdictional) fishery management plans[8] developed by the Atlantic States Marine Fisheries Commission (ASMFC).

In September 1998, the NMFS Northeast region, in cooperation with ASMFC and its member states, conducted a state-federal Atlantic coastal aquaculture workshop. The workshop developed recommendations[9] on several different areas, including strategic planning, FMP integration, and aquaculture data collection. Subsequently, in September 2000, the NMFS Northeast region entered into a cooperative agreement with ASMFC to develop a *'code of conduct'* and/or related guidelines in communication with the aquaculture industry and the ASMFC member states on responsible aquaculture in Atlantic coastal waters. Through a series of workshops, this effort is bringing together a wide and diverse audience from the state, federal, and private sectors to provide a needed focus on best business practices. The effort also takes into account the relevant environmental, biological, technological, economic, social, and commercial considerations. The guidelines[10] being developed through this state-federal partnership approach are not binding, but are forging an essential constructive dialogue among fishery management agencies, industry interests, and public stakeholders on mutually acceptable guidelines for present and future aquaculture in waters under state jurisdiction.

In recent years, the ASMFC and the Gulf States Marine Fisheries Commission have both conducted inventories on aquaculture activities and related laws and regulations concerning aquaculture in each of the commissions' member states.

(vii) The States

NMFS and state fishery management agencies uniquely have shared responsibilities for stewardship of living marine resources. And it is in this vesting of legislative authority where the potential for NMFS/state partnerships in aquaculture have tremendous potential for achieving mutual strategic management priorities. State (versus federal) governments have primary control over the conduct of most marine aquaculture because most aquaculture operations occur in coastal waters under state jurisdictional authorities. However, programs and mandates vary from state to state, and aquaculture responsibilities are often either undefined or shared between two or several state governmental agencies.

The NMFS interacts with state governmental authorities as both a primary player and, at other times, a catalyst through inter-jurisdictional fishery enhancement initiatives, habitat protection, protected species concerns, and research grants. The states and federal government have established collaborative programs, for example, in restoring anadromous salmonid stocks through enhancement and aquaculture practices on both coasts, and for striped bass in Chesapeake Bay. One state-federal program involving NMFS merits particular attention. The large-scale salmon enhancement program in Alaska, which began in the 1970s, is a good example of how aquaculture technology can help improve capture fisheries. It also illustrates how NMFS can partner with states and play a significant R&D role in support of aquaculture and stewardship of living marine resources, while providing expertise and technology in both public and private sectors.

[8] Plans with aquaculture interests include Atlantic sturgeon, Atlantic striped bass, and summer flounder.

[9] Specific recommendations included the development of a *'framework-type'* approach to address species aquaculture issues during FMP development, including both commercial production and enhancement, and the improvement of needed partnerships among state and federal fishery management agencies relative to aquaculture and associated marine resources stewardship responsibilities.

[10] Draft guidelines were circulated for comment in May 2002. This will be followed with the release by NMFS Headquarters of a similar report focusing on aquaculture activities in the EEZ.

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Appendix V
Resources of the National Marine Fisheries Service

1. Fisheries Financial Programs

(i) Grant Programs

Each year, NMFS administers several federal/state grant programs. These provide significant contributions to aquaculture research and development in response to industry needs and related fishery management information. The most well-known is the Saltonstall-Kennedy (S-K) Grant Program, which, in 2001, specifically solicited proposals to advance the implementation of marine aquaculture in the offshore environment by addressing technical aspects, such as systems engineering, environmental compatibility, and culture technology. However, the impact of the program has been declining because of reduced funding[1], leaving high-quality aquaculture proposals unfunded.

NMFS assists[2] aquaculture-related research and development through the Northeast Fishing Industry Grants Program. The objectives are to help restore overfished New England groundfish and shellfish stocks through hatchery programs, and to provide new business opportunities for displaced fishermen.

The Columbia River Fisheries Development Program, administered under the provisions of the Mitchell Act of 1938 and amended in 1946, issues grants[3] to state governments for the protection and enhancement of the salmon and steelhead resources in the Pacific Northwest. Project activities include enhancement studies and the construction, operation, and maintenance of salmonid fish hatcheries.

NMFS provides funds to the University of Southern Mississippi[4] for a stock enhancement program in the Gulf of Mexico. The project, now in its fourth year, is a multifaceted initiative to develop the technology required to spawn and raise red snapper and augment wild stocks through enhancement.

The Hawaii Stock Management and Fisheries Development Initiative provides funds[5] from NMFS to the private Oceanic Institute in Hawaii to evaluate enhancement practices for several species of marine finfish.

[1] Between 1989-1991, NMFS funded 27 aquaculture projects nationwide under the S-K Program, at a level of $3 million. In FY2000, there were only 17 projects at a level of $600,000.

[2] NMFS awarded $4.2 million to support 22 aquaculture projects under the program between 1994-1995.

[3] Approximately $176 million was awarded during the period 1970-1996 alone.

[4] USM's Gulf Coast Research Laboratory leads a consortium that includes the private Mote Marine Laboratory (in Florida) and the Oceanic Institute (in Hawaii). Funding in FY2001 was $2.5 million.

[5] The grant to the Oceanic Institute is $500,000 annually.

(ii) Seafood Inspection Program (SIP)

SIP has a long and active history with all fish and shellfish products from both aquaculture and wild harvest, and destined for either the domestic markets or for export. Typically, for the domestic catfish and trout industries, this consisted of in-plant processor presence, but with the development of HACCP inspection controls for safety hazards and quality attributes in the 1990s, the procedures have changed.

Many aquaculture products, such as hybrid striped bass, tilapia, clams, and oysters are handled on a lot-inspection basis, as is every batch of imported fish and shellfish. Aquaculture products comprise an increasing volume of seafood purchases by the retail supermarket chains, which require USDC inspection and certification to ensure that they meet established purchase specifications.

Although the primary activity of SIP is for the safety, wholesomeness, quality, and condition of fishery products destined for human consumption, USDC inspectors at times fulfill a supporting role of assuring the health of the animals as required by the countries importing U.S. fishery products. When requested by an exporter, inspectors may officially remove any products for the detection and identification of specific pathogens at recognized health laboratories.

(iii) Trade

The Office of Industry and Trade (OIT) is able to work closely with the aquaculture industry on a number of trade-related issues, particularly, barriers to trade of cultured products[6]. It also works on cases where the potential impacts of trade would be on cultured products[7].

OIT also works with foreign governments to try to ensure that import restrictions do not reflect non-tariff trade barriers, which could disadvantage U.S. products, whether they are from wild capture or aquaculture. In most instances, foreign governments attempt to use non-science-based barriers, which must be refuted. Trade assistance is also provided to U.S. producers of farmed products who are negatively impacted by dumping of foreign-farmed products on the U.S. market.

(iv) Small Business Innovative Research (SBIR)

The SBIR program is a contractual arrangement, not a grant program. It is mandated under the Small Business Development Act of 1992, and administered within NOAA by the Office of Research and Technology Applications (ORTA). The Industry and Trade Program represents NMFS on the NOAA SBIR Committee.

ORTA solicits topic areas for research from DOC scientists, and organizes their ideas within a booklet distributed to small businesses. They, in turn, propose their innovative research ideas pertaining to the topics[8]. Phase 1 winners are selected and given $75,000 to carry out their idea, with NMFS providing reviewers and technical monitors.

After 6 months, and/or the completion of Phase 1, businesses may apply for Phase 2 awards. ORTA then conducts a technical review, and a selection process allows 3 or 4 of them to continue with further research and production. The Phase 2 awards are $350,000. After 2 years, and/or the completion of Phase 2, the last phase concerns commercialization of a product. No SBIR capital is provided for this final phase.

[6] Most recently OIT assisted U.S. certified disease-free salmon egg suppliers to fight a ban by Chile on the importation of this commodity to protect its own producers on a pretext of disease transfer. OIT intervened also on the issue of importing disease-free marine shrimp from Central America.

[7] U.S. exports salmon to Australia and New Zealand, countries without indigenous salmon populations but with growing salmon farming industries.

[8] Two aquaculture projects have received SBIR funding. (i) Rapid and sensitive methods for identification of viral pathogens of shrimp received $75,000 followed by $350,000. (ii) Shrimp virus disinfecting techniques for aquaculture and processing wastes received $75,000.

2. NMFS Facilities and Staff Expertise

NMFS resources for aquaculture are distributed widely throughout headquarters, the regional offices, and the 5 fisheries science centers together with their satellite laboratories and field stations. Because of the multi-disciplinary nature of aquaculture research, in addition to the many staff who have basic backgrounds in fisheries science, NMFS personnel have an array of different qualifications and experience. Moreover, a large number of the research staff in the science centers have worked in fish and shellfish production in the private sector.

(i) The Regional Offices

NMFS regional offices include programs dedicated to habitat conservation and protected resources. Nationwide, about 150 employees review applications for marine-related projects, which include aquaculture facilities, and provide technical comments and recommendations. That annual workload includes about 10,000 proposed actions in state and federal waters, of which several dozen projects relate to the aquaculture industry. NMFS's permit review mandates are granted by the Clean Water Act, Rivers and Harbors Act, Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, Fish and Wildlife Coordination Act, and the National Environmental Policy Act. Often, following a site visit and discussions with applicants and other agencies, NMFS's comments will document whether and to what extent the project may affect water and sediment quality, NMFS trust resources, and the associated ecosystem. If significant adverse impacts are likely, comments to permitting agencies will recommend alternative project designs or operational procedures to minimize those impacts.

These important NMFS mandates have shaped the agency's habitat and protected resource programs since the 1970s. As certain aquaculture sectors expanded in the 1980s, NMFS efforts expanded to include much more detailed collaboration to simplify the permitting process. For example, the NMFS Northeast Region initiated an effort with state and federal partners and the Atlantic salmon culturists in Maine to develop standards of practice for facility siting and operations. Guidelines and protocols simplified permitting and implemented industry-supported monitoring to document environmental quality issues. Similar efforts with other industry sectors and the state fisheries commissions have been used to simplify permitting, standardize procedures, and address regulatory burdens for the aquaculture industry.

(ii) Northwest Fisheries Science Center (NWFSC)

There are over 30 staff members in the Resource Enhancement and Utilization Technologies Division (REUT), which is responsible for a wide variety of research and development — mostly with finfish — at NWFSC and its field stations. In addition to fisheries biology, staff members' qualifications include veterinary medicine, oceanography, food science and nutrition, chemistry, physics, engineering, behavioral psychology, microbiology, immunology, and agriculture. The majority are contract employees.

NWFSC in Seattle houses a separate fish culture research facility with a computer-controlled recirculation system supplied with both fresh and saltwater. Laboratories are well equipped for research studies in fish endocrinology, nutrition, developmental biology, molecular biology, microbiology, and food science. Practical facilities include a new disease laboratory (which meets all quarantine criteria with effluent treatment) for studies of diseased fish and

shellfish *in vivo*, a feed-preparation laboratory, and a pilot unit for work on post-harvest technology and product quality.

The principal aquaculture resources are at the Manchester Research Station[9]. The station has 20-acres of land on Puget Sound with extensive large-scale facilities supplied with both seawater and freshwater. A unique feature of the station is the effluent treatment system used to prevent disease transfer. This feature makes the station the key facility for programs to conserve and restore ESA-listed salmon stocks. The work of the station is principally concerned with anadromous salmon and marine fish. Therefore, in addition to great numbers of onshore tanks adaptable for both fresh and saltwater, the station has an offshore floating complex of marine net-pens. The station has a complement of support buildings, analytical and wet laboratories, a pathology unit, small hatchery facilities, and other auxiliary rooms. A large area, which includes a natural stream channel, is dedicated to fish behavior studies.

The Mukilteo Research Station, north of Seattle, is another saltwater facility for the breeding and propagation of marine fish. It is also provided with an effluent post-treatment system.

The center also operates a small field station at Big Beef Creek on the Hood Canal. This station is used for holding and breeding populations of salmonid stocks listed under ESA.

(iii) Northeast Fisheries Science Center (NEFSC)

Responsibility for aquaculture research and development in the NEFSC is with the Aquaculture and Enhancement Division. The division has over 30 personnel, most of whom are actively involved with shellfish-related disciplines at the Milford Laboratory. About 10 are active in finfish culture, as well as habitat and stock enhancement fields at the Sandy Hook and Narragansett Laboratories.

The Milford Laboratory[10] in Connecticut has been an important part of the U.S. shellfish industry for over a century. The professional staff is a multidisciplinary team of more than 30 scientists trained in physiology, biochemistry, genetics, immunology, bacteriology, algal physiology and nutrition, disease, pathology, fishery biology, ecology, and water chemistry. Collectively, they provide multiple strengths and a broad scope to their very practical studies with both shellfish and finfish.

Most basic research at Milford is carried out in experimental units in covered wet laboratories, and serviced by environmentally controlled recirculating water systems. Outdoor raceways for practical production work are supplied directly with seawater. One large laboratory is dedicated to mass production of microalgae, and a second for the culture of live food organisms.

The James J. Howard Marine Science Laboratory at Sandy Hook in New Jersey has a state-of-the-art seawater system, which services laboratories adaptable to a variety of research projects for both marine fish and shellfish. One special feature of the Howard Laboratory is a two-story research aquarium that can simulate daily and seasonal changes in light intensity.

The Narragansett Laboratory in Rhode Island has large tanks capable of holding broodstock populations of marine fish. The tanks are adapted with some environmental controls. Currently, the laboratory is using its facilities for the propagation of cod and haddock.

[9] NMFS scientists at Manchester pioneered the saltwater culture of Pacific salmon in the early 1970s, thus opening the way for net-pen farming in the United States. Later, working with U.S. Fish and Wildlife, they acclimated Atlantic salmon in saltwater pens as part of a conservation program for New England stocks. This work, in turn, led to the more profitable Atlantic salmon farming in the Pacific Northwest.

[10] In the years following WWII, when the U.S. shellfish industry was near death, Milford became the focus of all major advances for shellfish in North America. The most important discovery was the technique producing cultchless seed for both American cupped oysters and clams. The staff also developed methods for spawning bivalves almost all year-round, and bred strains of oysters for fast growth. Within 15 years, growers were producing numbers back to their historical peaks. Many Milford culture techniques are still used worldwide.

(iv) Southeast Fisheries Science Center (SEFSC)

Aquaculture research at SEFSC concerns both marine finfish production and turtle conservation.

SEFSC collaborations with researchers from the regional state governments and universities provide additional expertise and facilities to add to the complement of professional scientists and engineers working on research and development in the 3 main laboratories of the center.

For 19 years (1963-1982), the Galveston Laboratory in Texas was the premier research facility for aquaculture research of commercially important brown and white shrimp. During this period, the laboratory became nationally and internationally known for leading research in shrimp aquaculture. Many international scientists, students, and entrepreneurs came to study and train in various aspects of the *'Galveston hatchery technique'* of shrimp culture. In 1982, most of the shrimp culture work was terminated, although cooperative studies on shrimp nutrition continued until the late 1980s. The body of research on marine shrimp culture resulted in 106 publications. After 1982, most of the staff transferred its focus of aquaculture to protected species, namely captive rearing of the endangered Kemp's Ridley sea turtle in a headstart program, and subsequently the loggerhead turtle, together with the relevant ecological research. Physical facilities consist of indoor raceways and replicate experimental units, all supplied with seawater from a central system. The facility also has a number of wet and dry analytical laboratories.

Staff at the Beaufort Laboratory in North Carolina work on the polyculture of black seabass, and Southern and summer flounder. The professional staff consists of experts in fisheries biology, ecology, chemistry, and physiology of fishes, all of which are necessary to help define life histories and determine habitat requirements for those marine species considered suitable for polyculture. Experimental units are in environmentally controlled wet laboratories both indoors and outdoors, and all supported by the necessary support facilities for live food production.

The staff of the Panama City Laboratory in Florida specializes in behavioral studies, again with the program to restore ESA-listed populations of turtles, but also for harvesting and fishery engineering studies. A unique feature of the laboratory is the large containment area for *in situ* behavioral studies.

(v) Alaska Fisheries Science Center (AFSC)

AFSC has a highly experienced group of scientists with broad expertise in aquaculture applications, including life history, fish culture, fish health, genetics, population dynamics, fish behavior, and stakeholder-constituent involvement.

Much of the research at the Auke Bay Laboratory in Juneau concerns the maintenance and on-growing of wild marine organisms to assess the effects of certain habitat-related perturbations, such as pollution and local land-use practices. Consequently, most of its experimental facilities are equipped with the necessary freshwater and saltwater life-support systems. There are also laboratory capabilities for experimental culture of fish and invertebrates.

The center operates Auke Creek Experimental Hatchery, close to the Auke Bay Laboratory, to study the downstream

and upstream migrations of 6 endemic anadromous salmonids from Auke Lake. The facility has a state-of-the-art two-way fish counting weir. Aquaculture research therefore relates to enhancement, genetics, basic biology, and life history traits of salmonids. The hatchery is also managed as a collaborative research facility for the University of Alaska, the Alaska Department of Fish and Game, and others.

Little Port Walter Station, on Baronof Island, conducts research on salmon enhancement and hatchery-wild stock interactions. The program began in the 1970s when salmon runs in Alaska were at record low levels[11]. The research is focused on helping to rebuild depressed common property commercial, recreational, and subsistence fisheries. It has been closely coordinated with the state's natural resource agencies and Regional Aquaculture Associations. In addition to a modern floating hatchery system, the facility has a unique feature: floating micro-raceways that allow the progeny of specific matings to be followed for detailed genetics studies on effective population sizes and parental origin.

(vi) Southwest Fisheries Science Center (SWFSC)

The extensive aquaculture experience of the staff at the SWFSC in La Jolla has been directed at the breeding and propagation culture of the demersal fishes of the California Current for the purpose of species identification and taxonomic descriptions. Its facilities are therefore, modest in size but very flexible, using high quality, temperature-controlled seawater, and light control. More recently, the staff added research on the impact of contaminants and UV light on fish eggs and larvae, and the genetic identification of larval fishes.

The Santa Cruz Laboratory has newer and larger facilities for the holding and rearing of salmonid broodstocks, and basic physiology. When complete, a new state-of-the-art aquarium will feature high quality temperature-controlled seawater, with features for salinity control and high water exchange rates.

3. International Cooperation

NMFS is recognized as the primary interface for international cooperation and scientific assistance by foreign agencies. For example, NMFS delegates attend the biennial Committee on Fisheries (COFI) of the Food and Agriculture Organization of the United Nations (FAO), which plans and approves the FAO program in international fisheries, including aquaculture. NMFS delegates are working members of the COFI Sub-committee on Aquaculture.

Similarly, NMFS delegates represent the United States in the Asia-Pacific Economic Council (APEC), an international organization for economic cooperation among Pacific Rim countries. They also serve directly on the Fisheries and Aquaculture panel.

NMFS helped instigate and manage the United States - Japan Natural Resources Cooperation (UJNR), which meets each year, alternating countries. The aquaculture group has been one of the principal mechanisms for exchanging science and technological information.

[11] NMFS scientists at Little Port Walter made major contributions to Alaska's highly successful salmon stock enhancement program which revitalized the fishery. These included development of floating freshwater raceways in marine estuaries, the use of low salinity lens in marine net-pens for short-term rearing of salmon fry, growing smolts in non-anadromous lakes above barrier falls, and development of broodstocks for controlled localized use.

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Appendix VI
Constraints to National Development

In 1978, the National Research Council published its study on the constraints and opportunities of aquaculture development in the United States, as mandated by the Food and Agriculture Act of 1977. For all intents and purposes, the constraints and opportunities have not changed for 25 years, and continue to be evident in 6 principal areas, as follows.

1. National Leadership

Aquaculture in the United States has never had a legal and administrative framework specific to its own activities and needs. But the country is not alone. The problem has been universal for fundamental reasons. First, aquaculture is a new food-producing sector but overlaps with two traditional sectors – agriculture and fisheries. Second, its existence is dependent on natural resources, and therefore competes directly with land-use planning, water-use planning, coastal and rural development, tourism, and even hunting. Third, it is very multidisciplinary, and so integrates with much science and technology development.

Because of aquaculture's lack of clear identity, governments have compressed it into existing national frameworks according to their own perception[1]. The results have had obvious consequences. Aquaculture is either neglected by the designated parent agency, as it is not its prime responsibility, or management is shared by a number of agencies, each exercising its own function. In either case, it is invariably governed by regulations created for other industries[2]. Aquaculture has only been really productive and successful in countries[3] where the government has identified a clear need for its use, in all or any of its many roles, and created a specific legal and administrative framework with the designation of a single responsible authority.

Until the widening of the annual seafood deficit in the 1980s[4], the United States had no real need for the products of aquaculture, or its benefits in goods and services and rural employment. Even the National Aquaculture Act of 1980 failed to nominate a lead agency but mandated a sub-committee[5] of 12 federal agencies for

[1] Aquaculture in 21 different African countries is identified with 19 different administrations. C.E. Nash, 1995, Aquaculture Sector Planning and Management, Fishing News Books, Oxford.

[2] The marketable size of farmed products and natural products have to be the same, and some aquaculture commodities have been included in quotas.

[3] Japan, Israel, and Taiwan were early industrial leaders structuring their national frameworks in the interests of food self-sufficiency. More recently, countries restructured to meet economic needs (Chile, Greece, India, Ireland, Thailand, etc.) or social benefits (Iran, Sweden, Vietnam, etc.).

[4] See Aquaculture and Capture Fisheries - Impacts in U.S. Seafood Markets, 1988, U.S. Department of Commerce, NOAA/NMFS, Washington D.C.

[5] The Food and Agriculture Act of 1977 first designated an Inter-Agency Committee on Marine Science and Engineering with responsibility for national aquaculture development. The forum subsequently was renamed the Joint Subcommittee on Aquaculture with responsibilities for study and assessment, coordination, planning, collection and dissemination of information, and provision of advice to the federal council.

inter-agency communication, but with a limited role. An amendment was made later in the National Aquaculture Improvement Act of 1985 designating USDA as the lead federal agency, but only with respect to the coordination and dissemination of national aquaculture information. As a result of this continuing indecision by the national legislature, each agency has regulated aquaculture development within the narrow purview of its own responsibilities and not the industry as a whole. Consequently, the aquaculture sector in the United States has become greatly over-regulated. This has led to a singular lack of trust in the regulatory agencies by potential entrepreneurs and investors.

2. The Bureaucratic Process

The interface of the aquaculture industry with the regulatory authorities primarily takes place at the state level. Unfortunately, the lack of leadership at the national level is reflected by the 50 states in their individual policies toward aquaculture development, and, consequently, in their own legislation[6].

Aquaculture development in the United States is dominated by the Southern region[7]. The number of Southern farms and value of products are both greater than the other three regions together. This bias is unusual, as globally the cooler temperate latitudes (>45°) are more diverse in types of aquaculture practices they support, and more productive in total weight than the warmer temperate latitudes (<45°). However, the principal reason for this imbalance is not the geographic climate, but the regulatory climate. In a study[8] on the state regulatory climate toward 5 types of finfish aquaculture, all of the 12 states surveyed in the Southern region replied. The stringency levels of the states' regulations and their administration were average or below the norm. For the most part, many states surveyed in the other regions did not reply, and those which did had stringency levels average or above the norm.

This lack of uniformity between the states in their legal, regulatory, and hence, promotional attitudes, is a major constraint to national development. It is particularly evident in the coastal states[9] where marine aquaculture had high priority for development support in the 2000 National Aquaculture Development Plan. With regard to coastal salmon farming, for example, Washington State has a moratorium on additional net-pen farms, while Alaska forbids 'for-profit' aquaculture enterprises altogether.

The differences are most apparent in the permitting process, which is long and costly. Many permits are required from any number of federal, state, and even county agencies. By and large, the Southern states have streamlined the process for the regulations within their authority, but others have not[10].

3. Capital Resources

Because of the lack of a responsible authority leading aquaculture, there has been a corresponding lack of fiscal policy instruments to bear the burden of new technology development together with private investment. Such schemes have enabled countries in Europe and Asia to make rapid progress in development. The European Union offers fiscal incentives[11] to its 13 members with direct grants and loans to support its policies for restructuring their aquaculture and fishing industries and to redevelop their coastal economies. In addition, many countries have financed their own loan-guarantee programs[12] with aquaculture identified as a priority recipient.

The United States is not a stranger to such policy instruments. The government has a long history of supporting a range of agriculture enterprises through the Farm Credit Administration and the Small Business Administration. Several aquaculture enterprises have received research support through USDA's Small

[6] H.D. McCoy, 2000, American and international aquaculture law: a comprehensive legal treatise and handbook, Supranational Publishing Company, Peterstown, WV.

[7] USDA, 1998, Census of Agriculture.

[8] All 12 states in the Southern region had *very low* or *low* stringency levels, with the exceptions of Georgia and Oklahoma, which had *average* levels. Of the 12 states in the Western region, 6 had *high* or *very high* stringency levels, and the other 6 (Alaska, Nevada, New Mexico, Utah, Washington, and Wyoming) did not respond to the survey at all. From F. Wirth and E.J. Luzar, 2000, A scale measure of state regulatory climate towards finfish aquaculture, J. World Aqua. Soc. 31(4):545-557.

[9] Of the 23 coastal states only 5 had *very low* or *low* stringency levels; 11 states had *average*, *high*, or *very high* levels, and 7 did not reply, including Alaska and Washington. From F. Wirth and E.J. Luzar, 2000.

[10] Requirements for a saltwater site in Washington include a lease for the use of aquatic lands (Department of Natural Resources), a Substantial Development Permit (local county), a Hydraulics Permit (Department of Fish and Wildlife), an NPDES permit (Department of Ecology), a navigational hazards permit (Corps of Engineers), and a SEPA review to determine if an EIS is required. The most difficult is the county permit because of local politics. Requirements for an upland facility exclude the lease and navigational hazards permit, but include water rights and discharge permits (Department of Ecology). Currently, there is a 5-year backlog of water right applications. The process has been known to take 5 years and cost over $500,000, of which two-thirds was for legal appeal costs. Washington Fish Growers Association, 2001.

[11] Between 1989 and the end of 1999, the EU ploughed ECU 16 thousand million of structural funds into 'zones dependent on fisheries and marine fish culture'. The funds were distributed among 13 countries, of which Greece (4.5 thousand million), Portugal (2.8) and Spain (2.6) had the most. Over the same period, aquaculture production from the Union doubled from 620,000 metric tons to over 1.2 million metric tons.

[12] Such countries include Canada (Federal Business Development Bank Venture Capital), Norway (Regional Development Fund), Scotland (Highlands and Islands Development Board), Ireland (Irish Fisheries Development Board), and Chile (Fundaçion Chile).

Business Innovative Research program. However, there are no loan guarantee programs similar to those of EU countries.

4. The Polarization of Domestic Seafood Producers

The aquaculture industry in the United States is unnecessarily constrained by antagonism between fishers and fish farmers. Both produce seafood and both compete fairly[13] for the same markets, but fishers who harvest products identical to those which are farmed, such as salmon and halibut, are particularly hostile.

The lack of federal leadership is again to blame for the polarization of domestic seafood producers. In many countries, there is a history of close cooperation. In European countries like France and Spain this is mostly because large parent organizations own both fishing fleets and aquaculture enterprises. In Japan, it is because the people have exerted increasing control over common property. First, the local villages, and later, the cooperatives were given ownership of resources and demarcated rights of tenure to aquatic lands. The Fisheries Cooperative Associations in Japan, therefore, play a crucial role in the success of fisheries and aquaculture development. But fishing in the United States is almost entirely in the hands of thousands of independent license holders, each of whom endeavors to make a living by owning and operating a single boat. Aquaculture enterprises are therefore seen only as competitors and not allies in the offensive against foreign competition or the struggle to maintain the economy and social structure of coastal fishing communities.

Possibly the first effort to bring the two producers together has been made by the National Fisheries Institute, the large fisheries business association. The new policy of the NFI is to treat aquaculture and fisheries, and farmers and fishers, as equal sources of seafood products.

5. International and Interstate Trade

The seafood deficit, now surpassing $7 billion, is widened each year by the unfair advantage of foreign producers. U.S. exports of seafood are frequently subjected to tariff or non-tariff barriers, particularly by the European Union and Canada. But U.S. trade policy imposes few restrictions on imports[14], and most products enter without duty.

The policy has had a heavy impact on American producers, particularly salmon farmers. Norway and Chile have not only been exporting fresh and chilled farm Atlantic salmon at less than fair market value, because of subsidies and other fiscal incentives[15], but also have been dumping fish by selling at less than the cost of production. A ruling by the ITA led to the imposition of a tariff to protect the industry but it was not in time to prevent takeover of a financially weakened national industry by large corporations from Europe and Canada.

A more recent concern involves Chile and the exportation of certified disease-free salmonid eggs, an export business once worth over $1 million to the U.S. industry. In 2000, after building up its own resource base from imported salmon stocks, Chile banned[16] importation of all further shipments in the *'interest of environmental protection.'*

Another challenge for fair competition between the United States and foreign seafood producers is to level the production playing field. U.S. fishers and farmers are increasingly constrained by environmental regulations, as well as some new regulations regarding animal welfare. Complying and continually monitoring for compliance of these stringent conditions significantly adds to the cost of domestic seafood production. Foreign producers, on the other hand, are not so constrained. Although the health and safety of U.S. seafood imports (and exports) is protected

[13] A study on Aquaculture and Capture Fisheries: Impacts in U.S. Seafood Markets, mandated by the National Aquaculture Improvement Act of 1985, indicated that dockside prices (of salmon and shrimp) received by U.S. fishermen are lower than they would be otherwise in the U.S. market. By the same token, U.S. consumers enjoy the benefits of lower prices that are the result of unrestricted foreign import supplies. U.S. salmon and shrimp fishers are at a competitive disadvantage to foreign imports of cultured salmon and shrimp that enter the United States duty free, while U.S. seafood export opportunities are hindered by foreign trade barriers. April 1988, U.S. Department of Commerce, NOAA/NMFS, Washington D.C.

[14] Many of the U.S. agriculture industries (dairy products, sugar, many fruits and vegetables), on the other hand, are protected to some degree through import quotas and tariff barriers.

[15] The U.S. International Trade Commission found that the Norwegian government subsidized its salmon industry through a variety of regional development loans and grants, regional capital tax incentives, federal payroll taxes, and advanced depreciation on assets.

[16] Through ITA intervention, a Memorandum of Understanding between the 2 countries was signed in 2001 to enable importation of stocks certified by APHIS (USDA). Currently, there are ongoing discussions to extend the term. However, exports dropped below $200,000 in 2000.

by the international acceptance and imposition of HACCP (Hazard Analysis Critical Control Point) practices, foreign producers have few regulations[17] which add significantly to preprocessing costs, or the welfare of producers and live animals. This also enables them to avoid the high legal fees associated with the regulatory process in the United States.

There are also some constraints on interstate trade of aquaculture products, which add another financial burden to American producers. Commercial aquaculture is discouraged in some states by the Lacey Act Amendment of 1981[18], which regulates the movement of live fish between states. The Lacey Act does not distinguish between fish as a public resource and fish as farm livestock, and the permit process and fees involved add unfairly to the production costs of some farmers and not others.

In the interest of fisheries management, some states have regulations which impose size and harvest limitations on certain species[19], or have even made possession illegal. In neighboring states, the same species may be legally farmed, but regulations effectively block the local markets for sales, or cross-state transportation to other markets.

Government intervention on behalf of producers in the matter of unfair trade practices at both the international and interstate level is becoming increasingly important, especially if government subsidies are involved.

6. The Environment

The rapid growth of global aquaculture, especially in a regulatory vacuum, has led in some cases to environmental problems and conflicts over limited resources. The most notable are the coastal farming of marine shrimp and salmon. Despite its great diversity in cultured species, production systems, culture environments, and intensity of resource use, aquaculture is equated with such cases and consequently given a biased negative press both in peer-reviewed articles and popular media[20]. This image has blurred the importance of the sector, especially in its creation of goods and services, and the conservation and enhancement of aquatic ecosystems.

Current environmental concern is focused on the farming of marine shrimp and salmon with the apparent objective of limiting development of such coastal aquaculture. Little is being done to address the issues on the basis of scientific information, rather than perceived threats, and to set sustainability guidelines and management strategies. More balanced and informed science-based approaches are required to address developmental and environmental issues, and to identify those solutions which are viable in the long term as well as the wider context of national and regional economic development[21].

(i) Physical Impact on Habitat

Aquaculture facilities are often sited near remote and undeveloped coastal waters, such as mangrove swamps and estuaries. However, these habitats invariably serve as nursery, reproduction, and recruitment habitats for many living marine resources.

The largest physical impact by aquaculture on habitat occurred in Asia in the 1980s. Large tracts of coastal mangroves were removed for marine shrimp production ponds in multi-million-dollar projects financed by the multi-lateral development agencies. While providing enormous local economic benefits to poor farmers, the loss of the important coastal habitat impacted the lives of coastal small-scale fishermen. Since that lesson, however, the agencies have been careful only to encourage development in smaller coastal areas carefully buffered from vital habitat.

[17] Inland hatcheries and farms in the United States must have a water right, a permit for discharge, and also pay for water use. This also entails additional costs for monitoring water quality. This is not the case in Chile or Norway.

[18] The purpose of the Amendment was further preservation and protection of indigenous species, but using state boundaries as borders became an arbitrary definition of geographic control. Consequently, the movement of fish from a hatchery to a grow-out farm, or live fish to markets across a state border could violate the Act.

[19] Possession or sale of striped bass in many Eastern states is illegal, but farmed production of striped bass in the United States was 4,415 metric tons in 1999 (Fisheries of the United States 2000).

[20] Rana, K. 1997. Recent trends in global aquaculture production: 1984-1995. *FAO Aquaculture Newsletter No.16: 14-19, August 1997.*

[21] The most constructive example has been the reduction in the use of antibacterial drugs in salmon farming in Norway. Due to well-financed prioritized research on vaccines and better husbandry practices, the industry reduced total drug use from 48.7 metric tons in 1987 down to 679 kg in 1998. At the same time production rose from 50,000 to 400,000 metric tons. (Intrafish, 2000, Industry report 2/00).

The problem is less severe in coastal estuaries because aquaculture structures are not fixed, and are usually small and always porous. Some inter-connected floating net-pens[22] may alter the water flow, exclude animals from natural habitats, and alter surroundings. Also, the habitat loss from several individual complexes may have cumulative impacts on recruitment and population health. Some on-bottom facilities might also change the suitability of physical habitat structure. But compared with fixed and impermeable coastal marinas and breakwaters[23], coastal aquaculture structures are aggregating devices, similar to artificial reefs. As such, they contribute to the biodiversity of the fauna, and even attract large predators to the epifaunal communities. Much of the eventual impact depends on siting and design of the aquaculture structure.

(ii) Chemical Impact on Habitat

Offshore aquaculture facilities may introduce several culture byproducts, thereby affecting overall water chemistry. The most abundant are the organic wastes of feces and uneaten feed, but also carcasses and bio-fouling debris.

With regard to the water column, research studies from many floating farms in a variety of environments show that there is a maximum oxygen reduction of 2 mg/L in water passing through well-sited, floating net-pens containing a large biomass of fish[24]. Only in some coastal sites that are naturally subject to oxygen-deficient upwelled water are there greater reductions at times.

The greater chemical impact is on the substrate beneath a fish farm with the build up of bio-deposits. This can last as long as the farm is in operation and remediation may take a year, hence the current industrial practice of fallowing after each cycle. Changes occur in total volatile solids and sulfur chemistry in the immediate vicinity of operational farms[25], together with decreased redox potential.

A number of other chemical additives have been used during the development of aquaculture, including veterinary medicines and drugs, parasiticides, anti-fouling compounds, growth hormones, and flesh-coloring pigments. Some are still being used in approved quantities.

The accumulation of both copper, from marine government-approved anti-fouling compounds used on structures, and zinc, from fish feeds, can be toxic in their ionic form[26] to benthic communities in sediments below net-pen farms. The accumulation of copper is now very low, as most nets are no longer treated *in situ* but removed, washed, and retreated with anti-fouling solutions in approved upland facilities. Zinc is an essential trace element for fish and must be added to artificial feed, but research by manufacturers is focusing on more bio-available proteinated forms of zinc, and methionine analogs.

Residual medicines and drugs in farmed products and in the environment are of considerable concern to the public. When FDA guidelines are followed, all drugs used in aquatic species farmed in the United States have been proven safe and efficacious, and are undetectable at the time of harvest. At present, only two antibiotics are registered and sold in the United States as feed additives for disease control in farmed fish.

The impact on non-target organisms by the use of therapeutic compounds is one of the most serious risks to the environment[27]. Therapeutic compounds are permitted to control sea-lice, and they are not specific within the Class Crustacea. Considerable research is being carried out to find biocides with a narrow spectrum or to develop an alternative pest management strategy for sea-lice.

[22] The USDA Census records 50 floating net-pen fish farms in the country. The 10 licensed commercial fish farms in Washington State cover 8.7 surface hectares of deep water. The Census records 338 prepared-bottom farms, most of which are for shellfish. Washington State leases 33,000 hectares of tidal waters for shellfish, and some farmers use staked long-lines, and bags. (USDA, 2000, Census of Aquaculture 1998, AC97-SP-3; and NOAA Tech. Memo. NMFS-NWFSC-49).

[23] Washington State also leases its coastal waters to 379 public and private marinas, which are typically 1-5 hectares in area. (NOAA Tech. Memo. NMFS-NWFSC-49).

[24] Typically, the data show that the reduction is <0.5 mg/L. As salmon are very sensitive to levels below 6 mg/L, oxygen depletion is not an immediate risk to the habitat.

[25] Sedimentation rates remain fairly constant irrespective of farm size, which currently is about 1,500 metric tons, and a typical volatile solids loading is 32.9 g/m2 per day for the perimeter of such a farm near peak production. Reduced accumulation of volatile organic material under farms can extend to distances of 145-205 m from the perimeter during peak production.

[26] The degree of risk from copper and zinc is dependent on the concentration of sulfide in the sediment, as it reduces bio-availability. Most observed concentrations are therefore non-toxic (NOAA Tech.Memo. NMFS-NWFSC-49).

[27] The problem is more acute in European countries. Pharmaceuticals to control sea-lice have not been used the Pacific Northwest for 15 years (NOAA Tech.Memo. NMFS-NWFSC-49).

(iii) Biological Impact on Habitat

Bio-deposits can enrich benthic biota beneath net-pen sites but the actual effects depend on the hydrodynamics of the site. Under extreme conditions, the sediments can become anoxic and depauperate. However, under any circumstances, effects are ephemeral and conditions return to normal within 1-12 months.

The accumulation of organic wastes in the sediments can change the abundance and diversity of the infaunal communities, but prolonged studies show the changes are correlated with site hydrodynamics. At well-flushed sites, the effects are positively correlated with total organic carbon, suggesting that these fish farms stimulate the infaunal community around them.

A series of issues regarding biological impact concern the interface between farmed and wild species. These concern, *inter alia*, hybridization, colonization of habitat, competition with native species, predation on native species, and transmission of disease. The potential for risk depends on the farmed species and its surrounding ecosystem, and cannot be generalized. As a signatory to international agreements on the introduction of exotic species, the federal government regulates the introduction of exotic species for aquaculture (and many other activities) in the United States, and state governments regulate interstate movement of livestock, including eggs, by the permit process. However, even indigenous species may pose certain risks when transplanted to a new location[28].

Another series of issues concerns the impact of farm-raised species on human health and safety. These concern, *inter alia*, heavy metal contamination of farmed products, rendered animal products in animal feeds, genetically modified organisms, nutritional supplements, biological hazards, transgenics, worker safety, and public safety.

The permit process keeps aquaculture sites away from traditional sources of heavy metals, such as industrial and municipal waste discharges, anti-fouling treatment areas, and users of organic pesticides, herbicides, and hydrocarbons. The use of tri-butyl tin, once a common biocide used in anti-fouling paints, is totally banned in the United States. Although not specifically prohibited by federal regulation, the use of rendered animal proteins in formulated feeds has been curtailed by public concern over bovine spongiform encephalopathy (BSE), and rules designed to prevent cross-contamination have effectively eliminated the use of these ingredients in fish feeds. Most feed suppliers also continue to offer only genetically modified-free ingredients. The use of growth hormones in fish feeds is prohibited, but pigments, antioxidants, and vitamin or mineral supplements are permitted in fish feeds by the FDA within prescribed limits.

Many of the above constraints have underlying technical issues that lend themselves to technical solutions when the scientific method is employed. Given an adequate level of funding, these constraints can be removed by researchers at the science centers and by targeting grant research at problem areas. This will require leadership and coordination to be most effective.

[28] One of most publicized issues is the introduction and escape of Atlantic salmon in Pacific salmon waters. Net-pen escapes of Atlantic salmon in Washington State between 1996 and 1999 totaled 613,639 fish. Some recoveries have been made as far as Alaska. There have also been 27 deliberate releases since 1951 by the State Fisheries Department. Canadian 'salmon-watch' teams have observed some juvenile Atlantics in British Columbia waters, but as yet, they have not hybridized *in vivo* with Pacific salmonids, or established their own breeding populations. Escapees do not compete with local species for forage or habitat (NOAA Tech. Memo. NMFS-NWFSC-49).

Contents

Appendix VII

Investments in Aquaculture Development By the Federal Government

1. Contribution to the Capital Needs of Development

Developing the nation's aquaculture potential requires a large capital investment. Developers will often be small- to medium-size entrepreneurs who will seldom have adequate access to the nation's normal capital markets – the stock market for equity capital and the bond market for long-term debt capital. These markets are generally restricted to large and resourceful enterprises, and are unlikely to support adequately the development of the national aquaculture potential.

Some smaller or less resourceful entrepreneurs sometimes gain access to the stock markets because of their perceived investment potentials, but aquaculture entrepreneurs are seldom among them. The market for over-the-counter equities tends to be less risk-averse than the more traditional equities market, but the recent dot-com debacle may increase even this market's future risk aversion.

Developing the nation's aquaculture potential requires a large capital investment

Commercial banks are another debt-capital alternative. Except for conventional real estate financing, however, most commercial banks are basically short-term lenders. They are the normal source of working capital financing for small and medium businesses. Commercial banks often provide intermediate-term financing for businesses in established sectors, but seldom in emergent ones. Interest rates tend to become prohibitive for longer terms and for more emergent sectors. The degree of risk aversion by commercial banks is cyclical, and may presently be entering a highly averse cycle.

Funds for research, development, and initial commercial application are even scarcer. Government is often a major source of research and development funds, particularly for entrepreneurs in emerging sectors.

(i) NMFS Long-Term Debt Financing

NMFS's Fisheries Finance Program (FFP) provides long-term debt financing for:

- Constructing, refurbishing, or purchasing fishing vessels, fisheries shore-side facilities, or aquaculture facilities;
- Reducing fishing capacity (by revoking permits and retiring vessels);
- Entry-level and small boat fishermen purchasing individual fishing quotas.

National aquaculture development will sometimes require financing risks

FFP vessel loans do not contribute to harvesting overcapacity, because they may not be used for initially financing the construction of new harvesting capacity.

The FFP's loans have longer terms (up to 25 years) than most private lenders' fish-related loans. This is the FFP's major benefit, because its longer loan maturities stretch debt repayment over longer periods more consistent with the cyclical economics of fishing and aquaculture. FFP interest rates are the U.S. Treasury's cost of public borrowing for comparable maturities plus 2%, but are still generally lower than most private lenders' fish-related loans. The FFP is self-supporting, and the great majority of its lending capital does not constitute an outlay for budgetary purposes.

Until a relatively recent amendment of its statutory authority, the FFP had no aquaculture financing authority. Since then, the FFP has provided long-term aquaculture loans totaling about $30.5 million. This relatively small amount has, for the following reasons, been far less than national aquaculture development warrants.

First, the Clinton Administration insisted on maintaining the fiction that the FFP had a subsidy cost under the Federal Credit Reform Act (FCRA) equal to 1% of its loan capital. This required Congress to unnecessarily appropriate 1% of each annual FFP loan ceiling (i.e., a $100 million loan ceiling would have required a budgetary outlay of $1 million), and artificially depressed the amount of annual FFP loan ceilings available[1]. Consequently, the FFP's loan ceilings during the last decade have been annually insufficient to accommodate national demand, and this has helped prevent the FFP from becoming a nationally significant aquaculture lender.

Far from a 1% FCRA cost, however, the FFP has instead historically made an FCRA profit equal to almost 16% of its traditional loans. The Bush Administration recognized this during the FY2001 budget year by establishing the FFP's FCRA cost rate for traditional loans at 15.66% (i.e., an FFP profit requiring no budgetary outlay in the form of an appropriated FCRA cost for newly appropriated loan ceilings). Unfortunately, the September 11 terrorist attacks have presumably prevented Congress from focusing on this change, and the FFP's FY2002 loan ceiling may once again prove too small.

NMFS does not, however, keep the FFP's annual FCRA profits. Instead, these revert to the U.S. Treasury, where they merely become another means of financing the public debt.

Second, national aquaculture development will sometimes require financing risks more venturesome than the FFP's traditional loans. These developmental risks will often appropriately have an FCRA cost, one sometimes higher even than 1%.

To become a nationally significant aquaculture lender, the FFP needs:

(a) Annual loan ceilings for traditional FFP lending risks sufficiently large enough to accommodate demand. Because these normal risk traditional loans involve no

[1] FCRA cost is the only budgetary outlay involved in Congress's annual authorization of FFP loan ceilings. Although Congress must authorize annual loan ceilings in appropriation acts, Congress does not appropriate actual loan capital in excess of FCRA costs. Instead, the FFP borrows non-appropriated loan capital from the U.S. Treasury, and repays the Treasury's loan from the repayment proceeds of the FFP's loans to fishers and aquaculturists.

FCRA cost, Congress can increase the annual loan ceiling for these risks without appropriating any portion of the loan ceiling or causing any budgetary outlay.

(b) Separate annual loan ceilings for the more venturesome risks that national aquaculture development will sometimes entail. Because these risks, unlike the FFP's traditional ones, will require some FCRA cost (and, thus, small budgetary outlays to authorize annual loan ceilings), it is necessary to convince Congress to appropriate the necessary FCRA costs. For this purpose, Congress could partially use the FCRA cost it has been unnecessarily appropriating for the last decade in authorizing loan ceilings for the FFP's traditional risks.

This will require:

- Careful preparation of the FFP's loan ceiling request in the President's FY2003 budget;
- Agency support within the administration;
- Administration support with Congressional appropriators.

The FFP's 2003 budget request should be:

- No-cost traditional risks (including aquaculture): a $100 million loan ceiling at a negative 15.66% FCRA cost rate (requires zero appropriation and zero budgetary outlay);

- Developmental aquaculture risks:
  - 1% cost: a $25 million loan ceiling at a 1% FCRA cost rate (requires a $250,000 appropriation and budgetary outlay);
  - 2% cost: a $10 million loan ceiling at a 2% FCRA cost rate (requires a $200,000 appropriation and budgetary outlay);
  - 5% cost: a $5 million loan ceiling at a 5% FCRA cost rate (requires a $250,000 appropriation and budgetary outlay).

(ii) NMFS Equity Information

NMFS's Capital Construction Fund (CCF) program provides a tax incentive to encourage the accumulation of equity funds for fishing vessel investment. This reduces the percentage of future capital costs that vessel owners must borrow in the form of debt. The tax incentive is deferral of the income taxes that vessel owners would otherwise have annually paid on the portion of their taxable fishing income that they reserve, under contract with NMFS, as the equity portion of their vessels' future capital costs.

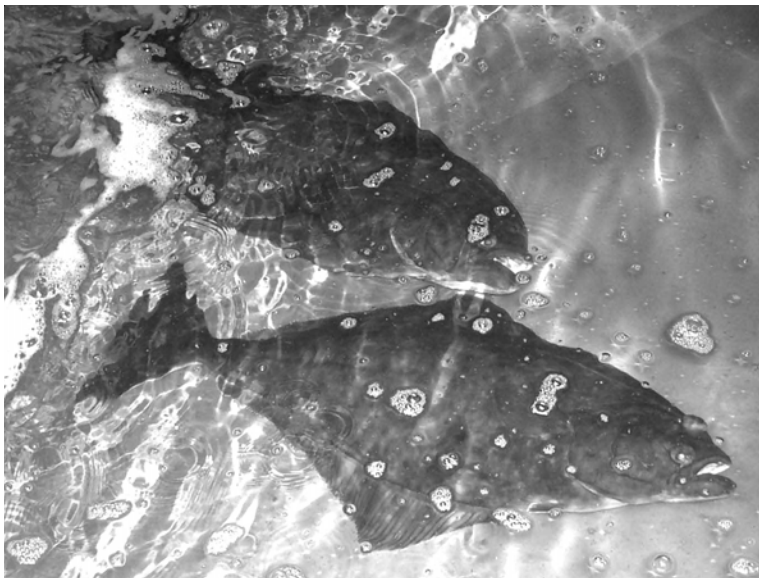
If, for example, a vessel owner deposits $100,000 of taxable income in a CCF reserve, this defers payment of the income taxes (say, $20,000 at a 20% income tax rate) that the owner would otherwise have paid on the $100,000. Consequently, $80,000 of the reserve is the vessel owner's money, while the remaining $20,000 is the U.S. Treasury's money.

These are tax deferrals, not tax exemptions. During the deferral period, the deferred taxes constitute an interest-free loan from the U.S. Treasury. The Treasury eventually recaptures the deferred taxes by reducing the depreciation basis, for tax purposes, of vessels constructed, reconstructed, or acquired with CCF reserves. This interest-free loan of the deferred taxes begins when vessel owners first deposit CCF funds and ends with the depreciable life of the vessels on which owners expend the CCF deposits. This can be as long as a quarter of a century. Vessel owners can invest CCF deposits and defer income taxes on the investment earnings as well.

Because of major evolving changes in the economic potential of the national

fisheries, some long-term CCF participants no longer wish to expend their CCF deposits for their intended purpose. This is a predicament for these CCF participants, because failing to use these tax-deferred equity reserves for their intended purpose requires paying to the Treasury an amount equal to the deferred taxes, their time value during the entire deferral period, and a heavy tax penalty. This predicament can potentially cost CCF participants up to 70% of their CCF deposits.

CCF participants in this predicament have a major incentive to expend their CCF deposits for alternative purposes that preserve the deferred taxes as interest-free loans and avoid the imposition of tax penalties. At present, however, there is no alternative. Only fishing vessels are eligible for CCF expenditures. The equity needs of national aquaculture development, however, make aquaculture the ideal alternative. It is therefore necessary to ask Congress to amend the CCF's statutory authority by extending it to aquaculture facilities. This would enable:



- CCF participants in this predicament to reschedule for aquaculture purposes the expenditure of their already accumulated CCF equities reserved for fishing vessels (and future deposits of fishing vessel income as well). This would at once benefit themselves, the fisheries, and aquaculture;

- Aquaculture developers to begin deferring taxes on taxable income from aquaculture operations to accumulate additional equity reserves from within the aquaculture industry itself.

CCF participants with large tax-deferred deposits of fishing vessel income could preserve their CCF tax benefits by individually purchasing equity shares in aquaculture enterprises. CCF participants with smaller tax-deferred deposits of fishing vessel income could do so by pooling their deposits and collectively purchasing aquaculture equity shares. The onerous penalties for fishing vessel owners not using their CCF reserves for their intended purpose provides a strong financial incentive for them to invest these reserves in aquaculture equities.

Equity formation is a prime need for national aquaculture development, but not presently a pressing one for fishing vessels[2]. This CCF proposal, consequently, provides both a significant source of already accumulated equity that fishing vessel owners can presently inject into aquaculture as well as a major incentive for both the fishing vessel owners and aquaculturists themselves to subsequently accumulate additional equity reserves for the future needs of national aquaculture development.

The long-term result, from a national tax perspective, will be increased tax revenues from the larger taxable income basis that new economic activity, like aquaculture, provides. This is, in the long run, a wise investment for both the fishing industry and the aquaculture industry as well as the Internal Revenue Service.

Simply adding aquaculture to CCF may prove sufficient to accomplish this objective. But, if need be, we could also consider legislation that allows the tax-free transfer of existing CCF equities from fishermen to aquaculture entrepreneurs. Although this would involve considerable complexity, the onerous penalties for fishing vessel owners not using their CCF reserves for their intended purposes would, again, provide sufficient incentive for both the vessel owners and aquaculture entrepreneurs to negotiate transfer discounts attractive to both.

[2] Although it will become one in the future as the various fishing fleets grow older and begin to require replacement.

(iii) NMFS Research, Development, and Initial Commercial Application Funding

The FFP and CCF proposals can significantly increase NMFS' capital contribution to national aquaculture development in two important ways:

- By increasing the FFP's ability to deliver significantly greater long-term debt financing;

- By allowing the CCF to formulate considerable equity.

Nevertheless, leading edge aquaculture development requires research, development, and initial commercial application funding beyond the reach of either the FFP or CCF proposal.

Considerable aquaculture research and development must often precede initial commercial application, but the research and development remains economically unfulfilled without its initial commercial application. The initial commercial application of successful aquaculture research and development will involve a high economic payoff potential as well as a high risk of capital loss. This is the realm of venture capital.

Equity formation is a prime need for national aquaculture development

These venture capital risks require disproportionately more equity than debt. This is true because the ventures will often initially produce insufficient cash flow to service disproportionate debt levels; and, from a debt collateral standpoint, debt should not measurably exceed the forced-sale value of the venture's physical assets (which, in these ventures, will often be a fraction of their acquisition cost).

NMFS' Saltonstall-Kennedy (S-K) Program provides competitive research and development grants to both the aquaculture and fishing industries. Each year it establishes grant funding priorities, and aquaculture has generally been among them. The S-K Program has provided modest research and development grants for essentially the entire range of aquaculture issues and opportunities, but has generally limited the grants to marine projects. During the last 2 decades, S-K grants for these purposes have totaled about $13 million.

The S-K Program does not fund the venture capital risk associated with initial commercial application of research and development, and NMFS presently has no effective means of assisting at this critical venture capital stage.

Two actions will increase NMFS' ability to contribute to national aquaculture research, development, and initial commercial application at the venture capital stage:

(a) **Research and Development.** The S-K Program's ability to contribute in this area has recently been hampered by the limited availability of grant funds, which have averaged only about $4 million per year during the last decade. S-K grant funds will, however, apparently increase to $11 million during FY2002. Consequently, NMFS should:

- Support an annual availability of S-K grant funds comparable to the FY2002 level during FY2003 and beyond;

- More strongly emphasize aquaculture's research and development needs as an annual grant priority (perhaps by reserving a specific portion of annual grant funds for an aquaculture priority and establishing appropriate aquaculture sub-priorities).

(b) **Initial Commercial Application.** NMFS should strongly consider seeking legislative authority for a modest venture capital revolving fund with which NMFS could make passive equity investments in the initial commercial application of

promising aquaculture research and development.

Although some of these ventures could be expected to fail and the revolving fund would lose its equity investment, the high payoff potential of successful commercial applications would allow NMFS to recoup the fund's losses by selling its passive equity interests once the ventures involved become commercially successful.

Several sources may be appropriate for progressively capitalizing this venture capital revolving fund. For example, a modest portion of annual S-K revenues, and/or the FFP's FCRA profits from its traditional lending activities (which now annually revert to the U.S. Treasury's miscellaneous receipts, where they become merely another means of financing the public debt).

(iv) Other Financial Services

A strong NMFS commitment to national aquaculture development should involve consideration of several other financial services. These include:

- Legislatively extending appropriate disaster assistance, under section 312(a) of the Magnuson-Stevens Fishery Management and Conservation Act, to aquaculture. Section 312(a) is presently available only for commercial fishery failures. Appropriate disaster assistance is particularly critical to marine aquaculture, which is highly susceptible to acts of God (weather, climate, disease, and other ocean conditions).

- Legislatively providing, particularly for marine culture, an industry-funded pool for sharing casualty risks to physical and animal assets. Commercially available insurance for some of these risks (like weather, climate, disease, and contamination) is often prohibitive, and a risk-sharing pool that participants' fees fund could productively offset this institutional inadequacy.

2. Bilateral Assistance

Primarily the international development banks have been responsible for capital assistance loans to aquaculture in developing countries, and the bilateral agencies have provided research support, education, and training.

USAID, which is the primary foreign aid agency in the United States, has been a relatively small player in fisheries development assistance[3]. Its programs have predominantly emphasized aquaculture development over capture fisheries. USAID still provides limited support. This is through two mechanisms, the Consultative Group for International Agricultural Research (CGIAR), which includes one fisheries entity, and Collaborative Research Support Program (CRSP) with land grant universities[4]. Like that of the U.S. Peace Corps, much of the early work of CRSP focused on tilapia species in Africa.

A few USAID overseas missions sponsor aquaculture projects. For example, the mission in Egypt funded ($25 million) the construction and staffing of a large aquaculture research center in the 1980s. However, there is now only one small project being funded in Bangladesh, together with some related but limited coastal zone management work in the Philippines, Indonesia, and Central America. The total worldwide aquaculture support by USAID each year is in the order of $3 million.

[3] JICA (Japan) is the major source of international aid, with many of its projects emphasizing products marketable in Japan. The United Kingdom, France, Italy, and Belgium mostly emphasize assistance to past colonies. NORAD (Norway) has been a consistent supporter of both fisheries and aquaculture projects, frequently using FAO as the executing agency.

[4] Oregon State University is the headquarters of the Pond Dynamics Aquaculture project.