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## AQUACULTURE SITUATION AND OUTLOOK REPORT 2009: CONNECTICUT

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### Industry Trends and Outlook

Shellfish production currently represents the largest segment of the aquatic farming industry in Connecticut. In fact, the state's largest farms are underwater and encompass greater than 77,000 acres of leased and franchised shellfish grounds managed by the State Department of Agriculture. Connecticut is a major producer of shellfish, including the eastern oyster (*Crassostrea virginica*) and the northern quahog (*Mercenaria mercenaria*). The combined value of aquaculture and fisheries production is greater than \$25 million dollars.

While traditional bottom cultivation of shellfish is still the predominant form of aquaculture in Long Island Sound, the use of submerged and floating aquaculture gear (e.g. bags, cages, upwellers, long lines and predator netting) and hatchery equipment has become increasingly popular.

Municipal shellfish commissions manage local shellfisheries resources, as well as recreational and commercial shellfishing. A number of commissions cultivate or stock shellfish for fisheries enhancement or restoration purposes.

The freshwater finfish industry grows mainly trout and baitfish, and contributes a small percentage of total State aquaculture revenues. Finfish are cultivated mainly for stocking in "Hunt Club" ponds and for bait use. The Department of Environmental Protection operates two trout hatcheries for stock enhancement, and the State also has a federally managed salmon culture facility.



Floating and submerged aquaculture gear are becoming more popular in near-shore areas, but still account for only a small percentage of production. (Photo: Tessa Getchis)

Ornamental fish culture, including fishes and invertebrates such as coral and shrimp, is very popular in Connecticut, though total production is unknown as the majority of producers are hobbyists. Both the Mystic Aquarium and Maritime Aquarium in Norwalk rely on ornamental culture rather than relying on unsustainable harvest of wild marine organisms.

### 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 the new initiatives and recent accomplishments in these areas.

## Emerging Issues and Critical Needs

The following issues were identified through the 2009 Connecticut Sea Grant's Stakeholder Needs Assessment. Survey participants were asked what they considered to be the most pressing issues and critical needs with respect to aquaculture in Long Island Sound. Multiple answers were allowed. There were 39 (response rate 42%) respondents who identified themselves as aquaculturists or municipal/state managers of aquaculture.

- Improve efficiency for aquaculture licensing
- Address water quality problems that effect aquaculture operations, improve monitoring on local scale
- Improve public perception of aquaculture and balance with competing uses
- Provide access to disease-resistant oyster seed and further disease research
- Investigate effects of aquaculture on the environment; improve sustainability
- Provide education on aquaculture techniques including restoration
- Improve government/non-government agency promotion of aquaculture
- Address invasive species impacting aquaculture operations
- Provide education on aquaculture regulations
- Improve cost competitiveness and improve economic climate
- Research early life history requirements for candidate aquaculture species
- Increase funding opportunities

## Commercial Species List

- Eastern oyster (*Crassostrea virginica*)
- Northern quahog (*Mercenaria mercenaria*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Brown trout (*Salmo trutta*)
- Brook trout (*Salvelinus fontinalis*)
- Golden trout (*Oncorhynchus aguabonita*)
- Largemouth bass (*Micropterus salmoides*)
- Bluegill sunfish (*Lepomis macrochirus*)
- Brown bullhead (*Ameiurus nebulosus*)
- Black crappie (*Pomoxis nigromaculatus*)
- Yellow perch (*Perca flavescens*)
- Pumpkinseed (*Lepomis gibbosus*)
- Fathead minnow (*Pimephales promelas*)
- Golden shiner (*Notemigonus crysoleucas*)
- Grass carp (*Ctenopharyngodon idella*)

## Aquaculture Research

The University of Connecticut (UConn) is the Land Grant and Sea Grant Institution for the State of Connecticut. Aquaculture research is conducted within various departments within the Colleges of Agriculture and Resource Economics, and Liberal Arts and Sciences. In addition, many other institutions such as the Connecticut State University (CSU) system campuses, Wesleyan University, the Maritime Aquarium at Norwalk are involved in aquaculture or related fields. The following projects are in progress:

**Development of an integrated recirculating aquaculture system for nutrient bioremediation in urban aquaculture** The objectives of the project are to: 1) demonstrate the performance of a continuously operating, integrated recirculating aquaculture system, from which finfish and marine plant biomass can be harvested; 2) demonstrate that acceptable water quality can be maintained and that effluent nutrient levels are well below guidelines being developed by the Environmental Protection Agency (EPA); 3) compare four candidate native species of *Porphyra* to act as biofilters and as crops; and 4) examine nutrient dose-response relationships to determine the maximum finfish biomass that can be maintained for a given marine plant biomass (and biofilter area).

**Print and Web Publication on Shellfish Aquaculture Permitting for the NOAA Aquaculture Program** The permitting process has been identified by producers and resource managers as the primary constraint to the development of the marine aquaculture industry. These stakeholders often acknowledge a lack of understanding of the application, review and/or



'Natural growers' harvest oyster seed from natural beds and then sell it to private cultivators who plant shellfish on leased beds in Long Island Sound. (Photo: Nancy Follini)



Northern quahogs (*Mercenaria mercenaria*) are an important recreational and commercial product in Connecticut. (Photo: Tessa Getchis)

approval process. One of the primary regulatory constraints with respect to permitting is the potential for shellfish aquaculture to impact living marine resources and their habitats. NOAA NMFS has trust responsibility over living marine resources and their habitats, including estuaries and bays where various forms of shellfish are commercially grown. Recent regulatory actions have increased NMFS' role in the oversight of most commercial shellfish activities. In light of increased regulatory involvement in these activities, NMFS and other stakeholders recognize the need to solidify and clarify the science of shellfish and the environment. The purpose of following projects is: to familiarize producers and resource managers with the aquaculture permitting process and available guidance documents, applicable agency policies and laws in their respective states and assist stakeholders in assessing and managing environmental risks associated with shellfish aquaculture. This should result in an improvement in knowledge about the process, aiding in the review of aquaculture applications and thus a reduction in the time required for producers to acquire aquaculture permits.

**Biofouling tunicates on aquaculture gear as potential vectors of harmful algal introductions** A previous study demonstrated that movement of bivalve mollusks for management or aquaculture purposes presents a risk that harmful algae may be introduced into receiving waters. The purpose of the current study is to determine the risk of transporting and introducing harmful algal cells and/or cysts originating from shellfish aquaculture facilities and gear via movement of gear and/or disposal of biofouling material; and to evaluate mechanisms to minimize these risks and facilitate bloom prevention through best management practices (BMPs) and prevention.

**Shellfish Aquaculture and the Environment – The Book** This project will result in the production of a book entitled, “Shellfish Aquaculture and the Environment” to be published by an internationally recognized science publisher (Wiley-Blackwell) and authored by recognized experts in their individual fields. In addition, an executive summary/outreach booklet (a summary of the book) will be produced for distribution to policy makers, legislators and user-groups such as municipal, state and federal resource managers. This book and the outreach publication will be of use to natural resource managers, policy makers, shellfish biologists, aquaculturists, watermen, and processors, and will provide them with the most current data available to assist in siting new and existing aquaculture operations, habitat management, and potentially restoration. It will also provide baseline information to aid in the development and evaluation of best management practices, which is critical to responsible environmental stewardship.

**Assessment of Environmental Impacts of Oyster Aquaculture in New England Waters** The intent of this project is to examine the interactions of oyster farms and the environment including such changes in water and sediment quality parameters and biodiversity. This study will lead to the development of guidelines for farm siting issues and carrying capacity. The project will utilize an aquaculture GIS format (STEM-GIS) to disseminate results from dissimilar sites in Maine and Connecticut.

**Recovering the Economic Viability of the Connecticut Oyster Fishery: A Research and Education Collaboration** The Center for Coastal and Marine Studies at Southern Connecticut State University (SCSU) is coordinating a study to examine the changes occurring in LIS which may affect the reestablishment and long-term viability of the Connecticut oyster industry. The collaborative project is designed to: (1) conduct a multidisciplinary laboratory and field-based research program drawing upon the expertise of CSU faculty, Wesleyan University faculty, and community stakeholders to address issues of concern regarding the health and recovery of the Connecticut oyster industry; (2) create sustainable education, research and outreach projects at the participating CSU campuses, the Sound School, and the Maritime Aquarium at Norwalk; and (3) produce data and analyses that will contribute to the foundation for a recovery plan for the Connecticut oyster fishery.

The Connecticut Department of Agriculture, Bureau of Aquaculture (DA/BA) is the lead State agency responsible for commercial shellfisheries and aquaculture. The Bureau of Aquaculture and



Bay scallops are cultured at the National Marine Fisheries Service Laboratory in Milford. Bay scallops are utilized for restoration and fishery enhancement projects. (Photo: Tessa Getchis)

Laboratory administers the following programs: shellfish sanitation, laboratory diagnostic services, shellfish habitat management and restoration, and aquaculture development and coordination. The following research and monitoring projects are in progress:

**Oyster disease monitoring** Sampling sites are monitored each fall for the presence of pathogens and histopathological changes in oysters (*Crassostrea virginica*). Prevalence of viral gametocyte hypertrophy, Rickettsia, *Roseovarius crassostrea* (JOD), *Haplosporidium nelsoni* (MSX), *H. costale* (SSO), *Perkinsus marinus* (Dermo), *Nematopsis ostrearum*, ciliates, trematodes, and pea crabs are recorded, as well as histopathological changes such as inflammatory responses, degenerations, cell and tissue death, growth derangements, hemodynamic and fluid derangements, and neoplasia. Oyster sets are recorded as well.

**Disease-resistant oysters** Disease resistant oysters (*Crassostrea virginica*) have been produced by selective breeding since the MSX epizootic of 1997. Seed from potentially disease-resistant broodstocks are tested for growth, mortality, yield, MSX, SSO, Dermo and JOD at Cedar Island Marina in Clinton. This year oysters will be grown and tested for pathogens in a common garden experiment as part of a collaborative study with scientists from Maine, Massachusetts, Rhode Island and New Jersey.

**Epizootic branchial adenocarcinoma in oysters** A collaborative study with Stony Brook University describes lesions in Long Island Sound oysters using light and electron microscopy.

**Enteric adenocarcinoma in oysters** A collaborative study with the EPA Narragansett laboratory describes

lesions found at low prevalence in Long Island Sound oysters. The study includes a twelve-year sampling period in Connecticut and archived slides from EPA.

**Apoptosis of *Perkinsus marinus* cells in oysters** This collaborative project with the Maryland Department of Natural Resources uses electron microscopy and *in situ* hybridization to study apoptosis, a type of cell death in cultured *P. marinus* (Dermo).

**Alternative host for MSX** A collaborative study with Connecticut Agricultural Experiment Station tries to identify a vector, of alternative host, for MSX transmission by molecular methods.

**Clam disease monitoring** Samples of northern quahogs (*Mercenaria mercenaria*) are collected each spring for pathological assessment. Prevalences of infectious agents such as QPX and *Chlamydia*, and histopathological changes are recorded.

**Viruses in soft shell clams *Mya arenaria*** A collaborative study with Connecticut Agricultural Experiment Station to identify viruses occurring in association with branchial papillomas in soft shell clams by molecular methods.

**Microsporidia in mussels** A collaborative study with Connecticut Agricultural Experiment Station to study molecular phylogeny of *Steinhausii mytilovum*, a parasite of mussel eggs.

The National Marine Fisheries Service (NMFS) Milford Laboratory conducts research on the aquaculture of marine shellfish and finfish that are economically important in coastal areas of the Northeast region; in addition, related studies are conducted to determine how habitats function as nurseries for young fish and shellfish that might be used in stock enhancement projects. The following are some of the major projects at the laboratory:

#### **Shellfish cultivation effects on habitat**

A cooperative research project with the East Coast Shellfish Growers Association, their Research Institute, and commercial shellfish growers is investigating interactions between shellfish cultivation and habitat. In reviewing topical literature, researchers have assembled over 300 relevant papers and are preparing a synthesis document. A field experiment is in progress to compare benthic biodiversity, abundance of macrofauna, and sediment biogeochemistry in areas where oysters or clams have been harvested, as well as in unharvested control areas. The study is focused on measuring ecological recovery over the course of cultivation cycles. Farming shellfish involves initial seabed disturbance, however bivalves can also offer beneficial ecological services as they grow.



The National Marine Fisheries Service is collaborating with shellfishermen to investigate the impacts of dredging and other cultivation practices on the environment. (Photo: Nancy Follini)

**Cultivation methods for the rearing of finfish and shellfish to market size** These methods are being developed using various technologies, including flow-through systems and recirculating seawater systems. Current experimental studies are directed at studying the nutritional aspects of various feeds on the growth of finfish. The particular species of interest at this time include the bay scallop, black sea bass and scup. Along with these studies, strategies to reintroduce hatchery-produced finfish and shellfish into the natural environment are being evaluated.

**Technological tools to better understand and manage marine aquaculture methods and practices** Specific areas of application include marine livestock health management and disease diagnosis and treatment (including effects of harmful microalgae and biotoxins); selective breeding of shellfish for desired traits; and production and effective use of microalgal feeds for shellfish and for invertebrate animals fed to cultured larval finfish. Directed experimental studies are conducted to develop and evaluate technologies, methods, and tools, which are tested in practice.

**Milford Aquaculture Seminar** This annual event, hosted by the NMFS Milford Laboratory includes sessions on disease and physiology, microalgae, regulation, and collaboration with academic, state, federal, and high school institutions with ideas that contribute to shellfish industry success. Aquaculture innovation and sharing research information continue as goals of this annual meeting.

## Aquaculture Extension

Connecticut has three full-time Extension faculty within the Sea Grant and/or Cooperative Extension Programs who are dedicated all or in part to programs in fisheries and aquaculture. These include finfish and

shellfish aquaculture specialists, a resource economist, and a seafood safety specialist. These specialists, based at several campuses within the University of Connecticut, have statewide responsibilities. In addition to those with formal extension appointments, individuals from resource protection agencies and non-profit organizations partner to provide outreach assistance in the area of aquaculture. The following is a summary of the major outreach projects:

**Online Resource Guide for Aquaculture in Connecticut** Connecticut Sea Grant has developed a comprehensive online aquaculture resource guide for stakeholders in Connecticut available at <http://www.seagrant.uconn.edu/aquaguide>. The guide includes practical information on aquaculture production, business development and seafood production tools, educational resources, journals and trade magazines, an event calendar, and contact information for extension, education and research specialists, as well as industry associations and private and government assistance agencies.

**The Dredge Newsletter** In an effort to enhance communication among stakeholders, the Connecticut Sea Grant Extension Program, the Connecticut Department of Agriculture and the National Marine Fisheries Service Milford Laboratory, have contributed to the development of a shellfisheries newsletter "The Dredge." The Dredge can be viewed or downloaded at: <http://web2.uconn.edu/seagrant/whatwedo/aquaculture/dredge/index.php>.

**Partnering to Streamline the Permitting Process for Aquaculture** The practice of shellfish aquaculture in Connecticut has begun a shift from traditional bottom culture to the use of surface and submerged gear.



The Quinebaug Trout Hatchery, located in eastern Connecticut, is a state-managed trout hatchery. The hatchery produces rainbow, brook, brown, and tiger trout. (Photo: Tessa Getchis)

However, the implementation of this gear along the highly urbanized coast of Long Island Sound has raised concerns about navigational hazards, use conflicts and environmental effects. Consequently, permitting has become complex and challenging to the producer and resource managers. To address this problem, a workgroup was formed; tasked with streamlining the process, producing educational resources on the process for producers and other stakeholder groups, and addressing concerns about the effects of shellfish and shellfish aquaculture on the environment in Connecticut.

**Hazard Analysis and Critical Control Points Program** HACCP is a food safety management program that first identifies and evaluates the risk of biological, chemical, or physical food safety hazards that may be associated with a particular species of fish or seafood product. The Connecticut and Rhode Island Sea Grant programs serve the seafood industry by jointly offering seafood HACCP training courses two to four times a year. Since 1997, we have trained more than 600 seafood processors, dealers, importers, and state and federal regulators in the principles and application of HACCP to seafood processing.

**Increasing producer eligibility for USDA farmer assistance programs** Following a nationwide survey, it was determined that many shellfish aquaculture producers were ineligible for USDA farmer assistance programs such as non-insured crop disaster assistance, crop insurance, loans, grants or incentive programs. Extension is leading an effort, in collaboration with state and federal officials, to increase the eligibility of producers for these programs by revising eligibility requirements.



Noank Aquaculture Cooperative members operate a shellfish hatchery and maintain several growout operations in eastern Long Island Sound. (Photo: Tessa Getchis)

**Seafood At Its Best** Connecticut Sea Grant Extension Program has adopted and will begin offering the "Seafood At Its Best" program, a nationally reviewed curriculum developed at the University of Idaho. "Seafood At Its Best" is designed to encourage the public to eat more seafood through a four-lesson curriculum focused on the health benefits of eating seafood, potential health risks of eating seafood, and how to select, purchase, handle, and cook seafood. The target audience includes family and consumer science educators, nutritionists, dietitians, food service personnel, and nutritional outreach professionals.

**Municipal shellfish commission assistance** Shellfisheries and aquaculture in town waters are managed by municipal shellfish and harbor management commissions in Connecticut. Commission members are volunteers appointed by town leaders. There is an ongoing need for training and the provision of educational resources to this user group. To this end, Extension has formed a partnership with municipal shellfish and harbor management commissions statewide and has established several avenues for communication within and among the commissions. Extension hosts an annual gathering and SHELLCOMM, a list-serve for these stakeholders. In addition, Extension staff provide Geospatial Information Systems (GIS) training to municipal officials allowing them to better plan for aquaculture activity in town waters.

## Aquaculture Education

In addition to commercial and community-based aquaculture, several of the State's Regional Vocational Agriculture Schools and specialized marine and aquaculture high schools participate in husbandry projects and restocking efforts in cooperation with producers and state agencies. The Bridgeport Regional Vocational Aquaculture High School and the Sound School in New Haven offer a formal aquaculture curriculum, while many other schools offer aquaculture courses and special projects to their students.

At the undergraduate level, the University of New Haven offers a minor in aquaculture business management and the University of Connecticut offers a minor in aquaculture biology.

**Development of a General Permit for Aquaculture** The creation of this general permit stems from an assessment and strategy of Connecticut's Coastal Management Program with regard to the nine areas of potential enhancement identified by the Federal Coastal Zone Management Act. Aquaculture was identified as an important industry in the State and the industry faces

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<b>Thomas Chen</b>	University of Connecticut Department of Molecular & Cell Biology (860) 486-5481 <a href="mailto:thomas.chen@uconn.edu">thomas.chen@uconn.edu</a>	structure, evolution and regulation of growth hormone and growth factor genes in finfish and shellfish
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<b>Kumar Venkitanarayanan</b>	University of Connecticut Department of Animal Science (860) 486-0947 <a href="mailto:kumar.venkitanarayanan@uconn.edu">kumar.venkitanarayanan@uconn.edu</a>	inactivation of pathogenic microorganisms in foods using antimicrobials; development of molecular methods for rapid detection of food-borne microorganisms
<b>Jason Vokoun</b>	University of Connecticut Department of Natural Resource Management and Engineering (860) 486-0141 <a href="mailto:jason.vokoun@uconn.edu">jason.vokoun@uconn.edu</a>	kernel estimation of fish space and habitat use; conservation of fish habitat in stream ecosystems; fish species of special conservation concern

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a number of emerging issues as it expands. Statutory changes have underlined the need to develop new administrative mechanisms to coordinate coastal management concerns with other federal and state agency processes. As such, the General Permit would allow certain aquaculture activities including the placement of cultch and “typical” off-bottom aquaculture structures that would pose little environmental impact or use conflicts. This application review process would be less extensive than that for a General Programmatic Permit, hopefully resulting in a time savings for growers.

## **Aquaculture Resources**

### **Guide to Permitting Marine Aquaculture and Shellfisheries in Connecticut**

<http://web2.uconn.edu/seagrant/publications/aquaculture/permitguide.pdf>

### **Guidelines for Utilizing Aquatic Organisms for Scientific/Educational Purposes in Connecticut:**

<http://web2.uconn.edu/seagrant/publications/aquaculture/aquause.pdf>

### **DEP Brief Guide to the Marine Aquaculture Permitting Process**

[http://www.ct.gov/dep/lib/dep/long\\_island\\_sound/coastal\\_management/aquaculture\\_brochure.pdf](http://www.ct.gov/dep/lib/dep/long_island_sound/coastal_management/aquaculture_brochure.pdf)

### **Department of Agriculture, Bureau of Aquaculture** Leasing information for Connecticut aquaculture operations, education and research projects

<http://www.ct.gov/doag>

### **AQUAGUIDE—Online Resource Guide**

Online resource guide for Connecticut producers, researchers, resource managers, municipal commissions, teachers, students, etc.  
<http://web2.uconn.edu/seagrant/whatwedo/aquaculture/index.php>

### **AQUACONN—Aquaculture Producer ListServ**

Connecticut aquaculture producers may subscribe to the listserv by contacting [tessa.getchis@uconn.edu](mailto:tessa.getchis@uconn.edu)  
Post to: [AQUACONN-L@listserv.uconn.edu](mailto:AQUACONN-L@listserv.uconn.edu)

### **SHELLCOMM—Shellfish Commission ListServ**

Shellfish and Harbor Management Commission members statewide may subscribe to the listserv by

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### **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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