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AQUACULTURE SITUATION AND OUTLOOK REPORT 2007: RHODE ISLAND

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Industry Trends and Outlook

Rhode Island is a producer of farm-raised shellfish, including eastern oysters *Crassostrea virginica* and northern quahogs *Mercenaria mercenaria*, valued at greater than \$1,348,525 (farm gate value) in 2006. The eastern oyster is the number one product in terms of production and value with 2.4 million pieces sold, representing 97% of the farm gate value total. There are 28 companies cultivating shellfish in Rhode Island (2006) with 99 acres under lease. The majority of the shellfish industry relies on purchase of hatchery seedstock, but there is some spat collection. The State Department of Environmental Management (DEM) operates three trout hatcheries and a warm water

hatchery for stocking of species such as largemouth bass. Other species of interest include: blue mussels, bay scallops and ornamental fish species. There is an annual Rhode Island aquaculture report produced since 1995 with detailed information about Rhode Island's Aquaculture Production available from the State Aquaculture Coordinator.

Cultured Species List

- Bay scallops (*Argopecten irradians*)
- Eastern oyster (*Crassostrea virginica*)
- European oyster (*Ostrea edulis*)
- Northern quahog (*Mercenaria mercenaria*)
- Brook trout (*Salvelinus fontinalis*)
- Brown trout (*Salmo trutta*)
- Koi carp (*Cyprinus carpio*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Tilapia (*Oreochromis aureus*)
- Clownfish (*Amphiprion* spp.)
- Atlantic Cod (*Gadus morhua*)
- Black sea bass (*Centropristis striata*)
- Haddock (*Melanogrammus aeglefinus*)
- Summer flounder (*Paralichthys dentatus*)
- Winter flounder (*Pseudopleuronectes americanus*)
- Eelgrass (*Zostera marina*)

Addressing Industry Needs

Researchers, Extension specialists, resource managers, industry associations and concerned



Workboat of Saltwater Farms, on the East Passage of Narragansett Bay, off Middletown. (Photo: Saltwater Farms)

Emerging Issues and Critical Needs

- Environmental impacts of aquaculture
- Disease management & quarantine issues
- Commercialization of non-traditional species
- Business management issues (i.e. costs, risk management, profitability)
- Permitting & policy issues related to multiple-use conflicts in public trust waters

stakeholders all play a role in addressing industry needs. The following sections outline new initiatives and recent accomplishments in these areas.

Aquaculture Research

The University of Rhode Island (URI) conducts aquaculture-related work at two campuses (Kingston and Narragansett Bay), and within five academic Colleges and several departments at the University. An overview of research topics is as follows:

- **Aquaculture Biotechnology** Faculty in the Department of Cell and Molecular Biology (CMB) in collaboration with Fisheries, Animal and Veterinary Sciences (FAVS) researchers have isolated protective heat shock proteins in salmon smolts, elucidated the molecular biology of growth in salmonids, and the physiology and molecular biology of several *Vibrio* species that are pathogens of a multitude of cultured species. Work is also underway to develop vaccines for the protection against bacterial infections in fish. Researchers in the Department of Biomedical Sciences in the College of Pharmacy are studying the pharmaceutical properties of biochemicals extracted from cultured algae.
- **Aquaculture Pathology** Aquaculture pathology has a long history in FAVS (one of the first fish disease laboratories in the region was established by departmental faculty.) Researchers have described a new type of *Vibrio* infection in summer flounder, characterized a Rickettsia-like infection of scallops, and described a retro-virus that induces neoplasia in soft-shell clams. Annually, URI cooperates with the Rhode Island Department of Environmental Management to survey bivalve diseases throughout the state. URI also serves the local aquaculture industry by providing diagnostic services using state-of-the-art tools in molecular

biology and genomics. For example, these tools are being used to investigate the molecular mechanisms of bivalves to parasitic infection. In collaboration with Roger Williams University (RWU), URI scientists are developing and selecting disease resistant strains of oysters for use by the local shellfish farmers.

- **Aquaculture Systems** Aquaculture in Rhode Island and the Northeast is hampered by user conflicts in the coastal zone and relatively high land and utility costs. As a result, research into aquaculture systems at URI has included improvements in water reuse and recirculation tank systems, development of transient-gear shellfish aquaculture systems, methods for nursery culturing of shellfish in small boat marinas, and the refinement and optimization of the design of floating upweller systems (FLUPSYs).
- **Bivalve Molluscan Aquaculture** URI research has focused on methods to improve shellfish production. This includes means to improve the overwintering survival of oysters and quahogs and optimizing the harvest yields of shellfish by managing stocking densities. Research has been undertaken to model shellfish growth in relation to food availability and water currents.
- **Coastal Policy and Aquaculture** URI's Coastal Resources Center (CRC) has a long-standing program to assist governments in developing countries to adopt policies to promote and manage sustainable forms of aquaculture in the coastal zone. CRC projects have included working with



Graham Brawley tending oysters on the Moonstone Oyster farm, Point Judith Pond, Rhode Island. (Photo: Moonstone Oyster Company)

local and national governments abroad to restrict the rates of mangrove deforestation for fishpond construction and to manage pond effluents. Additionally, faculty from the Department of Marine Affairs (MAF) have conducted several studies on fisheries and coastal property rights as they relate to aquaculture industry development.

- **Culture of Novel or Non-traditional Species** Faculty in FAVS and the Graduate School of Oceanography are working on culture methods for novel fish species including tautog, winter flounder, summer flounder, haddock, cod, and black sea bass. FAVS and Biological Sciences researchers have studied the culture of lobsters in an effort to remediate environmental accidents (e.g., oil spills).
- **Economics and Business of Aquaculture** Faculty in the Department of Environmental and Natural Resource Economics (ENRE) have interests in the economics of salmon and shrimp production, economics of aquaculture production systems, eco-labeling of aquaculture and other seafood products, the economics of global trade of aquaculture-based products, and the relative valuation of multiple uses of aquatic environments. URI's College of Business Administration (CBA) has been active in assisting aquaculture businesses in Rhode Island, nationally and internationally through workshops and face-to-face assistance in business planning. Recently, CBA has undertaken a project to characterize the financial structuring of aquaculture businesses throughout the Northeast.
- **Environmental Impacts of Aquaculture** Environmental science is one of the most notable institutional strengths at URI. A number of aquaculture and extension projects are involved with assessing the environmental impacts of aquaculture. Internationally, the CRC has analyzed the impacts of shrimp farming in Ecuador and Indonesia, and advised on the management of seaweed and pearl farming for greater environmental sustainability in Indonesia and Tanzania. Other projects undertaken by URI faculty include improvements in methods to minimize the environmental impacts of cage culture of groupers and finfish in the Philippines and improvement of integrated tilapia culture systems in Africa.
- **Nutrition and Feeds for Marine Species** From the 1980's to the present, Drs. David Bengtson, Terry Bradley, Jennifer Specker and, in recent years, Chong Lee have conducted research on development of the larval fish digestive tract and



Bob Rheault, Shellfish grower and East Coast Shellfish Growers Association President, demonstrates his floating up-wellers system. (Photo: Mike Rice)

processing of ingested feeds; protein sparing with lipids in diets for juvenile summer flounder and black sea bass; substitution of plant proteins for fish meal in diets for juvenile summer flounder; and use of squid hydrolysate in diets for larval and juvenile fish.

- **Salmonid Aquaculture** Research on the culture of salmonids has a long history at URI. Recent research projects involving salmonids have focused on the characterization of the physiology of smoltification or the changes that occur to the anadromous fish as they adapt to salt water. Much of this research has been dedicated to characterizing various indicators of the timing of the onset of smoltification and the characterization of control systems involved in the smoltification process.
- **Sociology and Anthropology of Fisheries and Aquaculture** The sociology and anthropology of aquaculture communities is another internationally recognized research area at URI. Projects have involved the study of the social factors leading to success of international development projects, including aquaculture, and the study of social factors in communities in transition from a predominantly capture fishery economy to an aquaculture-based economy.

The National Marine Fisheries Service (NMFS) Narragansett Facility focuses on reproductive biology and artificial propagation of marine finfish species of the North Atlantic. Currently, scientists at the Narragansett Laboratory are developing methods for the intensive culture of cod and haddock and conducting research to fill critical voids in our knowledge of their early life history. Both Atlantic cod and haddock broodstock are maintained at the Narragansett Laboratory. Methods are under



Dr. Dale Leavitt and student Eric Payne of Roger Williams University placing oysters in Jenny's Creek Estuary, Prudence Island (Photo: Karin Tammi)

investigation to produce high quality embryos, larvae and juveniles through out the year. Swimming behavior, activity, feeding, digestion and metabolism (oxygen consumption) are examined as they relate to development, growth, and prey availability. The effects of the physical environment (temperature and turbulence) are considered. Results will be integrated into individual-based, bioenergetic models of growth and survival. This facility, with its two large seawater tanks and extensive seawater systems, has allowed the scientists at Narragansett to spawn and rear over a dozen different species of marine fish, many for the first time in captivity.

Roger Williams University supports academic research, technology transfer and outreach that promote the aquaculture industry within Rhode Island and the northeast region. The university accomplishes this by providing: 1) release time for full-time faculty to permit research, 2) institutional funds to allow faculty and students to travel and network with other aquaculture researchers at national and international meetings, 3) facilities for workshops, courses and meetings for local and regional aquaculture outreach, and 4) administrative support and grants management from the university. The range of projects is broad, with species diversity from fresh to salt water and from local to tropical in nature. The current RWU aquaculture permits allow the culture of 35 shellfish species and 60 fish species, and production systems include both flow-through and recirculating on scales ranging from tanks to ponds. RWU maintains a number of field sites that include floating upwellers for shellfish culture at local marinas, and several experimental aquaculture lease sites throughout Narragansett Bay. A brief description of the major research projects currently underway or recently concluded are:

- **Public Benefit Aquaculture** In collaboration with local commercial shellfishermen, the ongoing research program rears clam and oyster seed at RWU and releases seed into the bay for subsequent harvest. Over 15 million seed have been planted since the inception of this project, and RWU staff are assessing the economic viability of this form of shellfish enhancement. Should this concept work in Narragansett Bay, the intent is to develop it as a resource management tool to enhance the recreational and commercial harvest of shellfish.
- **Culture of alternative species** Shellfish farms in Rhode Island grow two species commercially, the oyster (*Crassostrea virginica*) and the quahog (*Mercenaria mercenaria*). To expand the opportunities for shellfish growers, RWU faculty and staff are developing methods for farming alternate shellfish species. RWU is investigating the potential of the razor clam, the surf clam and the bay scallop as additional species for local cultivation.
- **Converting non-profitable cranberry bogs to fish production** Cranberry farming in the region has faltered because of competition and overproduction. RWU is working with local farmers to incorporate fish farming as an alternate cash crop for the cranberry grower. This involves modifying an existing cranberry bog into a fish farm to demonstrate crop diversification. The fish farm is entering into its third year of operation and is transitioning to a commercial enterprise.
- **Generating native strains of disease resistant oysters and oyster restoration in Narragansett Bay** Oyster farming is the largest aquaculture business in Rhode Island, and oyster diseases are a significant risk for local oyster farmers as well as wild harvesters. RWU staff are working with



Roger Williams University Student Maura Flynn holding bay scallop seed. (Photo: Karin Tammi)

disease specialists at URI and Rutgers University to breed selected disease resistant lines of oysters using native oyster stocks. Disease resistant Rhode Island oysters have been produced by the RWU Shellfish Hatchery for restoration in the bay and for use by commercial oyster farmers.

- **Hydroponics** Effluent management is an important component of fish farming. An effective strategy to manage effluent is to use fish waste effluent as a nutrient source for growing commercially important plants. RWU maintains several active recirculating hydroponic systems to test the effectiveness of this concept.
- **Developing a tropical fish hatchery for the ornamental aquarium trade** The market for ornamental marine fish in the Northeast is large, however a major bottleneck to supplying this market is the cost and risk of shipping tropical fish from farms in the south. RWU is testing the economic feasibility of operating a commercial ornamental fish hatchery in Rhode Island. Current efforts are focused on rearing the clownfish, sea horse and ornamental shrimp.

Aquaculture Extension

In the traditions of both Land Grant and Sea Grant, the University of Rhode Island manages extension program in aquaculture that has maintained strong ties with the Northeastern Regional Aquaculture Center since the Center's inception. Through the Rhode Island Aquaculture Initiative (RIAI), a federally funded program jointly administered by Roger Williams University, Rhode Island Sea Grant and the Rhode Island Coastal Resources Management Council (CRMC), URI has joined with RWU to expand aquaculture extension programming to Rhode Island's East Bay. Aquaculture extension programming at URI over the years has included assisting the aquaculture industry to organize into the Ocean State Aquaculture Association (OSAA), providing topical aquaculture classes for fishers, offering gear workshops, business workshops, and instituting and hosting Rhode Island's Annual Aquaculture Conferences and in cooperation with the Northeastern Aquaculture Extension Community assisting in the organization and implementation of the biennial Northeastern Aquaculture Conference and Exposition (NACE).

Aquaculture Education

Rhode Island has a rather modest involvement in aquaculture education in the secondary schools. In the past 10 years, individual teachers on their own initiative have taken on aquaculture as part of marine



The Blount Aquaculture Research Laboratory opened in 2005 at the University of Rhode Island Narragansett Bay Campus. (Photo: Michael Rice)

studies curricula. Two notable cases include the inclusion of aquaculture of shellfish as part of the Marine Technology curriculum at South Kingstown High School, and for several years in the late 1980s to early 2000s, an aquaculture curriculum at the Davies Technical High School and Career Center in Lincoln, RI offered instruction in methods of tank culture of freshwater finfish. Both of these programs have been discontinued due to lack sustained instructor interest.

At the post-secondary education level, Rhode Island has two Universities involved in aquaculture education, the University of Rhode Island (URI) and Roger Williams University (RWU). The aquaculture program at the University of Rhode Island, begun in 1969 and administered by the Department of Fisheries, Animal and Veterinary Sciences (FAVS), is one of the oldest aquaculture programs in the northeastern United States. The Aquaculture Program offers a degree program at the undergraduate level (B.S. in Aquaculture and Fisheries Technology) as well as opportunities to study at the graduate level in or M.S. in Fisheries and Aquaculture program or our Ph.D. program in Environmental Sciences with an aquaculture emphasis. Students in the programs at URI have come from throughout the United States and from many foreign countries. Faculty in the department have research interests in culture of salmonids, culture of marine finfish and marine finfish larviculture, DNA vaccines, culture of bivalve mollusks, recirculation aquaculture systems, development of new aquaculture species, and environmental impacts of aquaculture among many others. The educational program in aquaculture at RWU is part of their bachelor's degree program in Marine Biology. Excellent experiential learning opportunities in aquaculture at RWU are

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Terence Bradley	University of Rhode Island (401) 874-5404 tbradley@uri.edu	physiology of salmonids; marine finfish aquaculture
Lawrence Buckley	National Marine Fisheries Service, Narragansett Lab (401) 782-3200 Larry.Buckley@noaa.gov	aquaculture of cod, haddock and other marine finfish species
Kathleen M. Castro	University of Rhode Island, Rhode Island Sea Grant (401) 874-5063 kcastro@uri.edu	lobster propagation & stock restoration
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enhanced its seaside location and its state-of-the-art aquaculture teaching laboratories housed in the Marine and Natural Sciences (MNS) building that was opened in 1997 and a recently acquired oyster farm site at Jenny's Creek on Prudence Island. Student research projects at RWU have included culture of oysters and other bivalves, as well as spawning and culturing of valuable marine aquarium species.

Aquaculture Resources

State of Rhode Island Annual Aquaculture Report

<http://www.crmc.ri.gov/pubs/index.html>

Coastal Resources Management Council

Aquaculture permitting and policy information

<http://www.crmc.ri.gov/>

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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