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# AQUACULTURE SITUATION AND OUTLOOK REPORT 2007: MAINE

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Atlantic salmon culture in Maine (Photo: Chris Bartlett)

## Commercial Species List

- American shad (*Alosa sapidissima*)
- Atlantic salmon (*Salmo salar*)
- Atlantic cod (*Gadus morhua*)
- Atlantic halibut (*Hippoglossus hippoglossus*)
- Bay scallops (*Argopecten irradians*)
- Blue mussel (*Mytilus edulis*)
- Brook trout (*Salvelinus fontinalis*)
- Brown trout (*Salmo trutta*)
- Cinnamon clownfish (*Amphiprion melanopus*)
- Clarkii clownfish (*Amphiprion clarkii*)
- Common seahorse (*Hippocampus kuda*)
- Eastern oyster (*Crassostrea virginica*)
- Emerald shiners (*Notropis atherinoides*)
- European oyster (*Ostrea edulis*)
- Golden shiners (*Notemigonus chrysoleucas*)
- Green sea urchin (*Strongylocentrotus droebachiensis*)
- Neon dottyback (*Pseudochromis aldabraensis*)
- Nori seaweed (*Porphyra* sp.)
- Northern quahog (*Mercenaria mercenaria*)
- Orchid dottyback (*Pseudochromis fridmani*)
- Ocellaris clownfish (*Amphiprion ocellaris*)
- Percula clownfish (*Amphiprion percula*)
- Rainbow smelt (*Osmerus mordax*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Sandworms (*Nereis virens*)
- Sea scallops (*Placopecten magellanicus*)
- Softshell clam (*Mya arenaria*)
- Splendid dottyback (*Pseudochromis splendens*)
- Sunrise dottyback (*Pseudochromis flevivertex*)
- Tomato clownfish (*Amphiprion frenatus*)
- Whitenose sucker (*Catostomus commersonii*)

## Industry Trends and Outlook

The Maine aquaculture industry is diverse with a variety of marine and freshwater species raised. Salmon production values are in the range of \$48 million per year, with annual production ranging between 11-36 million pounds from 2000-2005; shellfish production throughout Maine is approximately \$10 million annually (O'Hare et al. 2003). Recent reinvestment in the salmon industry will probably raise those values, as will husbandry practices that limit the adverse effects of disease. True North Salmon (Cooke Aquaculture) has publicly pledged to raise production levels sufficiently in the State to support the year round operation of a salmon processing plant in Maine.

## Critical Needs and Emerging Issues

- Workforce and professional development: Facilitation of the entry of new aquaculture professionals, and advancement of the skills and abilities of existing industry members
- Access to startup capital and tax incentives: Capital is limited in the aquaculture industry, especially so for new start-ups, and the earlier phases of commercial development
- Regulatory barriers to entry: The aquaculture industry is highly regulated, and in many cases regulation effectively constitutes an obstacle to entry, and to the development of new techniques, species and equipment
- Assessment of appropriate environmental indicators: Assessment of the scientific validity of existing environmental indicators and evaluation of new indicators which may be more valid
- Biofouling control for finfish and shellfish: Biofouling is a long-standing problem for aquaculture producers, and eradication remains an area of critical need
- Waterfront access for marine businesses: Despite many advances in waterfront access for marine businesses in Maine, access continues to be in critically short supply and is essential for a healthy mariculture industry
- Establishment of husbandry practices and equipment to minimize negative environmental effects and to accentuate positive effects: This ongoing need is front and center in the continued viability of the aquaculture industry, both for protection of the resources that producers depend on, and on the goodwill of other resource users, managers, and groups
- Eelgrass/shellfish culture management: The dynamics between eelgrass and shellfish aquaculture (suspended and bottom) is an area where study is strongly needed
- Marketing program to develop “Maine-brand” identity linked to sustainable farming methods
- Access to suitable growing sites continues to be a constraint to industry development
- Continued forums for public discussion and education about methods, practices and species being cultured in Maine are necessary

- Polyculture, or co-culture, of marine organisms can take many forms, including integrated, multi-trophic aquaculture. This strategy of production is in its early stages in Maine, but is expected to make stronger advances in the near future
- Predation by eider ducks continues to be a significant obstacle to higher production levels of blue mussels in suspended and bottom culture
- Macroalgae are expected to become more significant in the overall production of marine culture products in coming years
- Significant advances in the culture of various freshwater finfish species used as bait have been made and, with a vigorous market for such products, baitfish production is expected to be a growth industry
- Culture of the sea scallop has been limited in the recent past, but upcoming changes to regulation and permitting may allow greater experimentation and production of this valuable species
- Culture of the green sea urchin has been limited in the past, but new research and changes to regulations and permitting may allow greater experimentation and production
- Improved harvesting techniques and equipment are needed, to improve productivity and safety and to minimize the environmental impacts of mechanical and diver harvesting
- In recent years, most new shellfish growers have been commercial fishermen, either active or retired. This trend is expected to continue, and brings with it issues of access to production areas, and the transition of some submerged lands from open fishing areas to areas of limited access by others, e.g. leases
- New marine finfish species are being developed for commercial culture in the state. Due to the unique growing conditions in the Gulf of Maine stakeholders must adapt, develop and improve husbandry techniques from others locales
- Conflicting pressures between working waterfronts, recreational and residential users: As competition for water resources increases, it is becoming increasingly necessary to develop new management strategies that support and encourage multiple uses of areas while reducing conflicts



Salmon culture cages in Maine (Photo: Chris Bartlett)

Marine finfish culture is expected to grow in the future as current producers expand and diversify their production and new producers enter the State.

In recent years, shellfish production has been on a slow and steady increase, especially for blue mussels and oysters. Likewise, there is an increased interest in expanding the existing freshwater finfish industry, both in terms of new baitfish producers and fee fishing operations.

## Addressing Industry Needs

Researchers, extension specialists, resource managers, industry associations and concerned stakeholders all play a role in addressing industry needs. The following sections highlight the major aquaculture research, extension and education facilities and organizations in Maine.

## Aquaculture Facilities

The University of Maine (UMaine) has a number of research facilities throughout the state including the Darling Marine Science Center, the Center for Cooperative Aquaculture Research (CCAR), the Aquaculture Research Center, the Food Sciences Lab and the Maine Aquatic Animal Health Lab (MAAHL).

Research at the Darling Marine Science Center, located in Walpole on the Damariscotta River, is focused on the development of sustainable shellfish culture techniques and is the home of the oyster broodstock program. This facility also has incubation space for aquaculture business that can house start-up shellfish, invertebrate, algal or finfish businesses.

The Center for Cooperative Aquaculture Research, located in Franklin on Taunton Bay, is a commercial scale applied aquaculture R&D facility and business incubator space. Facilities include a variety of rearing tanks, over a dozen marine and freshwater recirculating systems, a new state of the art multi-species marine

finfish hatchery, and a water system that allows for rearing of marine, brackish and freshwater species. The facility currently houses halibut and cod broodstock and juveniles, the world's only indoor recirculating marine polychaete worm farm, a green sea urchin hatchery, and culture and net seeding facilities for nori.

The Aquaculture Research Center, located on the University of Maine campus in Orono, has a laboratory system used for small scale marine, brackish and freshwater research. It specializes in recirculation technology. The Center also houses a wave tank that is used for engineering and testing new aquaculture equipment. Current work at the Center includes breeding and rearing of new tropical marine species.

The Food Sciences Laboratory is a completely equipped facility including a twin screw extruder. This lab participates in fish nutrition studies and manufactures trial diets as needed. They work cooperatively with other university facilities to conduct feeding trials and develop new diets.

The Maine Aquatic Animal Health Lab is designed as a shared-user magnet research facility for aquatic animal health and disease research, and is located at the University of Maine Orono campus. The mission of the MAAHL is to foster applied aquatic animal health research and diagnostics along with providing outreach with education to address the needs of Maine's aquaculture and fisheries communities. Private and public entities are encouraged to collaborate in the activities of the MAAHL. The laboratory is equipped with state of the art imaging, culture and molecular equipment needed to conduct cutting edge research on aquatic animal pathogens of any nature. In particular, the lab is currently home to the only disease isolation wet lab in the state for conducting experimental infectivity trials. The MAAHL is a program of the University of Maine Cooperative Extension and the Department of Animal and Veterinary Sciences.

The Maine Aquaculture Innovation Center (MAIC) is housed at the University of Maine in Orono. The mission of MAIC is to assist in the development of economically viable aquaculture opportunities along the coast of Maine and at appropriate inland sites by:

- sponsoring and facilitating innovative research and development projects involving food, pharmaceuticals and other products from sustainable aquatic systems;
- investing in the enhancement of aquaculture capacity in Maine;
- serving as a clearing house of educational information to enhance public visibility and

acceptance of aquaculture; encouraging strategic alliances tasked with promoting research, technology transfer, and the commercialization of aquaculture research.

The U.S. Department of Agriculture operates its National Cold Water Marine Aquaculture Center research facilities in Franklin, with additional research facilities planned in Orono. Facilities in Franklin are located adjacent to the University of Maine Center for Cooperative Aquaculture Research (CCAR). Facilities in Orono will be located on the University of Maine campus. The Franklin facility is the home of the USDA Atlantic Salmon Broodstock program. The National Cold Water Marine Aquaculture Center (NCWMAC) has been conducting research since 2003 in Franklin using two temporary greenhouses prior to construction of permanent facilities. One greenhouse has 144 small 50-gallon culture tanks for rearing Atlantic salmon from fry to advanced parr stage. The second greenhouse has 4 larger 2,500 gallon tanks for rearing smolts prior to stocking into sea cages. This greenhouse also has a 4,000 gallon tank for culturing sub adult salmon prior to completion of permanent facilities. All research tanks are supplied with water from recirculating filtration systems. The permanent research facilities were completed in 2007 and consist of a 42,000 square foot main research building with approximately 300 research tanks and two approximately 3,000 square foot individual research buildings.

The Downeast Institute for Applied Marine Research and Education (DEI) is located on Great Wass Island in Beals. This education and research facility produces commercially important marine shellfish in a commercial-scale hatchery facility. DEI is best known for the annual production of millions of soft-shell clam seed for public stock enhancement for Maine coastal communities. In addition, research projects at the facility include regional growth of hatchery-reared lobster juveniles, growth/survival of hard clams in the cold waters of eastern Maine, and an examination of the efficacy of closed bottom areas with respect to managing wild populations of sea scallops. Downeast Institute staff work with scientists and students from the nearby University of Maine at Machias, which considers the facility its marine field station. In addition, DEI staff and UMM scientists work in conjunction with fishermen, entrepreneurs, and educators to help develop programs and projects that have both educational and economic benefits to the residents of coastal Maine. The Downeast Institute is a non-profit organization administered by a 15-member Board of Directors. The mission of DEI is to improve the quality of life for the people of downeast and

coastal Maine through applied marine research, technology transfer, and public marine resource education.

The Maine Aquaculture Association's (MAA) conducts applied research on member farms that addresses industry issues and supports the development of sustainable husbandry techniques. Recent and ongoing research includes: the development of an independent third party verified containment management system for all salmon culture facilities in the state, development of Best Management Practices, development of composting techniques for fish waste from freshwater hatcheries, demonstration of plant culture techniques to reduce nutrients in hatchery effluent and development of inventory system for bottom cultured oysters.

Lists of other aquaculture projects in Maine can be found by checking with the principal funding agencies which include the Northeast Regional Aquaculture Center, Maine Sea Grant, and the Maine Aquaculture Innovation Center. Projects range from deterrent devices for eider predation on mussels, to broodstock development in oysters, and improvements in baitfish production.

## Extension Programs and Facilities

Centers of extension activity in Maine include:

- Maine Sea Grant at the Washington County Community College
- Maine Sea Grant at the Darling Marine Center
- Maine Aquaculture Innovation Center
- Maine Aquaculture Association
- University of Maine at Orono

Extension activities for Maine Sea Grant (ME SG) include: programs for technology transfer and



Oysters ready for planting. (Photo: Eric Horne )

professional development within the industry, and programs to educate or connect citizens to the aquaculture industry and its products in various ways. Partners in these efforts include the Maine Aquaculture Association, Maine Aquaculture Innovation Center, Maine Department of Marine Resources, and other institutions and citizen groups. Examples of our activities include: hosting industry meetings to discuss important issues and solutions, collaborating with regional partners on the biannual Northeast Aquaculture Conference and Exposition (NACE) conference, convening forums where industry and concerned citizens can work on issues of concern, organizing visits to aquaculture sites and facilities, and various speaking engagements. ME SG also produces publications relevant to the aquaculture industry.

The Maine Aquaculture Association (MAA) focuses its extension and outreach efforts in two primary directions. First, we provide various professional development opportunities to existing growers in the state. These efforts focus both on improved husbandry and/or management skills and improved business skills. Often we will work with other partners such as Maine Sea Grant or the Maine Aquaculture Innovation Center in these efforts. MAA also directs significant efforts to educating the general public about aquaculture in the state. This is accomplished through several methods including our website, public presentations and outreach efforts at public trade shows and events. Staff members often lecture to various civic organizations or school groups, and we recently concluded a series of public lectures hosted along the entire coast. We can also be seen at numerous trade events such as the Maine Sportsman Show, The Agricultural Trade Fair, Fisherman's Forum, Tourism shows, Local Festivals and of course the Big E down in Springfield, Mass. Please visit our website for a list of up coming events <http://www.maineaquaculture.com>

There are many activities that fall into the category of extension by other groups throughout the state. Brief examples: the Maine Aquaculture Innovation Center hosts 'lunch and learn' professional development activities for growers throughout the state. The Downeast Institute transfers technology to others in marine industries regarding the culture of soft shell clams and development/operation of lobster hatcheries. The Center for Cooperative Aquaculture Research works with growers on culturing new species in Maine waters.

## Education Facilities

The University of Maine in Orono has undergraduate and graduate programs in aquaculture,



Carter Newell examines blue mussels at his raft culture operation. (Photo: Dana Morse)

including freshwater and marine species, finfish, shellfish and algae. Faculty members within the School of Marine Science teach and conduct research in topics ranging from culture of marine macroalgae, to salmon feeds, oyster broodstock development, and design of aquaculture equipment.

The Darling Marine Center is an established center for shellfish culture education, on formal and informal levels. Researchers, industry members, extension personnel, and members of the public are involved in such educational programs as a course on Shellfish Mariculture Techniques, Oyster Gardening, and lectures by guest speakers. The DMC also serves as a central meeting space where shellfish growers gather, to learn and discuss programs from Crop Damage Insurance to water quality, and the progress of the Oyster Broodstock Program.

A Maine Sea Grant College Program staff member is housed within the Washington County Community College (WCCC), and conducts a variety of aquaculture-related activities such as coordinating the Fish Health Workshop, conducting educational day trips to school and other groups, and participating in aquaculture research in finfish, shellfish and marine algae.

Southern Maine Community College (SMCC) offers the Applied Marine Biology and Oceanography (AMBO) program. This program provides students with the academic background and applied skills required for employment as research assistants and technicians or for transfer into a four-year baccalaureate program. The curriculum emphasizes hands-on laboratory and field procedures. Special attention is given to collecting and identifying marine organisms, oceanographic sampling aboard the school's

research vessel, aquaculture, and service projects in the southern Maine community.

Unity College has an integrated aquaculture and fisheries program that combines the tradition of preparing fisheries biologists and fisheries technicians for federal, state and private agencies and conservation groups with the education in the multi-faceted aspects of aquaculture. Students are sought by employers and graduate schools because the curriculum provides opportunities for students to become proficient in basic biological and physical sciences while giving them theoretical and practical exposure to the fields of aquaculture and fisheries sciences. Students also develop an appreciation for the intricacies of aquaculture production, fisheries management, and fish pathology.

The University of New England (UNE) has an Aquaculture and Aquarium Science major that is designed so that graduates will have the skills to either find jobs in the private or governmental sectors including owning their own businesses or working at a public aquarium. There are four dedicated classes and two business classes plus plenty of opportunity to gain hands-on experience maintaining both captive tropical reef fish and local Gulf of Maine species. The students learn to grow phytoplankton and zooplankton and to design and build recirculating systems and exhibit tanks. Students get a good overview of the state of aquaculture in Maine as well as the world, and also the role that aquariums and aquarium science will take in the future of marine science and conservation.

The University of Southern Maine (USM) has a modest link to aquaculture with some biology classes, and at least one faculty member involved in aquaculture research.

The Herring Gut Learning Center (HGLC) is a non-profit marine education and resource center located in the small fishing village of Port Clyde, Maine. Staff at HGLC teach marine science, aquaculture, geology, and coastal ecology to students of all ages through a variety of hands-on school-based, community outreach and summer camp programs.

Lubec Consolidated School Aquaculture Lab is a state of the art science center that teaches applied biological sciences to grades 6 through 12 students. The lab has over 7000 gallons of recirculating aquaculture systems raising tilapia, brook trout and various ornamental fishes. The tilapia system is an environmentally friendly simulated wetland aquaponics system, that utilizes plants growing in an 800 square-foot greenhouse to purify the fish water. The aquaponic greenhouse has the capability to grow enough

vegetables to serve the students a salad bar in the cafeteria every day. The lab also conducts distance learning courses to any interested schools, and we are regularly hosting virtual field trips via a T.V. polycom system. Classes are very interactive utilizing five fixed and mobile cameras around the class in microscopes and in the tanks themselves. The students at Lubec Consolidated School and other interested schools can take courses in Vocational Aquaculture, Aquaponics, Botany, Aquaculture, Aquascience, and for the middle school Applied Science.

Presque Isle Regional Career and Technical Center offers a one-year elective course to tenth, eleventh, and twelfth graders. It is designed to introduce the students to growing freshwater and tropical fish under controlled conditions.

The Maine Sea Grant College Program (MESG) is involved in aquaculture education through the Marine Extension Team (MET -a partnership with Univ. of Maine Cooperative Extension), and through its Communications Department. The MET works with other groups and agencies to develop and implement information educational programs such as tours, workshops, seminars, speaking engagements and conferences, and collaborates with the Communications Department to produce items such as fact sheets, research briefs, and other documents and publications. The Maine Sea Grant Program also funds research in aquaculture through its bi-annual Research Program, and projects funded by MESG are required to have an extension and education component.

## **Aquaculture Resources**

### **Maine Aquaculture Innovation Center**

<http://www.maineaquaculture.org>

### **Maine Aquaculture Association**

<http://www.maineaquaculture.com>

### **Maine Department of Marine Resources**

<http://www.maine.gov/dmr/>

### **Red Tide and Shellfish Sanitation Hotline**

[http://www.maine.gov/dmr/rm/public\\_health/closures/shellfishhotline.htm](http://www.maine.gov/dmr/rm/public_health/closures/shellfishhotline.htm)

### **Maine Department of Environmental Management**

<http://www.maine.gov/dep/>

### **Maine Sea Grant**

<http://www.seagrants.umaine.edu>

### **Maine Oyster Broodstock Program**

[http://www.marine.maine.edu/~rawsonp/oyster\\_broodstock/start.htm](http://www.marine.maine.edu/~rawsonp/oyster_broodstock/start.htm)

## Research Contact Information

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Susan Brawley	University of Maine Sea Grant (207) 581-2973 <a href="mailto:brawley@maine.edu">brawley@maine.edu</a>	sea vegetable aquaculture
Ian Bricknell	University of Maine (207) 581-4315 <a href="mailto:ian.bricknell@umit.maine.edu">ian.bricknell@umit.maine.edu</a>	fish immunology and vaccination, larval immunity, immunostimulants, sea lice
Nick Brown	University of Maine, CCAR (207) 422-9096 <a href="mailto:npbrown@maine.edu">npbrown@maine.edu</a>	recirculation technology, marine fish and invertebrate rearing technology, broodstock management, live feed production
Jeri Fox	University of New England (207) 283-0170 <a href="mailto:JLFox@une.edu">JLFox@une.edu</a>	marine ornamental aquaculture, sustainable harvest of reef fish for aquarium trade, first feed diets for larval marine fish
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Paul Rawson	University of Maine (207) 581-4326 <a href="mailto:prawson@maine.edu">prawson@maine.edu</a>	molecular genetics of shellfish, oyster broodstock development
John Riley	University of Maine (207) 581-2715 <a href="mailto:jriley@maine.edu">jriley@maine.edu</a>	development of equipment and methods for the State's aquaculture, fishing and food processing industries

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Jeri Fox	Univ. of New England (207) 283.0170 <a href="mailto:JLFox@une.edu">JLFox@une.edu</a>	aquaculture and aquarium science
Chuck Gregory and Brian Tarbox	Southern Maine Technical College (207) 767-9509 <a href="mailto:cgregory@smccME.edu">cgregory@smccME.edu</a>	aquaculture in the classroom

## Education Contact Information (continued)

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Elaine Jones	Maine Department of Marine Resources (207) 633-9500 <a href="mailto:elaine.jones@maine.gov">elaine.jones@maine.gov</a>	K-12 education
Jim Masterson	St. George Elementary School (207) 372-9605	elementary education
Mike Pietrak	Maine Aquaculture Association (207) 622-0136 <a href="mailto:mike@maineaquaculture.com">mike@maineaquaculture.com</a>	public education

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**Center for Cooperative Aquaculture Research**

<http://www.ccar.um.maine.edu/>

**Maine Legislature: Joint Standing Committee on Marine Resources**

[http://janus.state.me.us/house/jt\\_com/mar.htm](http://janus.state.me.us/house/jt_com/mar.htm)

**Maine Technology Institute**

<http://www.mainetechnology.org/>

**Gulf of Maine Ocean Observing System**

<http://www.gomoos.org>

**Army Corps of Engineers, New England District**

<http://www.nae.usace.army.mil/>

**Northeastern Regional Aquaculture Center**

The NRAC is one of five Regional Aquaculture Centers established by the U. S. Congress which supports research and outreach efforts to promote the development of the aquaculture industry.

<http://www.nrac.umd.edu>

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The cooperating agencies' programs are open to all citizens without regard to race, color, gender, disability,

