



University of Maryland, 2113 Animal Science Building
 College Park, Maryland 20742-2317
 Telephone: 301-405-6085, FAX: 301-314-9412
 E-mail: nrac@umd.edu Web: <http://www.nrac.umd.edu>

AQUACULTURE SITUATION AND OUTLOOK REPORT 2007: DELAWARE

Dennis McIntosh, Delaware State University
John Ewart, Delaware Sea Grant Program, University of Delaware

Industry Trends and Outlook

Aquaculture production in Delaware is limited in terms of commercial producers. There are a handful of individuals involved with the industry to varying degrees. The largest single producer in the state (Blessing Aquaculture Farm in Houston) is growing tilapia for the live market and currently there is only one farm in production in this sector. Another established company (Delmarva Aquatics in Smyrna) specializes in the production of eggs, fry and fingerlings of hybrid and straight striped bass and yellow perch, and distributes a variety of other culture and wild finfish species. In addition to this operation, there are individuals involved with smaller scale production/distribution of various pond stocking species, American eel capture/hold/live-haul and crab peeling (shedding) operations. Delaware currently has no commercial shellfish or marine aquaculture, but oyster and hard clam aquaculture is part of a shellfish research, restoration and demonstration program being conducted by the Delaware Center for the Inland bays (CIB) with technical assistance from the Delaware Sea Grant Marine Advisory program and Delaware State University. Also, the Delaware Bay Oyster Restoration Task Force is working to revitalize the oyster population in the Delaware Bay.

Despite the small size of the current industry, interest in aquaculture as an alternative to, and diversification from, traditional agriculture production continues from both the Delaware Department of Agriculture and potential producers; however, the



The Delaware State University Aquaculture Research and Demonstration Facility in Dover. (Photo: Lori Brown)

number of serious inquiries from prospective producers remains low. Identification of suitable species that can be raised in an environmentally sustainable and economically viable way in Delaware will likely change this.

The Delaware Aquaculture Act <http://www.delcode.state.de.us/title3/c004/index.htm> enacted in 1990 designates the Delaware Department of Agriculture as the lead state agency for aquaculture development. The Department has proposed a series of regulations for aquaculture in non-tidal waters <http://www.state.de.us/research/register/april2002/proposed/5%20DE%20Reg%201864%2004-01-02.htm>

Emerging Issues and Critical Needs

- Delaware does not have a state aquaculture plan or formally adopted regulations in place for either freshwater or marine aquaculture.
- No state policy has been developed for either shellfish or finfish in tidal (marine) waters.
- Federal and state policies on containment of Viral Hemorrhagic Septicemia (VHS) affecting live transport of fish is a significant concern.

that have not been formalized. No specific regulations exist for aquaculture in tidal waters. Shellfish or finfish aquaculture in tidal waters is presently subject to governance on a case-by-case basis under existing fishery statutes and regulations by the Delaware Department of Natural Resources and Environmental Control (DNREC).

Commercial Species List

- Channel catfish (*Ictalurus punctatus*)
- Crappie (*Pomoxis* spp.)
- Koi (*Cyprinus carpio*)
- Largemouth bass (*Micropterus salmoides*)
- Smallmouth bass (*Micropterus dolomieu*)
- Striped bass (*Morone saxatilis*)
- Sunfish (*Lepomis* spp.)
- Tilapia (*Oreochromis niloticus*)
- Yellow perch (*Perca flavescens*)
- Various minnows

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.

Aquaculture Research

Delaware State University (DSU) operates an Aquaculture Research and Demonstration Facility on its campus in Dover, Delaware. The facility includes 34 ponds and a temperature and humidity controlled 14 m x 20 m wet laboratory. The lab houses five independent systems, in three configurations enabling rearing various life stages of many marine or freshwater species. Research efforts include:

- **Baitfish Aquaculture** As part of a continuing effort to foster the development of an environmentally and economically sustainable aquaculture industry in Delaware, baitfish aquaculture husbandry techniques are being developed for the saltwater baitfish, *Fundulus heteroclitus*, or mummichog.
- **Weakfish Aquaculture** Weakfish, a popular food fish, are impacted by fisheries and habitat loss in their nursery habitats in the mid-Atlantic region. The potential for captive rearing programs for weakfish warrants serious consideration, and efforts are underway. Therefore, to determine experimentally derived, baseline information on weakfish production is fundamental to captive rearing (larval rearing, weaning, growth).

The USDA Agricultural Research Service (ARS) maintains an Oyster Virology Laboratory (Microbial Food Safety Research Unit) on the DSU campus. <http://www.ars.usda.gov/SP2UserFiles/Place/19353000/PDFFiles/CRIS045.pdf>. The research program is focused on the development of molecular and biochemical detection, and intervention methods for bacterial and viral pathogens in oysters and other aquaculture products.

Research at the University of Delaware Graduate College of Marine and Earth Studies (CMES) in Lewes, Delaware includes the following:

- Development of genetic markers in eastern oyster (*Crassostrea virginica*) for breeding programs
- Mapping of disease-resistance genes for aquaculture and fisheries restoration and stock enhancement
- Applied field research and demonstration to evaluate the use of aquaculture methods for



Disease-resistant oysters are being used for stock enhancement and restoration. (Photo: John Ewart)

shellfish restoration and stock enhancement

- Oyster disease research (pathogen detection and diagnostics using PCR methods)
- Development of a governance framework for marine aquaculture in the U.S. Exclusive Economic Zone (EEZ)
- Seafood safety and post harvest treatment using high hydrostatic pressure.

Aquaculture Extension

Delaware Cooperative Extension and Delaware Sea Grant Marine Advisory Program both have aquaculture extension responsibilities in Delaware. Delaware Cooperative Extension and Sea Grant are separate, independent programs, but both specialists collaborate to provide information and other extension services to current and prospective aquaculturists, state agencies and decision makers, Agriculture Education program secondary school students, and the general public. A Seafood Technology Specialist for the Delaware Sea Grant Marine Advisory program conducts public outreach and training on Hazard Analysis and Critical Control Points (HACCP) program and seafood nutrition, preparation and safety.

Delaware State University

Over the last two years, DSU has organized aquaculture sessions for current and prospective producers at the Delaware Agriculture Week (2006 and 2007), and taken their traveling display to the East Coast Commercial Fishermen's and Aquaculture Exposition sponsored by the Maryland Watermen's Association, the Delaware State Fair and University of Delaware's Coast Day annual open house at the College of Marine and Earth Studies campus in Lewes, Delaware.

Beginning last spring, Delaware State University has partnered with the University of Maryland and West Virginia University to obtain funding through the USDA's Sustainable Agriculture Research and Education (SARE) program to demonstrate the economic and environmental benefits of integrating aquatic plant culture with aquaculture. The project seeks to provide several educational opportunities around the region via workshops, tours of integrated culture systems in all three states, and individual technical support to assist in implementation. After the first field season, DSU has developed a Web site, hosted a technology transfer session at NACE 2006 and have expanded the scope to evaluate additional plant species.



Hatchery-raised clam seed. (Photo: John Ewart)

Delaware Sea Grant Marine Advisory Program Activities

The Delaware Aquaculture Resource Center (DARC) Home page <http://darc.cms.udel.edu> is an expanding archive of links, resources and other information about aquaculture in Delaware and the Mid-Atlantic region. The Web site is a member of the DOC/NOAA Sea Grant Network of Aquaculture Information Services (NAIS). Other NAIS collaborators include the Aquaculture Network Information Center (AquaNIC), the National Sea Grant Library, DOC/NOAA Aquaculture Information Center, Maryland Sea Grant, Illinois-Indiana Sea Grant and the Mississippi-Alabama Sea Grant Consortium.

The Delaware Sea Grant Marine Advisory program has been conducting field research and demonstration work since 1998 in collaboration with the Delaware Center for the Inland Bays (CIB), a non-profit community-based organization and member of the National Estuary Program. The goal of the program is to determine how best to integrate the use of aquaculture technologies for shellfish restoration and stock enhancement into the overall management of Delaware's three coastal (known locally as "inland") bays. Other program participants include the University of Delaware College of Marine and Earth Studies, Delaware State University, Delaware Department of Natural Resources and Environmental Control (DNREC) and the regional office of the U.S. Environmental Protection Agency (EPA) in Philadelphia. Sussex County government, local municipalities such as Fenwick Island, Delaware and other community groups and volunteers are also actively involved with funding support, donations, materials, supplies, and other in-kind services.

As part of the cooperative shellfish research and demonstration effort, a pilot-scale oyster gardening project was initiated during summer 2003 to produce juvenile oysters for field restoration. Fifteen Inland Bay gardening sites were established in residential lagoon communities around the estuary and twenty-one coastal resident volunteers were trained to raise oysters in floating baskets (Taylor floats) attached to their docks. As of 2007, oyster gardening has expanded rapidly into a community-based program with 105 locations involving 150 volunteers. The program has demonstrated that environmental conditions in all areas of the estuary will support oyster growth, especially in residential lagoon systems, generally characterized by degraded water quality. Oyster gardens perform well in these marginal environments, and also provide excellent local habitat for juvenile fish and other macro-invertebrates. Volunteers and middle/secondary school students participating in the program and coastal community residents are also educated about the impacts of excess nutrient input (eutrophication) on estuarine water quality and the important ecological role of filter feeding bivalve shellfish. A Web site <http://darc.cms.udel.edu/ibog> provides additional information about the program and related shellfish research, demonstration and restoration work.

Aquaculture Education

Neither the University of Delaware nor Delaware State University offer degrees in aquaculture, although DSU's Department of Agriculture and Natural

Table 1. DSU Degree Programs

Degree	Course Title
B.S. in Fisheries / Wildlife Management (Fisheries Option)	Aquaculture Fish / Wildlife Management Ichthyology Fisheries Science Environmental/Wildlife Law Fisheries Management
M.S. in Natural Resources (Thesis)	Population Biology Ichthyology Fisheries Policy Thesis Research

Resources offers both graduate and undergraduate degrees in related subject areas (see table 1).

In addition to the formal educational opportunities listed here, the DSU Aquaculture Research and Demonstration Facility relies heavily upon students to manage and conduct the various research and demonstration projects, affording them the opportunity to learn aquaculture 'hands-on.' Similar hands-on aquaculture learning opportunities exist throughout the state at the high school level through the AgriScience education program administered by the Delaware Department of Education.

Research Contact Information

Name	Address	Specialty:
Biliana Cicin-Sain	Gerard J. Mangone Center for the Study of Marine Policy College of Marine and Earth Studies University of Delaware (302) 831-8086 bcms@udel.edu	policy framework development and governance for offshore marine aquaculture
Pat Gaffney	College of Marine and Earth Studies University of Delaware (302) 645-4364 pgaffney@udel.edu	oyster genetics and development of genetic markers for disease resistance and restoration/stock enhancement
David H. Kingsley	USDA Agricultural Research Service Eastern Regional Research Center Microbial Food Safety Research Unit (302) 857-6406 dkingsley@desu.edu	molecular & biochemical detection and intervention methods for bacterial and viral pathogens in oysters and other aquaculture products

Research Contact Information (continued)		
Name	Address	Specialty:
Adam Marsh	University of Delaware College of Marine and Earth Studies (302) 645-4367 amarsh@udel.edu	impact of Dermo on larval recruitment; characterization of the molecular response of a larva to the presence of <i>Perkinsus marinus</i> , to identify biochemical markers that may provide disease resistance
Dennis McIntosh	Delaware State University (302) 857-6456 dmcintosh@desu.edu	freshwater and marine aquaculture; water quality; integrated aquaculture/agriculture systems; aquaculture effluents; recirculation technology
Gulnihal Ozbay	Delaware State University (302) 857-6476 gozbay@desu.edu	shellfish, water quality, harmful algal blooms
Gary Richards	U. S. Department of Agriculture Agricultural Research Service Eastern Regional Research Center Microbial Food Safety Research Unit (302) 857-6419 grichard@desu.edu	molecular & biochemical detection and intervention methods for bacterial and viral pathogens in oysters and other aquaculture products
Extension Contact Information		
John Ewart	University of Delaware Delaware Sea Grant Marine Advisory Service (302) 645-4060 ewart@udel.edu	shellfish, finfish aquaculture; shellfish restoration, stock enhancement; aquatic production systems/live transport; commercial, recreational fisheries; waste/effluent management; policy; marine/estuarine water quality; technology transfer and training; Information Technologies
Doris Hicks	University of Delaware Delaware Sea Grant Marine Advisory Service (302) 645-4297 dhicks@udel.edu	seafood safety and processing, sensory evaluation, and product development
Dennis McIntosh	Delaware State University (302) 857-6456 dmcintosh@desu.edu	freshwater and marine aquaculture; water quality; integrated aquaculture/agriculture systems; aquaculture effluents; recirculation technology
Education Contact Information		
Karen Hutchison	Delaware Department of Education AgriScience Education (302) 739-4681 khutchison@doe.k12.de.us	
State Aquaculture Coordinator(s)		
Orlando Camp	Delaware Department of Agriculture (302) 698-4600 orlando.camp@state.de.us	

Aquaculture Resources

Delaware Aquaculture Resource Center (DARC)

An expanding archive of links, resources and other information about aquaculture in Delaware and the Mid-Atlantic region. <http://darc.cms.udel.edu>

Delaware Aquaculture Act (1990)

<http://www.delcode.state.de.us/title3/c004/index.htm>

Delaware Bay Oyster Restoration

<http://www.delawareestuary.org/onthegroundactivities/oysterrevitalization.asp>

Delaware Center for the Inland Bays (CIB)

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

Delaware State University Aquatic Sciences Program

<http://cars.desu.edu/aqua-sci/>

Partnership for the Delaware Estuary

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

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>

Acknowledgements

This publication was prepared with funding from the Northeastern Regional Aquaculture Center (NRAC) as part of project Number 2004-38500-14589 from the United States Department of Agriculture Cooperative States Research, Education, and Extension Service. The authors gratefully acknowledge support from NRAC and USDA CSREES.

The cooperating agencies' programs are open to all citizens without regard to race, color, gender, disability, religion, age, sexual orientation, marital or parental status, or national origin. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the U.S. Department of Agriculture, the Northeastern Regional Aquaculture Center, or the University of Maryland.

A copy of this report may be downloaded from: <http://www.nrac.umd.edu>

© 2007

