AQUACULTURE SITUATION AND OUTLOOK REPORT 2009:
DELAWARE

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Industry Trends and Outlook

Aquaculture production in Delaware is limited in terms of commercial producers, though there are a small number of individuals involved with the industry to varying degrees. The largest single producer in the State (Farmers Catch in Houston, Delaware) is growing tilapia for the live market and is currently the only farm in production in this sector. Another established company (Delmarva Aquatics in Smyrna, Delaware) specializes in the production of eggs, fry, and fingerlings of hybrid and straight striped bass and yellow perch for domestic and international markets and distributes a variety of other cultured and wild finfish species. In addition to this operation, there are individuals involved with smaller scale production and 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 Service and Delaware State University. Also, the Delaware Bay Oyster Restoration Task Force has a program to revitalize the oyster population in the Delaware Bay.

Despite the small size of the current industry there is increasing interest in aquaculture as an alternative to, and as a means of diversification from traditional agriculture production. Research and demonstration efforts with appropriate fish and shellfish species that can be raised in an environmentally sustainable and economically viable way in Delaware are facilitating this trend.

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

Commercial Species List

- Channel catfish (*Ictalurus punctatus*)
- Crappie (*Pomoxis* sp.)
- Koi (*Cyprinus carpio*)
- Largemouth bass (*Micropterus salmoides*)
- Smallmouth bass (*Micropterus dolomieu*)
- Striped bass (*Morone saxatilis*)
- Sunfish (*Lepomis* sp.)
- 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 freshwater ponds and a temperature- and humidity-controlled wet laboratory. The lab houses seven independent systems, in three configurations which enables the rearing of 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 larval rearing, weaning, and growth.

Catfish Monitoring

Catfish production continues to dominate the domestic aquaculture industry. This is not surprising as the industry is well developed and the product readily accepted in the marketplace. A project is underway to determine the prevalence of heavy metal contaminants and food borne pathogens in both domestic and imported retail catfish products.

The USDA Agricultural Research Service (ARS) maintains a Microbial Safety of Aquaculture Products Center of Excellence on the DSU campus. ([http://www.ars.usda.gov/SP2UserFiles/Place/19353000/PDFFiles/CRIS045.pdf](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.

Current or recent aquaculture research at the University of Delaware College of Earth Ocean and Environment (CEOE) 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 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 the Delaware Sea Grant Marine Advisory Service 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 policy makers, agriculture education program secondary school students, and the general public. In addition, a Seafood Technology Specialist for the Delaware Sea Grant Marine Advisory Service conducts public outreach and training on the Hazard Analysis and Critical Control Points (HACCP) program and seafood nutrition, preparation, and safety.

Through the Delaware Cooperative Extension Aquaculture Technical Assistance and Outreach Program, DSU has organized numerous aquaculture informational workshops, hands-on training and educational sessions throughout the State for current and prospective producers. The DSU traveling aquaculture display is exhibited at several annual events including the East Coast Commercial Fishermen’s and Aquaculture Exposition sponsored by the Maryland Watermen’s Association, the Delaware State Fair, Delaware Agriculture Week and the University of Delaware’s Coast Day.

Most recently, DSU implemented a hands-on workshop series, *Aquaculture 101*, to help new and prospective aquaculturists gain practical knowledge and skills needed to operate a successful aquaculture business.

In support of the catfish monitoring research efforts, a catfish production and processing demonstration project is being planned. As designed, this will include a series of educational fact sheets, a multi-year production demonstration, and the establishment of a fish processing lab at the DSU Aquaculture Research and Demonstration Facility.

The Delaware Aquaculture Resource Center (DARC) website [http://darc.cms.udel.edu](http://darc.cms.udel.edu), administered by the Delaware Sea Grant Program, is an archive of links, resources, and other information about aquaculture in Delaware and the Mid-Atlantic region.

The Delaware Sea Grant Marine Advisory Service 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 (NEP). The goal of the program is to determine how best to integrate the use of aquaculture technologies for shellfish restoration stock enhancement and commercial production into the overall management of Delaware’s three coastal bays (known locally as “inland bays”). Other program participants include the University of Delaware College of Earth, Ocean, and Environment, Delaware State University, the Delaware Department of Natural Resources and Environmental Control, and the U.S. Environmental Protection Agency (EPA) regional office in Philadelphia.

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 2009, oyster gardening has expanded rapidly into a community-based program with more than 100 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 poor circulation and degraded water quality. A recently completed DSU Master’s Thesis (2008) identified 49 species of fish and invertebrates associated with a series of Fenwick Island gardening sites.

Local support for the oyster gardening program is provided by Sussex County government and municipalities such as Fenwick Island and South...
Bethany, Delaware. Other community groups and volunteers are supporting the program through donations, materials, supplies, labor, and other in-kind services. Coastal residents participating in the program, middle/secondary school students, and other community volunteers are also educated about the impacts of excess nutrient input (eutrophication) on the Inland Bays, and estuarine water quality and the important ecological role and benefits of filter feeding bivalve shellfish. A website [http://darc.cms.udel.edu/ibog](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 offers degrees in aquaculture, although DSU’s Department of Agriculture and Natural Resources offers both graduate and undergraduate degrees in related subject areas (Table 1). In addition to the formal educational opportunities listed, the DSU Aquaculture Research and Demonstration Facility substantially relies 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. [http://www.doe.k12.de.us/infosuites/staff/ci/content_areas/agriscience.shtml](http://www.doe.k12.de.us/infosuites/staff/ci/content_areas/agriscience.shtml)

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<tr>
<td>B.S. in Fisheries/Wildlife Management (Fisheries Option)</td>
<td>Aquaculture Fish/Wildlife Management Ichthyology Fisheries Science Environmental/Wildlife Law Fisheries Management</td>
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<tr>
<td>M.S. in Natural Resources (Thesis)</td>
<td>Population Biology Ichthyology Fisheries Policy Thesis Research</td>
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Table 1. Delaware State University Degree Programs.

**Aquaculture Resources**

**Delaware Aquaculture Resource Center (DARC)**
An archive of links, resources and other information about aquaculture in Delaware and the Mid-Atlantic region. [http://darc.cms.udel.edu](http://darc.cms.udel.edu)

**Delaware Aquaculture Act (1990)**

**Delaware Bay Oyster Restoration**

**Delaware Center for the Inland Bays (CIB)**

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

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<tr>
<th>Name</th>
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<th>Specialty/Title</th>
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<tbody>
<tr>
<td>Adam Marsh</td>
<td>University of Delaware  &lt;br&gt; College of Marine and Earth Studies &lt;br&gt; (302) 645-4367 &lt;br&gt; <a href="mailto:amarsh@udel.edu">amarsh@udel.edu</a></td>
<td>impact of Dermo on larval recruitment; characterization of the molecular response of a larva to the presence of <em>Perkinsus marinus</em>, to identify biochemical markers that may provide disease resistance</td>
</tr>
<tr>
<td>Dennis McIntosh</td>
<td>Delaware State University &lt;br&gt; (302) 857-6456 &lt;br&gt; <a href="mailto:dmcintosh@desu.edu">dmcintosh@desu.edu</a></td>
<td>freshwater and marine aquaculture; water quality; integrated aquaculture/agriculture systems; aquaculture effluents; recirculation technology</td>
</tr>
<tr>
<td>Gulnihal Ozbay</td>
<td>Delaware State University &lt;br&gt; (302) 857-6476 &lt;br&gt; <a href="mailto:gozbay@desu.edu">gozbay@desu.edu</a></td>
<td>shellfish, water quality, harmful algal blooms</td>
</tr>
<tr>
<td>Gary Richards</td>
<td>U. S. Department of Agriculture  &lt;br&gt; Agricultural Research Service  &lt;br&gt; Eastern Regional Research Center  &lt;br&gt; Microbial Food Safety Research Unit &lt;br&gt; (302) 857-6419 &lt;br&gt; <a href="mailto:grichard@desu.edu">grichard@desu.edu</a></td>
<td>molecular &amp; biochemical detection and intervention methods for bacterial and viral pathogens in oysters and other aquaculture products</td>
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### Extension Contact Information

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>John Ewart</td>
<td>University of Delaware  &lt;br&gt; Delaware Sea Grant Marine Advisory Service &lt;br&gt; (302) 645-4060 &lt;br&gt; <a href="mailto:ewart@udel.edu">ewart@udel.edu</a></td>
<td>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</td>
</tr>
<tr>
<td>Doris Hicks</td>
<td>University of Delaware  &lt;br&gt; Delaware Sea Grant Marine Advisory Service &lt;br&gt; (302) 645-4297 &lt;br&gt; <a href="mailto:dhicks@udel.edu">dhicks@udel.edu</a></td>
<td>seafood safety and processing, sensory evaluation, and product development</td>
</tr>
<tr>
<td>Dennis McIntosh</td>
<td>Delaware State University &lt;br&gt; (302) 857-6456 &lt;br&gt; <a href="mailto:dmcintosh@desu.edu">dmcintosh@desu.edu</a></td>
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<th>Name</th>
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<tbody>
<tr>
<td>Karen Hutchison</td>
<td>Delaware Department of Education  &lt;br&gt; AgriScience Education &lt;br&gt; (302) 739-4681 &lt;br&gt; <a href="mailto:khutchison@doe.k12.de.us">khutchison@doe.k12.de.us</a></td>
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### State Aquaculture Coordinator

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>John Ewart (acting)</td>
<td>University of Delaware  &lt;br&gt; Delaware Sea Grant Marine Advisory Service &lt;br&gt; (302) 645-4060 &lt;br&gt; <a href="mailto:ewart@udel.edu">ewart@udel.edu</a></td>
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</table>
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

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

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