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AQUACULTURE SITUATION AND OUTLOOK REPORT 2009: 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 \$1,587,857 (farm gate value) in 2007. The eastern oyster is the number one product in terms of production and value over 2.5 million pieces sold, representing 99% of the farm gate value total. There are 28 companies cultivating shellfish in Rhode Island (2007) with 123 acres under lease. The majority of the shellfish industry relies on purchase of hatchery seedstock, but there is some wild spat collection. A new business opened in Rhode Island in 2008, New England Marine Ornamentals (Warren, Rhode Island), that is cultivating a variety of fish for wholesale aquarium sales in the region. They are currently

marketing Ocellaris clown fish, sea horses (*Hippocampus erectus*), dottybacks (*Pseudochromis* sp.), and assorted other marine ornamentals. 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 and bay scallops. The State Aquaculture Coordinator has, since 1995, produced an annual Rhode Island aquaculture report, containing detailed information about Rhode Island's aquaculture production.

Commercial Species List

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



The *Shellfish for You* company, producers of the trademarked Watch Hill Oysters, operates from a 6 acre lease in Winnepaug Pond, near Misquamicut, Westerly Rhode Island. (Photo: Michael A. Rice)

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
- Water quality in the urban coastal zone

Addressing Industry Needs

Researchers, extension specialists, resource managers, industry associations, and concerned 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 examined 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.

In addition, 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 FAVS 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 bivalve susceptibility 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 U.S. 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) for shellfish.

Bivalve Molluscan Aquaculture URI research has focused on methods to improve shellfish production. This includes improving 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, and to model the 'carrying capacity' of shellfish aquaculture in Rhode Island waters.

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, cobia, 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



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

planning. Recently, CBA has undertaken a project to characterize the financial structuring of aquaculture businesses throughout the Northeast.

Nutrition and Feeds for Marine Species From the 1980s to the present, fish nutrition research has been conducted at URI including the following topics: development of the larval fish digestive tract and 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 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.

Finfish Aquaculture 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 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 (RWU) supports academic research, technology transfer, and outreach that promotes 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, this 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 be effective 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 northern 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.

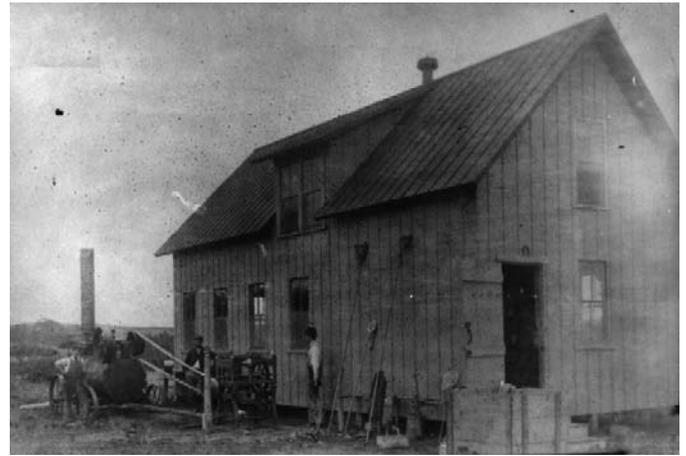
Generating native strains of disease resistant oysters and oyster restoration in Narragansett Bay Oyster farming is the largest aquaculture business in Rhode Island, and oyster diseases are a significant risk for local oyster farmers as well as wild harvesters. RWU staff are working with disease specialists 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.

Collaborative research in rearing marine ornamental species RWU has entered into a Memorandum of Understanding with the New England Aquarium to establish a Minor degree in Aquarium Science and Aquaculture and to enhance the Aquarium's capacity to rear marine species that routinely breed in the display tanks. As a part of this agreement, the two institutions share a faculty position for a fish culturist and Dr. Andy Rhyne took the position in September 2008. Dr. Rhyne is currently working on improved live feed culture, culture of triggerfish and other marine species, and systematics of a wide range of ornamental shrimps.

Center for Aquatic Animal Health As a part of the newly constructed shellfish hatchery at RWU, the Center for Aquatic Animal Health and has hired Dr. Roxanna Smolowitz to direct its development. In order to meet a need for expanded aquatic animal health services, the Center will be available for routine diagnostic work and aquatic animal health certification, emergency assistance, and research on aquatic animal health issues.

Aquaculture Extension

In the traditions of both Land Grant and Sea Grant, the University of Rhode Island, along with Roger Williams University, manages extension programs in aquaculture that have 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



The first marine laboratory in Rhode Island was the Agricultural Experiment Station Marine Lab established by Dr. George E. Field in 1897 in the village of Jerusalem on Point Judith Pond to investigate the reasons for oyster mortalities on farms in the pond. Scientific recommendations by Dr. Field led to the state's creation of a permanent breachway into the pond beginning in 1901. (Photo: University of Rhode Island Special Collections)

aquaculture extension programming to Rhode Island's East Bay. Aquaculture extension programming at URI and RWU over the years has included assisting the aquaculture industry in organizing 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 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, Rhode Island 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 and Roger Williams University. The aquaculture program at the

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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 the M.S. in Fisheries and Aquaculture program, or the 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 molluscs, 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 the bachelor's degree program in Marine Biology and has recently expanded to include a Minor degree in Aquarium Science and Aquaculture. Excellent experiential learning opportunities in aquaculture at RWU are enhanced by its seaside location and state-of-the-art aquaculture teaching laboratories. These are housed in the Marine and Natural Sciences (MNS) building, which was opened in 1997, as well as 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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