

NOAA 10-YEAR PLAN FOR
MARINE AQUACULTURE
OCTOBER 2007



U.S. Department of Commerce



National Oceanic and
Atmospheric Administration

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Carlos M. Gutierrez, Secretary

National Oceanic and Atmospheric Administration

Conrad C. Lautenbacher, Jr., Vice Admiral, U.S. Navy (Ret.), Under Secretary

National Marine Fisheries Service

William T. Hogarth, Ph.D., Assistant Administrator for Fisheries

U.S. Department of Commerce



National Oceanic and
Atmospheric Administration



**UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration**

NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

THE DIRECTOR

October 30, 2007

Dear Readers:

I am pleased to present the National Oceanic and Atmospheric Administration's (NOAA) *10-Year Plan for Marine Aquaculture*, the result of extensive work by NOAA's Aquaculture Program Office under the leadership of Dr. Michael Rubino, drawing on the expertise and counsel of NOAA's Marine Fisheries Advisory Committee over the past two years. This plan will guide NOAA as we work to establish marine aquaculture as an integral part of the U.S. seafood industry, and as a viable technology for replenishing important commercial and recreational fisheries.

The role of aquaculture and its relevance to a safe, sustainable U.S. seafood supply have been the subject of important recent reports, particularly the U.S. Commission on Ocean Policy's final report to Congress, the President's Ocean Action Plan, and the Woods Hole Marine Aquaculture Task Force Report. The consensus is aquaculture – the fastest growing form of food production in the world – poses a tremendous opportunity as well as challenges for the Nation as we make our way forward.

Several notable recent events have also helped stimulate a healthy debate about the future of aquaculture in the United States as we seek to expand this type of seafood production. This past June, U.S. Secretary of Commerce Carlos M. Gutierrez hosted the 2007 National Marine Aquaculture Summit. At the Summit, national business leaders, policy experts, government officials, and researchers focused on the future of marine aquaculture in the United States. Summit participants made solid recommendations on how the United States can join the global aquaculture community by accelerating the integration of commercial aquaculture into domestic seafood production in an environmentally, economically, and socially responsible manner.

Summit participants also agreed on the need for national legislation to provide regulatory certainty for those considering investing in aquaculture in federal waters. Congress is considering an Administration proposal that would provide a regulatory framework for federal waters and a comprehensive research program for all marine aquaculture – both key elements of this plan.

As the Nation's ocean agency, NOAA takes its stewardship responsibilities for marine resources seriously, and I believe this plan contains the necessary actions to develop marine aquaculture in the United States. In addition to the goals and actions, this plan acknowledges and emphasizes the appropriate safeguards for the protection of the marine environment and for our coastal communities who depend on traditional fisheries. NOAA is committed to the successful implementation of this plan, and recognizes that its



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THE ASSISTANT ADMINISTRATOR
FOR FISHERIES



success depends on stakeholder support and involvement. I also consider this a living document, which will be updated as progress is made.

Finally, I wish to thank all of those inside and outside NOAA who have contributed to this plan, and I look forward to your continued participation.

Sincerely,

A handwritten signature in cursive script that reads "Bill".

William T. Hogarth, Ph.D.
Assistant Administrator
for Fisheries



Harvesting oysters from an oyster float in the Pacific Northwest requires a hands-on approach.



The integration of aquaculture and commercial fishing is beginning to take place in some parts of the U.S.



The U.S. has been a global leader in aquaculture research and development for over 30 years.



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For more information:
 NOAA Aquaculture Program Office
 1315 East-West Hwy.
 SSMC-3 - Route: F/AQ
 Silver Spring MD 20910
 Phone: (301) 713-9079
 Website: www.aquaculture.noaa.gov

<http://www.aquaculture.noaa.gov>

Cover: Bill Dewey of Taylor Shellfish Farms, left, shows an oyster to a visitor at the company's Samish farm in Skagit County, Washington. Also pictured, in back, are Bill Taylor and his father, Justin Taylor. Photo: © Argus Newspaper

Small images L to R:

- The Aquapod, seen here on the surface, is one type of submersible pen used for open ocean fish farming in the U.S. Photo: © Snapperfarm, Inc.
- The marine finfish *Seriola rivoliana*, also known as Hawaiian yellowtail, is being farmed commercially in Hawaii. Photo: Sea Grant Aquaculture Program
- Farmed in the U.S. and elsewhere, manila clams are among the most popular species of cultured shellfish in the world. Photo: NOAA Aquaculture Program
- Aquaculture facilities use a variety of grow-out systems to accommodate finfish as they grow, including tanks and raceways. Photo: © Hubbs-SeaWorld Research Institute

Introduction

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In the Chesapeake Bay region, new approaches to oyster culture are being tested, such as this rack-and-bag system.

In response to a request from the Marine Fisheries Advisory Committee (MAFAC), the National Oceanic and Atmospheric Administration's (NOAA) Aquaculture Program first drafted this *10-Year Plan*, to frame the agency's vision and plans for development of marine aquaculture in the United States. This document was not mandated or intended to fill any legal requirement. It was drafted in response to a request from MAFAC to provide the agency with a broad framework for marine aquaculture* and goals for the program.

In July 2006, the initial draft of the plan was reviewed and endorsed by MAFAC. Based on MAFAC's comments, the plan was revised by NOAA and made available for further public comment in November 2006. In October 2007,

the plan was adopted by NOAA as an agency-wide policy document intended to guide a broad, national initiative for marine aquaculture based on four distinct goals:

- 1] A comprehensive regulatory program for marine aquaculture.
- 2] Development of commercial marine aquaculture and replenishment of wild stocks
- 3] Public understanding of marine aquaculture.
- 4] Increased collaboration and cooperation with international partners.

The plan also provides an assessment of the challenges NOAA will face in its effort to reach these goals, such as the need for congressional and Executive Branch actions to provide additional legislative and budget support.

As noted by Dr. William Hogarth, NOAA's Assistant Administrator for Fisheries, the plan will continue to be a work in progress as the agency moves forward with a strong focus on enabling marine aquaculture to grow as a complement to fishing to increase domestic seafood production. At the same time, NOAA and the related federal agencies will continue to pursue research to better understand the environmental, social, and economic implications of aquaculture and to guide agency decisions.



Commercial aquaculture operations use paddlewheel technology in land-based systems to farm microalgae.

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* For purposes of this plan, **aquaculture** is defined as the propagation and rearing of aquatic organisms in controlled or selected environments for any commercial, recreational, scientific, or public purpose.

Background

NOAA AQUACULTURE PROGRAM



Net pens are typical of the equipment used to culture marine finfish in many parts of the world.

Momentum is building for the United States to use aquaculture to become more self-sufficient in the production of seafood and the replenishment of wild stocks. Recognizing this, in June 2005 the Marine Fisheries Advisory Committee (MAFAC) requested that the National Oceanic and Atmospheric Administration (NOAA) prepare a plan to support the future development of marine aquaculture in the United States.

Based on its initial discussion of an “Aquaculture Development Initiative” in June 2005, MAFAC viewed a strong, forward-looking plan from NOAA as the basis for a broad national marine aquaculture program. To provide specific recommendations to the agency regarding the development of marine aquaculture, MAFAC asked NOAA to detail the approach it would take over the next decade to fully support the development of marine aquaculture in the United States.

MAFAC’s request for this plan was timely. The national profile of aquaculture was raised significantly by recent events highlighting the need for greater attention to the development of marine aquaculture in the United States. These events include the delivery of the U.S. Commission on Ocean Policy’s final report and recommendations to Congress in September 2004, the release of the President’s U.S. Ocean Action Plan in December 2004, and the submission of the Administration’s *National Offshore Aquaculture Act* of 2005 (S. 1195) in June 2005 to establish a coordinated regulatory regime for aquaculture in federal waters.

In its 2006 report, “State of World Aquaculture”, the U.N. Food and Agriculture Organization (FAO) reported that nearly half of the fish consumed as food worldwide are raised on fish farms (compared to 9 percent in 1980) and estimated that world wide aquaculture production would have to increase from 45.5 million mt in 2004 to 80 million mt in 2050 to just maintain current per capita consumption levels. The FAO highlighted the

growing consumer demand for seafood as one of the most important driving forces behind the surge in production. Media coverage of the FAO report along with more recent concern over the safety of seafood imports has added context and urgency to the U.S. effort to spark more domestic seafood production through aquaculture to meet the growing demand. Also in 2006, NOAA hosted the international scientific research community in Seattle, Washington, to showcase the latest advances in aquaculture-based rebuilding of wild stocks that support commercial and recreational fisheries worldwide. This pivotal event provided an opportunity for the world’s leading researchers and practitioners in this field to refine the technologies and identify how aquaculture can contribute to a better understanding of the biological processes within fisheries.

In December 2006, an ad-hoc committee of the American Fisheries Society formed by the president of AFS published its recommendations on open ocean aquaculture in the journal *Fisheries*. Also in early



NOAA AQUACULTURE PROGRAM

The SeaStation, seen here on the surface, is one type of submersible pen used for open ocean fish farming in the U.S.

BACKGROUND, CONTINUED

2007, a task force of experts, policymakers, and practitioners —convened through the Woods Hole Oceanographic Institute — published its recommendations on marine aquaculture in the United States. Those recommendations highlighted the ongoing federal effort to support sustainable approaches to increased seafood production and wild stock rebuilding through aquaculture.

One of NOAA's greatest current challenges, in terms of improving public understanding of its overall goals for aquaculture, is to provide context for offshore aquaculture in the United States. NOAA's aquaculture responsibilities are much broader than offshore regulation which has received extensive public attention. NOAA reviews permits for coastal aquaculture and engages in research and development for all forms of marine aquaculture (e.g., shellfish farming, algae culture, feeds, hatchery techniques, closed recirculating systems, and biomedical products), and aquaculture-based rebuilding of species important to commercial and recreational fisheries. Under NOAA, the National Sea Grant Program is the lead for outreach and extension to producers and the public. NOAA's National Sea Grant Program Office also administers the research funding for the National Marine Aquaculture Initiative.

In light of the renewed national debate on the future of marine aquaculture, it is important to note that aquaculture — now a \$1 billion industry (farm gate sales) in the United States — is not new. NOAA and its predecessor agencies have been involved with commercial marine aquaculture and enhancement of wild finfish and shellfish stocks since the late 1800s.

For decades, NOAA-led research (e.g., on finfish and shellfish biology and reproduction, habitat use and restoration, environmental impact assessment, and fish pathology) has supported all facets of private and government aquaculture, including aquaculture-based rebuilding activities for wild finfish and shellfish. For more than 40 years, NOAA has also been a leader in international scientific research and collaboration, organizing and participating in various formal and informal international workshops and exchanges through the FAO and with international counterparts in Canada, Chile, China, the Faroe Islands, France, Iceland, Ireland, Japan, Korea, Norway, Scotland, and Taiwan.



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The U.S. is one of the world's leading producers of broodstock for the Pacific white shrimp.

To date, much of the scientific information and technology developed by NOAA has been used in the commercial aquaculture, commercial fishing, and recreational fishing sectors, where it has been instrumental in the development of finfish and shellfish hatcheries and culture operations. Recent examples include NOAA research and development support for commercial shellfish and salmon replenishment, and open ocean culture technology in Hawaii for moi and amberjack, in Puerto Rico for cobia, and in New Hampshire for mussels and cod.

NOAA's involvement in marine aquaculture has taken place under a number of legislative and policy drivers. Beginning in the 1970s, several laws were enacted that gave NOAA comprehensive environmental stewardship responsibilities for marine resources, including the Magnuson-Stevens Fishery Conservation and Management Act, Marine Mammal Protection Act, Endangered Species Act, Coastal Zone Management Act, and National Environmental Policy Act. Under these laws, NOAA is responsible for considering the potential environmental impacts of planned marine aquaculture facilities on its trust resources through formal permit reviews and consultations.

BACKGROUND, CONTINUED

In addition the National Aquaculture Act of 1980, National Sea Grant College Program Act, the Saltonstall-Kennedy Act (as amended), and the Merchant Marine Act gave NOAA authority to develop and provide assistance for both public- and private-sector aquaculture.

In the 1990s, rising demand for seafood, declining market share of domestically wild-caught fish, and increasing imports led to renewed interest in the potential of marine and freshwater aquaculture. In response to increased demand for and a growing trade deficit in seafood, NOAA and the Department of Commerce (DOC) developed aquaculture policies, which were adopted in 1998 and 1999, respectively. In 2003, as part of its commitment to implement the FAO Code for Responsible Fishing, NOAA's National Marine Fisheries Service (NMFS) prepared a draft voluntary Code of Conduct for Responsible Aquaculture Development in the United States Exclusive Economic Zone, which called for a precautionary approach—combined with adaptive management — as a guiding principle. Descriptions of these authorities and policies are provided in Appendix 1.

More recently, several high-profile internal and external events, initiatives, and accomplishments have helped shape NOAA's expanding role in aquaculture:

- NOAA designated aquaculture as a cross-agency matrix program under the agency's Planning, Programming, Budgeting, and Execution System (PPBES) in 2003. In 2004, a permanent, full-time NOAA Aquaculture Program Manager was hired.
- In September 2004, the U.S. Commission on Ocean Policy submitted to Congress a final report and recommendations, including several on aquaculture. In response, the Administration prepared its 2004 *U.S. Ocean Action Plan*, which highlighted national priorities based on the Commission's recommendations. Both documents called for new authority for the Secretary of Commerce to develop the regulatory framework for aquaculture in federal waters.
- In June 2005, the Administration transmitted to Congress the *National Offshore Aquaculture Act*. The purpose of the act was to establish a regulatory framework for aquaculture in federal waters, as outlined in the *U.S. Ocean Action Plan* and to support research and development of marine aquaculture. The act, which was subsequently introduced as S. 1195, was the focus of two Senate hearings in 2006. However, the 109th Congress ended without taking action on the bill. In March 2007, the Administration transmitted to the 110th Congress a revised *National Offshore Aquaculture Act* based in response to stakeholder feedback which focused on strengthening the environmental safeguards in the June 2005 proposal. It was introduced in the Senate as S. 1609 and in the House of Representatives as H.R. 2010 which held a hearing in July 2007.
- A \$3 million increase was included in the President's FY 2008 Budget for NOAA to establish the regulatory framework for environmentally sustainable commercial aquaculture opportunities.



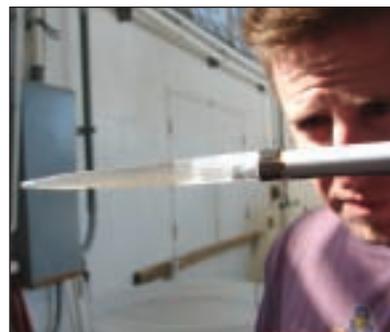
NOAA AQUACULTURE PROGRAM

Development of new aquaculture technologies could provide new opportunities for fisheries-dependent coastal communities in the U.S.

BACKGROUND, CONTINUED

Other recent program milestones include:

- Since 2003, a federal interagency team commissioned under the auspices of the Joint Subcommittee on Aquaculture has led an ongoing effort to develop and implement an aquatic animal health management program for the United States.
- In 2005, NOAA co-sponsored the first international meeting focused on the role of aquaculture in ecosystem-based management. The meeting resulted in specific scenarios for managing coastal resources, which include aquaculture, fisheries, and coastal communities. The results of the meeting will be published in 2007.
- In 2006, NOAA awarded \$3.6 million in competitive grants to 11 marine aquaculture demonstration and research projects under the *National Marine Aquaculture Initiative* (NMAI). This funding supported projects to assess the commercial potential of marine aquaculture, feasibility of aquaculture-based rebuilding, environmental impacts of aquaculture in various environments, and research on key aquatic animal nutrition and health issues. Since 1998, NOAA has funded \$15 million through the initiative to support research to boost the production of commercially and recreationally valuable marine shellfish and finfish species in the United States.
- Also in 2006, several key research documents, authored by agency technical experts, were published, including *Guidelines for Ecological Risk Assessment of Marine Fish Aquaculture*, and papers on shellfish immunology, probiotic bacteria for shellfish hatcheries, and harmful algal interactions with mollusks.
- NMFS funded and participated in regional aquaculture initiatives in 2006, including the initial development of the *Chesapeake Shellfish Aquaculture Plan*.
- NOAA has administered \$15 to \$20 million annually for research and development projects directed by Congress to nonprofit institutes and universities for commercial aquaculture and aquaculture-based rebuilding of wild stocks (excluding salmon).
- NMFS and NOAA's National Ocean Service (NOS) science centers continued pioneering research in the area of aquaculture-based rebuilding for wild stocks such as West Coast rockfish, king crab, Pacific cod, summer flounder, and salmon, including reform of hatchery practices for Columbia River and Puget Sound salmon species.



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The commercial production and replenishment of oysters are the focus of research initiatives across the U.S.

- U.S. Secretary of Commerce Carlos M. Gutierrez hosted a National Marine Aquaculture Summit in July, 2007. At the Summit, **national business leaders, policy experts, government officials, and researchers** discussed the opportunities and challenges for marine aquaculture in the United States. Summit participants also made recommendations on how the United States can join the global aquaculture community and **accelerate the integration of domestic aquaculture into domestic seafood production** in an environmentally, economically, and socially responsible manner. Summit participants agreed on the need for national offshore legislation to provide regulatory certainty for those considering investing in federal waters.

Setting the Stage for Marine Aquaculture Development



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In Hawaii, producers use the power of the sun to grow algae which is fed to cultured finfish during early life stages.

A compelling case can be made for developing additional domestic marine aquaculture capacity. Aquaculture can help meet the growing demand for seafood and help rebuild our wild fish stocks, while maintaining an infrastructure in coastal communities to support both wild stock fisheries and commercial aquaculture. The potential synergies — rather than competition—among those engaged in commercial and recreational fisheries, marine aquaculture, seafood processing, and marketing are the keys to maintaining resource-dependent coastal communities and to ensuring a lead role for the United States in the global seafood market.

The following facts are integral to any discussion on the potential of marine aquaculture in the United States:

- The U.S. aquaculture industry (marine and freshwater) currently has an approximate farm-gate value of \$1 billion.**
- Americans consumed 16.5 pounds (7.5 kg) of seafood per person in 2005, up from 12.5 pounds (5.7 kg) in 1980, while the United States population increased from 225.6 million to 298.2 million between 1980 and 2006.***
- Nutritionists are encouraging Americans to double our consumption of seafood, from one seafood meal per week to two. According to a recent study, eating more seafood has the potential to reduce heart attack deaths in the United States by as much as 34 percent.
- Imports comprised over 80 percent of the U.S. edible seafood supply in 2006 (round weight).***
- The U.S. seafood trade deficit for edible products was \$9.1 billion in 2006.***

** Source: U.S. Department of Agriculture National Agricultural Statistics Service, Census of Aquaculture 2005

*** Source: U.S. Department of Commerce, Fisheries of the United States 2006



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About 20% of all U.S. aquaculture products are marine species such as oysters and clams.

- Many important commercial and recreational species are overfished and need to be rebuilt. Aquaculture could play a role in providing recruits and information to improve traditional fisheries management.
- U.S. firms currently supply aquaculture technology, services, investment capital, brood stock, and feedstuffs to a global aquaculture industry.

Setting the Stage

Increasing Seafood Production from Commercial Marine Aquaculture

NOAA is weighing the best prospects for increasing future commercial seafood production through marine aquaculture, while also recognizing other potential non-food uses for marine aquaculture products. For example, a preliminary analysis by NOAA shows that annual domestic commercial aquaculture production (freshwater and marine) could be increased by 1 million mt by 2025 (Table 1). The additional production could include 760,000 mt from finfish aquaculture 47,000 mt from crustacean production (crayfish and shrimp), and 245,000 mt from mollusk production (oysters, mussels, clams, scallops, and abalone) Of the 760,000 mt of finfish aquaculture, 590,000 mt could come from new production of marine finfish species, while increasing production of freshwater species such as catfish, striped bass and tilapia by 70,000 mt and anadromous species such as salmon and rainbow trout by 100,000 mt.

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The marine finfish *Rachycentron canadum*, also known as cobia, is being farmed commercially in Puerto Rico.

The figures used in this analysis reflect projections based on best available data, current technology, market demand, access to sites, and the advice of agency experts. *These figures are not specific agency targets for production of seafood from aquaculture.*

Group	Current U.S. Production	Increase	Target for 2025
Mollusks	100,000	245,000	345,000
Crustaceans	18,000	47,000	65,000
Finfish	340,000	760,000	1,100,000
TOTALS	458,000	1,052,000	1,510,000

Table 1. Potential scenario for increased annual aquaculture production by 2025 (in metric tons).

Source: Nash, C.E. (2004). Achieving policy objectives to increase the value of the seafood industry in the United States: the technical feasibility and associated constraints. Food Policy 29(6):621–641.

Many challenges face us as we aim to increase commercial seafood production in the United States, including:

- A complicated, inefficient, and uncertain federal regulatory process to permit marine aquaculture facilities.
- Need for additional research on environmental and socioeconomic implications and ecosystem carrying capacity for marine aquaculture.
- Lack of an adequate supporting research, development, and technical infrastructure.
- Need to better communicate and foster understanding on the environmental, economic, and social implications of marine aquaculture.
- Lack of access to coastal sites for marine aquaculture facilities because of competition for high-value land for development and tourism.
- Rapid international growth of worldwide aquaculture with supply, demand, and price implications for U.S. consumers and seafood producers.



Depleted marine finfish species, such as lingcod, are the focus of stock enhancement research by NOAA in the Pacific Northwest.

Setting the Stage

Rebuilding Wild Stocks

Many commercial and recreational marine fisheries in the United States are seriously depleted, and rebuilding them to sustainable levels could take a long time. For example, the West Coast rockfishes have been classified as overharvested and the prognosis for their recovery is dire. In some cases, rebuilding plans for these species are estimated to require nearly 100 years, even in the absence of wild commercial capture or recreational harvests.

Fisheries managers have a limited set of tools for rebuilding these valuable marine fisheries. Traditional methods include reducing harvest (e.g., through size limits, seasons, closures, and trip limits) and limiting harvest techniques. A second long-term management technique is to protect and restore critical habitat and to create closed areas that exclude harvest (marine protected areas).

Replenishment — or aquaculture-based rebuilding — is a third technique that may be used to restore commercial and recreational stocks (also called stock enhancement). This technique uses cultured juvenile fish and shellfish released to the wild to grow and recruit into stocks to accelerate recovery of a species or to enhance and ensure wild stocks of various commercially, recreationally, and ecologically valuable species. Aquaculture-based rebuilding techniques are being applied in the United States for salmon, redfish, and oysters, and research is being conducted on many other species (e.g., white seabass and abalone in California, snook in Florida, summer flounder in New England, and king crab in Alaska). As part of its broad, ongoing mission for aquaculture, NOAA will further investigate the feasibility of helping rebuild depleted U.S. species through the use of aquaculture technologies.

Similar culture-based rebuilding programs are used in other countries. For example, Japan has used these techniques to recover and augment a variety of coastal marine fish species. Flounder, yellowtail, sea bream, rockfish, herring, abalone, and scallops have shown promise as the science of marine fisheries enhancement develops. Japanese scientists, collaborating with fishermen, are now experimenting with releases of more than 70 species of marine fish, crustaceans, and mollusks.



Filter feeders, such as these farmed oysters, improve water quality in the surrounding marine environment by consuming algae and other nutrients.

REBUILDING WILD STOCKS CONTINUED

The science needed to evaluate candidate species for their potential for aquaculture-based rebuilding depends on many variables. In general, the following process is used to collect information for determining whether a species has the traits that would allow it to be cultured for release:

- Develop the methods to acquire, maintain, and spawn broodstock.
- Intensively produce, rear, tag, release, and monitor juveniles after release.
- Model rebuilding of cultured fish populations using existing fishery data, including consideration of genetic and ecological interactions with natural fish populations.
- Test whether hatchery-raised fish can survive to successfully recruit into the focal and or target species populations.
- Reduce costs for juvenile production.

Once this information is known, the following questions can be addressed to determine whether this technology can be more broadly applied to rebuild U.S. fisheries:

- Can these fish populations be cultured and what are their environmental requirements?
- Can they be economically produced?
- Will they survive in numbers to economically contribute to fishery rebuilding?
- What genetic and ecological impact will they have on natural stocks?
- How will success be monitored over time?

NOAA scientists have participated in framing these aquaculture-based rebuilding protocols, along with colleagues from research institutions in the United States and in other countries. Some of the agency's leading researchers are testing and refining the latest scientific advances in this area of research. The information and expertise these experts develop will help resource managers integrate aquaculture-based rebuilding as part of an ecosystem approach to fisheries management, along with other fisheries management and habitat protection and restoration techniques as appropriate.



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NOAA's plan calls for the expansion of the research, development, and extension infrastructure that supports aquaculture development with hatcheries, diagnostic services, advances in feeds and nutrition, and other scientific research.

Program Goals and Strategies

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The U.S. aquaculture industry has a farm-gate value of \$1 billion annually.

In 2005 and 2006, NOAA's Aquaculture Program team reevaluated program goals and strategies, using legislative mandates and NOAA policies and history as a starting point. In addition, the team met with a wide variety of stakeholders and federal and state agencies to gather their input concerning the type of marine aquaculture program NOAA should pursue.

The following principal agency responsibilities and services emerged from the mandates and stakeholder consultations:

■ A certain and transparent regulatory structure in line with ecosystem-based management is needed for marine aquaculture. This structure needs to enable aquaculture production, safeguard environmental resources, and balance multiple uses. The myriad overlapping government regulations for coastal aquaculture must be coordinated and simplified, and a framework for aquaculture in federal waters must be established.

■ Research and development partnerships and financial incentives are needed to support commercial aquaculture, similar to supporting infrastructure for other agriculture products and fisheries. This includes determining the potential of technologies for aquaculture-based wild stock rebuilding.

■ As the lead agency for the nation's oceans and fisheries, NOAA must provide clear, accurate, and up-to-date scientific information to decision makers and the public regarding the environmental, socioeconomic, and health impacts related to marine aquaculture.

■ NOAA must continue to be engaged in international aquaculture developments. Most of the seafood consumed in the United States is imported, ocean resource management is transnational, U.S. commercial interests participate in a global seafood industry, and aquaculture research exchanges are important to U.S. aquaculture production. Aquaculture technology in many other countries is advanced compared to the United States. In addition, as one of the largest markets for aquaculture-produced seafood, the United States should set a global example for the use of sustainable aquaculture practices and encourage their adoption by other countries.



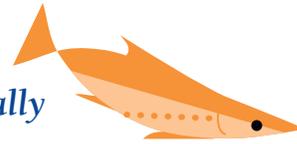
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Proactive aquaculture research, including testing technologically advanced equipment for open ocean aquaculture, such as the feed buoy pictured above, is needed in order to advance marine aquaculture in the U.S.

These issues, responsibilities, and services are restated below as the agency's aquaculture goals, along with specific strategies or actions for accomplishing each goal.

Goal 1

A comprehensive regulatory program for environmentally sustainable marine aquaculture



Regulations under Existing Laws — By the end of 2007, develop policies, guidelines, and protocols for use in the review of proposed marine aquaculture facilities by NOAA regional and program offices under current NOAA mandates. The purpose of these reviews is to assess the impacts of aquaculture facilities and operations on fishery resources, marine habitat (including essential fish habitat), endangered and threatened species, marine mammals, coral reefs, coastal communities, and marine sanctuaries and, where appropriate, recommend mitigation measures or permit conditions. These review criteria will be developed by a working group with representation from several NOAA programs and offices, and will be based in part on information gathered from the scientific literature, industry management practices, public consultations, and other sources.

Regulations in Federal Waters — Secure passage of the National Offshore Aquaculture legislation in 2007 and promulgate implementing regulations for a coordinated permitting process within 2 years of enactment of legislation. A programmatic environmental impact statement (EIS), regional mapping exercises to identify suitable and acceptable sites for offshore aquaculture, and interagency, state, and public consultations will be required as part of the regulatory design process.

Federal Regulatory Coordination
— Work with the Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (Corps), and other federal, regional, and state agencies to coordinate these reviews to make them more timely, effective, and specific. Examples are national or regional general permits under consideration by the Corps for shellfish farming, and mapping/zoning work to steer permit applicants to partially pre-permitted areas.



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Greater regional food supply and security is a benefit of increased domestic aquaculture production.

Bringing Science to Regulation and Management Decisions — Build and maintain a sufficient in-house science capability and associated infrastructure in NMFS and in the National Ocean Service (NOS), and an external research capability through the Office of Oceanic and Atmospheric Research (OAR) National Sea Grant Program, to fulfill NOAA's regulatory and public policy missions for both commercial aquaculture and aquaculture-based rebuilding of wild stocks. This will require the expansion of NMFS, OAR, and NOS science capability during 2008–2012 to address key regulatory issues (e.g., determining acceptable management practices for species and site selection, aquatic animal health, and seafood safety; assessing and monitoring potential environmental, economic, and social impacts of marine aquaculture facilities on habitat, marine life interactions, and disease transfer; and conducting research on marine aquaculture feeds to reduce reliance on fishmeal but maintain human health benefits). For example, by 2008 the *National Aquatic Animal Health Plan* will be completed and implemented in conjunction with our federal partners, key state agencies, and industry. Additional research will be conducted to reduce uncertainties associated with aquaculture-based rebuilding programs for wild fish stocks and threatened or endangered marine species.

Goal 2

Development of commercial marine aquaculture and replenishment of wild stocks

Aquaculture Research Plan — Complete and implement a national aquaculture research plan in cooperation with the Joint Subcommittee on Aquaculture, and a NOAA aquaculture research plan with appropriate NOAA offices.

Partnerships — Increase extramural funding capability based on OAR's National Sea Grant Program and National Marine Aquaculture Initiative and other programs that support pilot projects, laboratory research, and technology transfer. These extramural initiatives may be based around regional centers of excellence for marine aquaculture that would include public-private partnerships between NOAA laboratories, Sea Grant institutions, USDA, and other federal agencies, states, universities, nonprofit research institutes, private companies, and coastal communities.

Investment Incentives — Identify and develop opportunities for DOC and other federal agencies (e.g., USDA, Economic Development Administration, National Institute of Standards and Technology, Small Business Administration, Farm Credit Administration, National Science Foundation, and Defense Advanced Research Projects Agency) to provide research and development and financial support for marine aquaculture.

Major New Initiative — Identify possibilities for a major infusion of government investment in aquaculture. The initiative could include a combination of research and development funds, grants, loans, and joint research projects financed with federal, state, and private funds.

Targeted Research — Based on the research plan developed above, conduct the key studies that will result in the maximum public benefit. These studies are needed by industry and non-industry stakeholders for development of sustainable aquaculture systems.

Proactive Research — Proactive research is needed to lay the groundwork for the next 10-year plan and beyond. This proactive research is focused on the future, and will explore the feasibility of future benefits to humans that may arise from marine aquaculture. Examples may include the use of aquaculture for algal feeds, global carbon sequestering, biofuels development, bioplastics, human health products, and ecosystem stabilization.

Research Infrastructure — The infrastructure for conducting research on marine aquaculture in the United States is not up to world standards. Infrastructure needs must be addressed for significant scientific advancement to be realized.



The marine finfish *Polydactylus sexfilis*, also known as Pacific threadfin or moi, is farmed commercially in Hawaii.

NOAA AQUACULTURE PROGRAM



One of NOAA's top priorities is to better communicate and foster understanding of the environmental, economic, and social implications of marine aquaculture.



Goal 3

Public understanding of marine aquaculture

Conduct a continuing interactive dialogue with key stakeholders on marine aquaculture issues representing aquaculture, commercial and recreational fishing, seafood processors and marketers, coastal communities, and environmental interests.

Maintain an agency website that provides information on the NOAA Aquaculture Program, including access to scientific advances, research reports, and other pertinent information.

Provide accurate, topical, and up-to-date scientific information on marine aquaculture to the public in coordination with Sea Grant Extension/Marine Advisory Services, the NOAA Library, and the NOAA Office of Education.

Develop a NOAA aquaculture outreach and communications plan that will engage interested stakeholders, the media, and other targeted groups on all levels.

Goal 4

Increased collaboration and cooperation with international partners

Develop a NOAA international aquaculture activities plan.

Gain from technology and science developed by other countries.

Actively participate in multilateral, regional, and bilateral research and policy to enhance development of responsible marine aquaculture and the production of safe seafood through negotiation, data, and information sharing, scientific exchanges, and cooperative studies

Implement the FAO *Code of Conduct for Responsible Fisheries*, which calls for the United States to promote responsible development and management of aquaculture.



Outcomes

© ALASKA KING CRAB RESEARCH
REHABILITATION AND BIOLOGY PROGRAM



In the U.S., aquaculture-based rebuilding techniques are being applied to salmon, redbfish, and oysters, and research is being conducted on many other species, including white seabass and abalone in California, snook in Florida, summer flounder in New England, and king crab in Alaska, as shown above.

If the requisite legislative mandates and funding are provided to implement the strategies described above, between 2007 and 2017 the NOAA Aquaculture Program, working with federal and state partners and stakeholders, plans to achieve or substantially contribute to the achievement of the following outcomes:

- Establish a fully operational and coordinated interagency permitting system for marine aquaculture that enables aquaculture production while safeguarding environmental resources, including an agency capacity for assessing and monitoring short- and long-term impacts of marine aquaculture operations.
- Establish and maintain several regional ecosystem management initiatives that include commercial and aquaculture-based rebuilding activities as key components.
- Demonstrate that offshore farming systems can be operated over several years in a range of sea conditions, and establish new offshore farms in the U.S. Exclusive Economic Zone (EEZ) for finfish, shellfish, and algae.
- Establish onshore hatcheries to produce juvenile fish and shellfish to be stocked in marine farms—offshore, on land, and in coastal waters—for commercial aquaculture and aquaculture-based rebuilding.
- Determine the feasibility of culturing marine fish identified as suitable candidates for aquaculture (e.g., cobia, redbfish, pompano, cod, halibut, sablefish, yellowtail, amberjack, Pacific threadfin, and tuna).
- Restore and expand coastal shellfish aquaculture in areas with appropriate carrying capacity and establish and expand the use of offshore methods for the production of oysters, mussels, abalone, and (possibly) scallops.

- Advance research on techniques for farming and processing certain marine species and seaweeds for use in nutritional, health, and other industrial products.
- Advance research on aquaculture-based rebuilding of priority marine or estuarine wild stock species.
- Develop world-class aquaculture research and demonstration facilities.
- Begin to determine other benefits to society that could be realized by marine aquaculture.

Achievement of many of these outcomes depends on actions by the Executive and Legislative branches of the Federal Government to enact new authorities for NOAA and to provide additional financial resources. Success will also depend on the actions of the private sector, states, and coastal communities to invest the time and capital necessary to expand the U.S. marine aquaculture industry.



NOAA AQUACULTURE PROGRAM

Across the U.S., specialized high school programs, such as this one in Alabama, generate interest in all aspects of aquaculture, from research and technology development to marketing.

Benefits

NOAA AQUACULTURE PROGRAM



Red abalone, *Haliotis rufescens*, shown here in vertical racks, is being farmed commercially in California.

The United States stands at a critical juncture in the development and implementation of marine aquaculture in our Nation. This important technology will provide new economic and environmental opportunities for all fisheries-dependent coastal communities. Communities damaged by hurricanes or that have experienced reductions in wild catch have lost their market niche, as seafood buyers have turned to imported aquaculture products to meet market demand. In addition, seafood prices may increase as other countries consume more and export less, making the health and nutritional benefits of seafood less affordable. With the requisite legislative mandates and funding, the following economic, social, and environmental benefits can be achieved:

- Creation of 75,000 direct and indirect jobs for every 1 million metric tons of domestic aquaculture production (based on job creation figures from the salmon and catfish aquaculture industries).
- New opportunities for coastal communities and the seafood industry to increase the domestic supply of seafood through commercial marine aquaculture and aquaculture-based rebuilding to maintain and continue to employ existing boats, processing facilities, cold storage, marketing, and transportation infrastructure. These business opportunities will create more resilient coastal communities with a more diversified economic base.
- Integration of commercial marine aquaculture, fishing, and aquaculture-based rebuilding activities for increased seafood production, recreational fishing opportunities, and species and habitat restoration.
- New domestic and global business opportunities for the U.S. grains and feed industry, health and nutrition products, equipment manufacturers, food processing, and other services.

- Greater regional food supply and security, as more of the seafood consumed in the United States would be grown here, under specific conditions and safeguards.

- Regional ecosystem management programs that integrate aquaculture production supporting habitat and species restoration, sustainable fisheries, and multiple coastal uses (e.g., restoration of depleted species, marsh grass and oyster bed replanting for water quality improvements, and alternative source production of overfished wild stocks).

- Significant expansion of a research, development, and extension infrastructure that supports aquaculture development with hatcheries, diagnostic services, advances in feeds and nutrition, and other scientific research.

- Assuming that aquaculture products contribute to increased seafood consumption, improved health for Americans (e.g., fewer heart attacks, strokes, and associated deaths).



NOAA AQUACULTURE PROGRAM

Supplying the global aquarium trade is a potential growth area for U.S. aquaculture.

Budget and Staffing Requirements

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The U.S. currently supplies aquaculture technology, services, investment capital, broodstock, and feedstuffs to a global aquaculture industry.

A significantly larger annual budget and additional staff positions are needed for the NOAA Aquaculture Program to meet its 10-year goals and outcomes. These budget and staffing requirements are allocated among four program components:

Administration and Regulatory Program — To establish and implement a legal, regulatory, and administrative framework for marine aquaculture, the current administrative budget and staff must be increased. Additional funds will be required to:

- Design and implement offshore legislation.
- Conduct a programmatic EIS for offshore aquaculture.
- Formally establish a NMFS headquarters office and aquaculture coordinators in each of the NMFS regional offices.
- Increase the science capabilities at NOAA laboratories to address regulatory and public policy issues for commercial aquaculture and aquaculture-based rebuilding.

Research and Development — Sound science and technology transfer must be provided to develop aquaculture. A significant increase in funding, staff, and improvement in infrastructure is required to conduct research at NOAA science centers/labs and in partnership with industry, state, university, and international scientific research institutions through competitive grants.

Outreach and Education — Information must be communicated to federal agencies, states, industry, international partners, the public, and other interested aquaculture stakeholders. A modest increase in budget and staffing is needed for maintaining/upgrading the program website, producing documentaries, holding stakeholder meetings, gathering and publishing scientific research, conducting media outreach, and providing additional Sea Grant Advisory and Extension Services.

International Activities — Modest funding in the past has been provided by OAR, the National Marine Aquaculture Initiative, NMFS, and NOS for international travel, conferences, and scientific exchanges; however, the majority of international activities are not yet coordinated. Opportunities to maximize benefits to the nation from a coordinated approach to international activities will be detailed in a NOAA Aquaculture international activities plan developed over the next 2 years.



© THE UNH ATLANTIC MARINE AQUACULTURE CENTER

Commercial fishermen in New England are using new technology to farm blue mussels, *Mytilus edulis*, on submerged ropes in the ocean.

Challenges



NOAA needs the support of a broad range of stakeholders to create opportunities for marine aquaculture to develop sustainably, while protecting the marine environment and privileges of other users of marine resources.

The NOAA Aquaculture Program must overcome several internal and external hurdles to meet its goals, including:

Budget, Staffing, and Infrastructure — The program needs to reach a minimum critical size in terms of budget, staffing, and infrastructure to fully achieve program goals and objectives. However, given the uncertain budget climate, staffing and financial resources for a fully operational program are not guaranteed.

Legislation and Regulatory Mandates — The program is currently operating under statutory authorities that, for the most part, were not provided specifically with the regulation of aquaculture in mind. The challenge is to address aquaculture growth in the marine environment within the context of NOAA environmental stewardship mandates. The conduct of NOAA's responsibilities for review of aquaculture permitting requests in coastal waters should be better coordinated, both internally and with other federal agencies. If Congress enacts offshore aquaculture legislation, NOAA will be charged with issuing permits for aquaculture in federal waters and coordinating actions of other permitting agencies. NOAA will also be authorized to implement a marine aquaculture science and research program

Stakeholder Support — The program needs the support of a broad range of stakeholders—particularly those in coastal communities—to create opportunities for marine aquaculture to develop sustainably, while protecting the marine environment and privileges of other users of marine resources.

Appendix I: Legislative and Policy Drivers

LEGISLATIVE DRIVERS

Coastal Zone Management Act – Requires NOAA to provide assistance to coastal states to support comprehensive planning, conservation, and management for living marine resources, including planning for the siting of aquaculture facilities within the coastal zone.

Endangered Species Act – Requires NOAA to take various actions to protect and recover all threatened and endangered species under the jurisdiction of the Department of Commerce, including actions to address potential impacts from marine aquaculture facilities.

Magnuson-Stevens Fishery Conservation and Management Act – Requires NOAA to review activities in marine waters that may have impacts on a managed species or essential fish habitat; aquaculture activities are therefore subject to review under this Act.

Marine Mammal Protection Act – Requires NOAA to take various actions to protect all marine mammals under the jurisdiction of the Department of Commerce, including actions to address potential impacts from marine aquaculture facilities.

Merchant Marine Act – Provides authority for NOAA to provide loans for the construction of aquaculture facilities.

National Aquaculture Act – Established the overall national policy that, "... it is ... in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States" [Section 2(c)]." Under the Act, the Secretary of Commerce is authorized to "provide advisory, educational and technical assistance" and to "encourage the implementation of aquacultural technology in the rehabilitation and enhancement of publicly owned fish and shellfish stocks ... and in the development of private commercial aquacultural enterprises."

National Environmental Policy Act – Requires NOAA to consider all reasonably foreseeable environmental effects of its proposed actions, including potential effects of marine aquaculture facilities.

National Sea Grant College Program Act – Provides authority for NOAA to conduct research, extension, education, and communications to achieve a sustainable environment and to encourage the responsible use of America's coastal, ocean, and Great Lakes resources, including support for aquaculture.

Saltonstall-Kennedy Act – Provides authority for NOAA to award contracts, grants, or cooperative agreements for fisheries research and development projects addressing any aspect of U.S. fisheries, including but not limited to harvesting, processing, aquaculture, marketing, and associated infrastructures.

POLICY DRIVERS

1998 NOAA Aquaculture Policy – Calls for a successful program to meet public needs for aquaculture development and environmental protection to focus on:

- Research, development, and technology transfer.
- Financial assistance to businesses.
- Environmental safeguards, including regulatory and permit procedures.
- Coordination with federal, state, and local agencies, as well as industry, academia, and foreign institutions.

This policy defined aquaculture as: "The propagation and rearing of aquatic organisms in controlled or selected aquatic environments for any commercial, recreational, or public purpose. Potential purposes of aquaculture include bait production, wild stock enhancement, fish culture for zoos and aquaria, rebuilding of populations of threatened and endangered species, and food production for human consumption."

1999 Department of Commerce Aquaculture Policy – Calls for achievement of the following goals by 2025:

- Increase the value of domestic aquaculture production (freshwater and marine) from the present \$900 million annually to \$5 billion.
- Increase the number of jobs in aquaculture from the present estimate of 180,000 to 600,000.
- Develop aquaculture technologies and methods both to improve production and safeguard the environment.
- Double the value of non-food products and services produced by aquaculture to increase industry diversification.
- Enhance depleted wild fish stocks through aquaculture, thereby increasing the value of both commercial and recreational landings and improving the health of our aquatic resources.

APPENDIX 1: LEGISLATIVE AND POLICY DRIVERS, CONTINUED

2003 Code of Conduct for Responsible Aquaculture Development in the United States Exclusive Economic Zone – A voluntary code that includes the following objectives:

- Promote the contribution of aquaculture to seafood supplies.
- Promote marine stewardship.
- Establish principles that embrace environmental, operational, management, and social concerns.
- Provide standards of conduct for government, companies, and individuals.

An Ocean Blueprint for the 21st Century

(September 2004) – The U.S. Commission on Ocean Policy’s Final Report to Congress called on the Secretary of Commerce to:

- Design and implement national policies for environmentally and economically sustainable marine aquaculture.
- Develop a comprehensive, environmentally sound permitting, leasing, and regulatory program for marine aquaculture.
- Expand marine aquaculture research, development, training, extension, and technology transfer, including a socioeconomic component.
- Set priorities for research and technology, in close collaboration with the National Sea Grant College Program, states, tribes, academia, industry, and other stakeholders.
- Work with the FAO to encourage and facilitate worldwide adherence to the aquaculture provisions of the Code of Conduct for Responsible Fisheries.

U.S. Ocean Action Plan (December 2004) – Includes the following recommendation:

In the 109th Congress, the Administration will propose a National Offshore Aquaculture Act that provides the Department of Commerce clear authority to regulate offshore aquaculture. This bill will empower the Department of Commerce to assist the private sector in obtaining necessary Federal agency approval for establishing an offshore aquaculture facility. The Department of Commerce has primary responsibility for the management and conservation of living marine resources in the EEZ and, as such, will ensure that offshore aquaculture enterprises operate in an environmentally sustainable manner that is compatible with existing uses.

NOAA’s 2005 Annual Guidance Memorandum for Fiscal Years 2008–2012 – Includes the following advice for the Aquaculture Program:

- Create environmental standards and appropriate monitoring and evaluation protocols that will set a new commercial code of conduct for marine aquaculture ... [and provide a] regulatory structure and robust scientific and technical support for marine aquaculture.

National Offshore Aquaculture Act of 2007

(H.R. 2010 and S. 1609) – The act:

- Includes authority for the Secretary of Commerce to issue offshore aquaculture permits.
- Requires the Secretary of Commerce to establish environmental requirements.
- Requires the Secretary of Commerce to work with other federal agencies to develop and implement a coordinated permitting process for offshore aquaculture
- Exempts permitted offshore aquaculture from fishing regulations that restrict size, season and harvest methods.
- Authorizes a research and development program for all types of marine aquaculture.
- Authorizes funding to carry out the Act and provides for enforcement of the Act.



National Oceanic and Atmospheric Administration

**NOAA Aquaculture Program Office
1315 East-West Hwy.
SSMC-3 - Route: F/AQ
Silver Spring MD 20910
Phone: (301) 713-9079
www.aquaculture.noaa.gov**